

Jan. 29, 1952

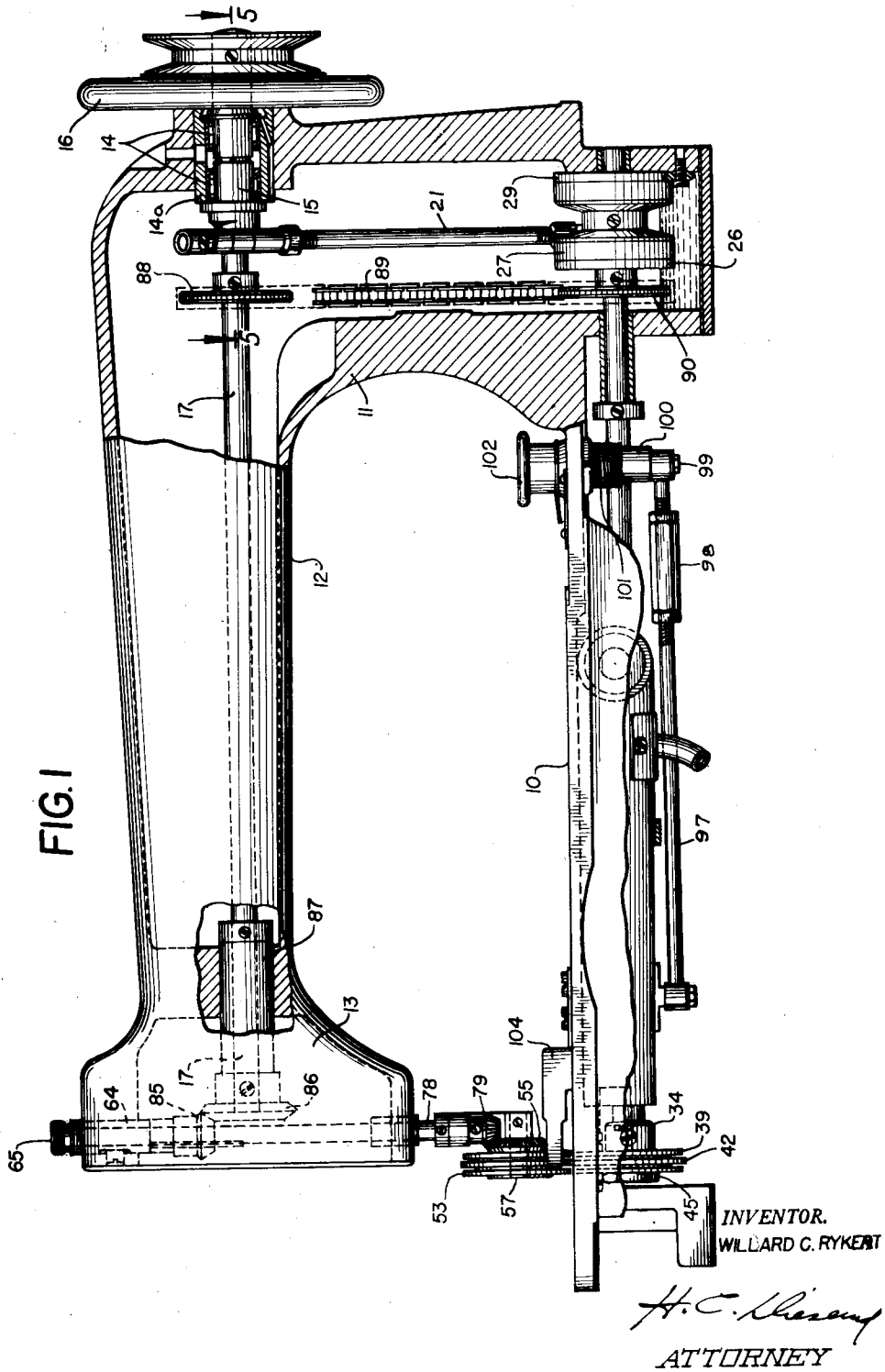
W. C. RYKERT

2,583,709

ELECTRONIC SEAMING MACHINE

Filed June 15, 1948

5 Sheets-Sheet 1



Jan. 29, 1952

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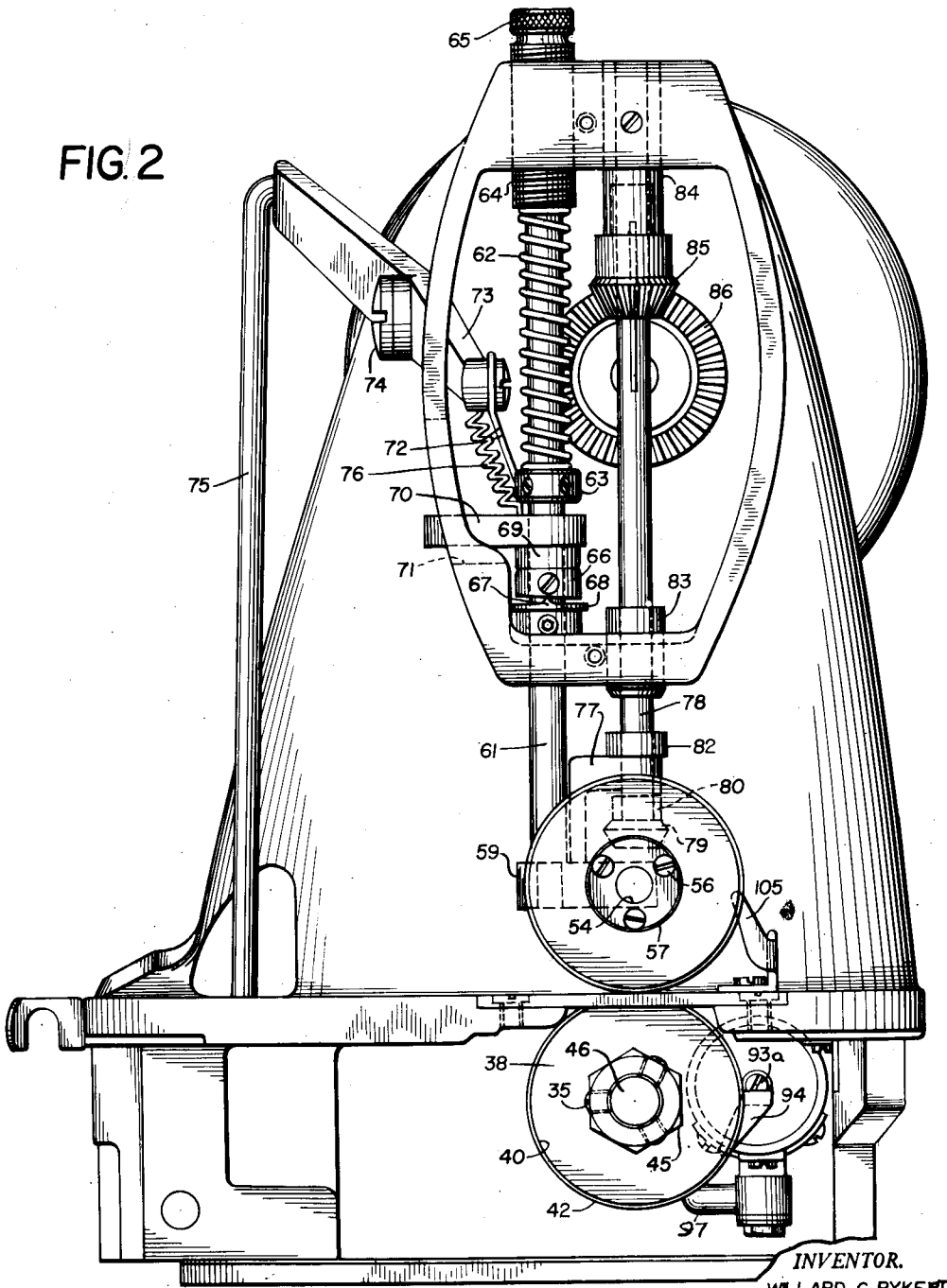
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ELECTRONIC SEAMING MACHINE

Filed June 15, 1948

5 Sheets-Sheet 2

FIG. 2



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ELECTRONIC SEAMING MACHINE

2,583,709

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5 Sheets-Sheet 3

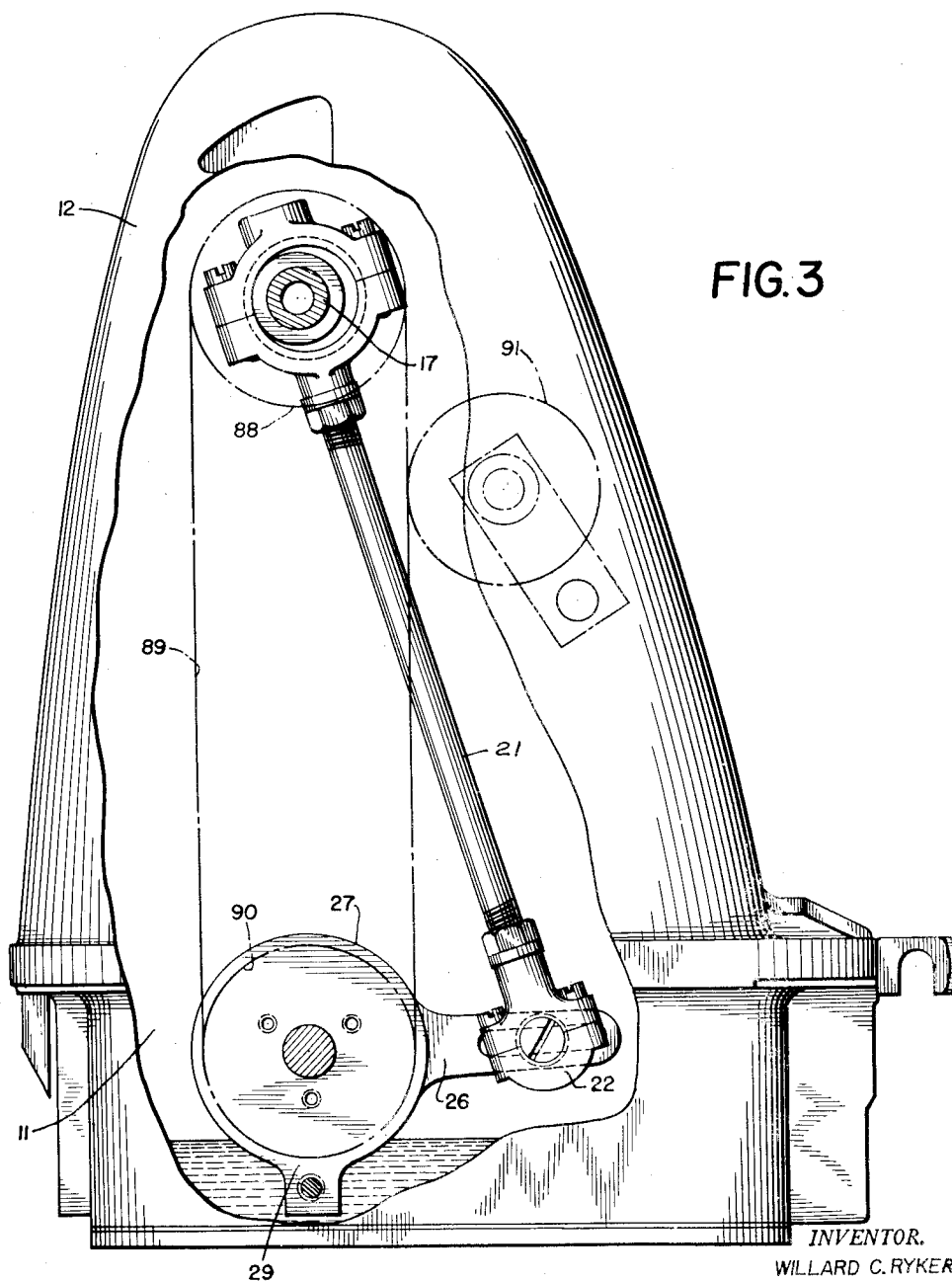


FIG. 3

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ELECTRONIC SEAMING MACHINE

Filed June 15, 1948

5 Sheets-Sheet 4

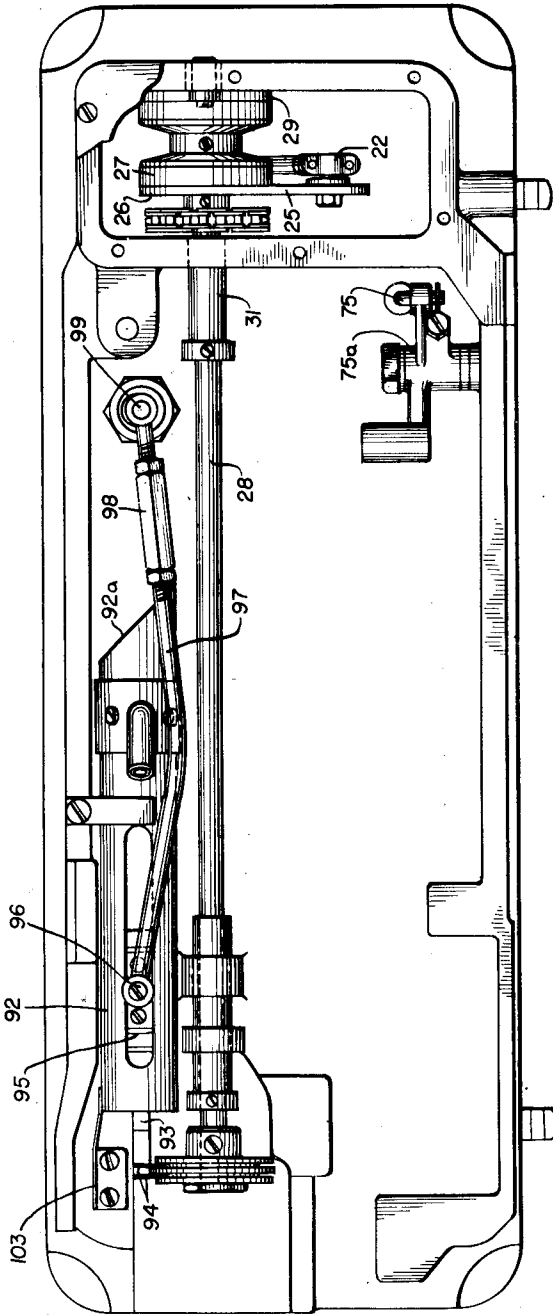


FIG. 4

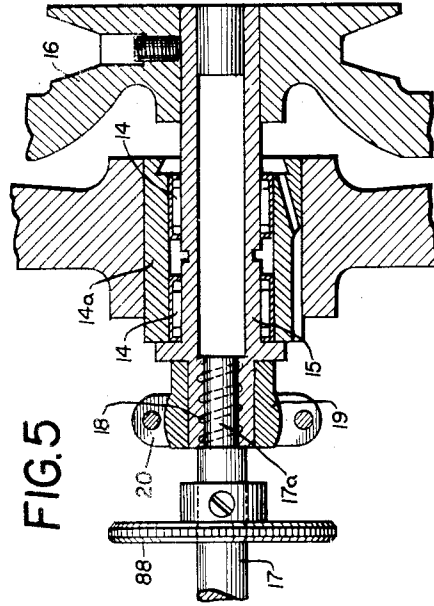


FIG. 5

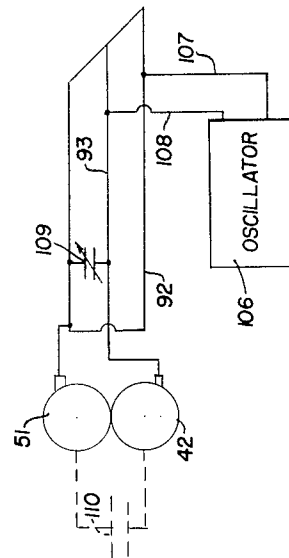


FIG. 10

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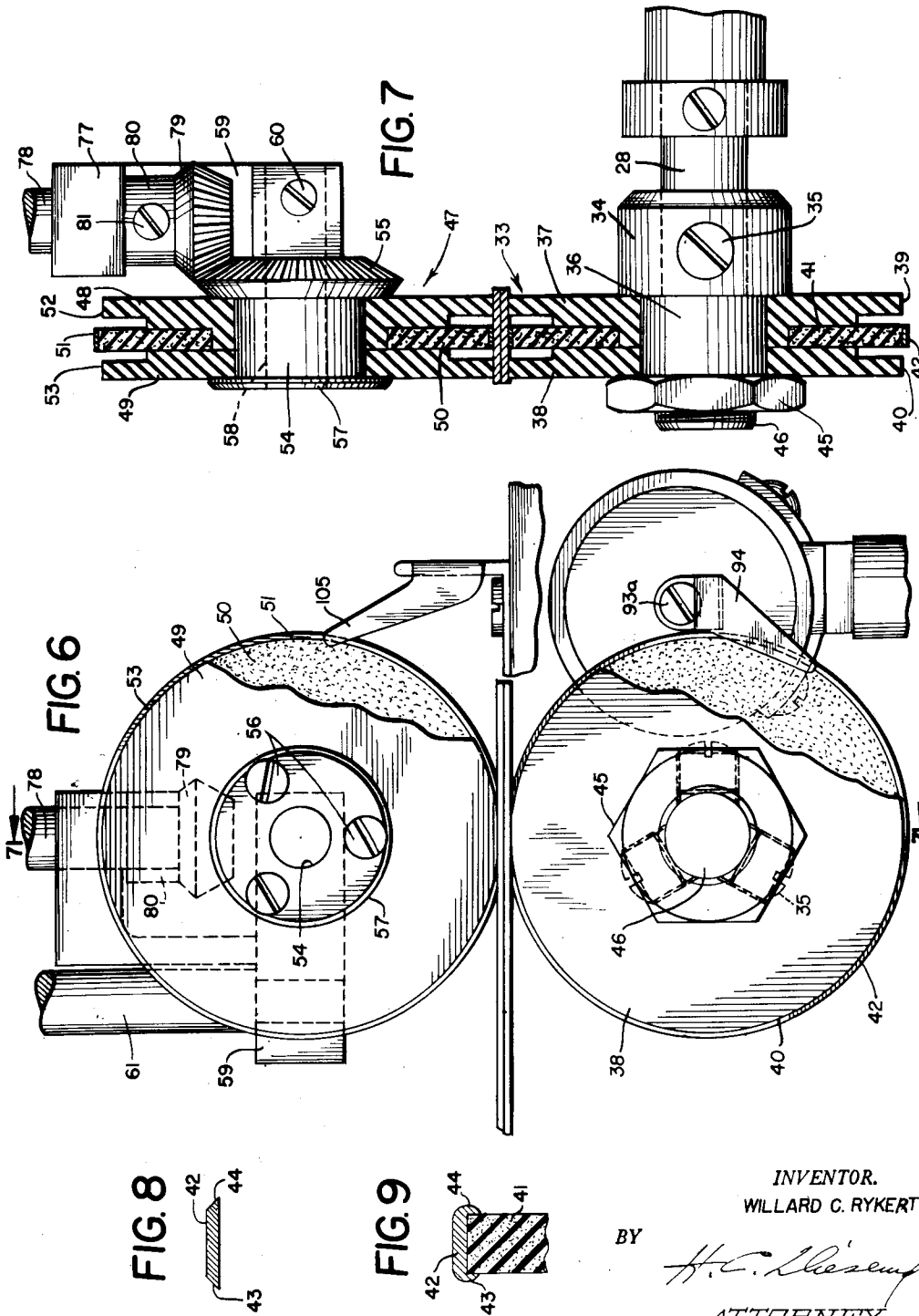
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Filed June 15, 1948

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,583,709

ELECTRONIC SEAMING MACHINE

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Application June 15, 1948, Serial No. 33,189

11 Claims. (Cl. 219—47)

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This invention relates to apparatus, commonly designated electronic seaming machines, used for the purpose of bonding together, by high frequency electric oscillations, sheets or sections of dielectric material. This is done by including in the seam one or more thermoplastic films or layers rendered adhesive by the dielectric losses therethrough resulting from the generation of an ultra high frequency field in the region of the seam. In machines of this character electrodes are engaged with the opposite faces of the sections of dielectric material constituting the work to be united, and relative movement is created between the electrodes and the sections of material to subject successive increments of the work to a high frequency field, thereby producing a bond along a desired seam line.

Heretofore machines of the foregoing character have been provided with rigid, unyielding rollers, in closely spaced relation, and the materials to be bonded have been fed through the bite of the rollers either by the frictional driving action thereof or through the aid of auxiliary feeding means. The rollers have served not only as work feeding means but as electrodes for the delivery of the high frequency oscillations to the work pieces for the generation of the desired heat. The rotary electrodes and work feeding rollers employed heretofore have been formed, largely of rigid metal so as to serve the dual functions indicated.

It has been found necessary in the operation of the machines, as heretofore constructed, to provide means for preventing the actual engagement of the electrodes with each other whenever the high frequency oscillations have been delivered thereto. It has been found that if the electrodes are permitted to come into direct contact with each other, objectionable arcing will occur when they are separated as the work pieces are advanced between them or as an incident to the introduction of the work. Such arcing has frequently caused the surfaces of the electrodes to become pitted and unsuitable for further use.

A primary object of the present invention has been to provide rotary electrodes of improved construction adapted to deliver the desired high frequency oscillations to the opposite faces of the work pieces under more favorable conditions than is possible through the use of the rigid rotary electrodes heretofore employed.

Toward the foregoing end, an important feature of the invention is the provision of rotary electrodes, for machines of the character indicated, which have yielding surfaces on elements

of good electrical conductivity adapted to engage the opposite faces of the work. These elements are adapted to engage the work over a greater area than is possible with rigid rollers. The rigid rollers, heretofore employed, have had a relatively thin line contact with the work, so that the field set up in the dielectric material, at any instant, has been of very limited area. In accordance with the present invention, on the other hand, the flattening of the peripheries of the rotary electrodes has served to increase their area of engagement with the work, so that the high frequency oscillations are set up through a portion of the work having a correspondingly greater area. A condenser of substantial area is thus formed by the parallel faces of the flattened portions of the electrodes and the interposed dielectric material. This gives rise to various advantages. It permits the use of a high frequency current of lower voltage, since the heating effect of the field set up in the dielectric material is maintained at each point over a longer period of time. A particular point along the line of seam may remain in the field during a plurality of feeding movements of the work so that the intensity of the heating action need not be so great. The increased effective area of the electrodes at any instant also permits higher seaming speeds to be employed.

Another object of the invention has been to provide a more positive feed for the work, while retaining the advantages of rotary electrodes. This is accomplished by the provision of flexible rotary electrodes adjacent to, or positioned between two portions of, a rigid feed roller. The flexible electrode for each roller is formed with a slightly greater outside diameter than its associated roller, so that as the rigid rollers are urged forcibly against each other, or the opposite faces of the work, the flexible electrodes are flattened at their points of contact. The arrangement is such, moreover, that the force required to flatten the flexible electrodes, to the extent permitted by the rigid feed rollers, is relatively small. This makes it possible to provide as much pressure as desired between the feed rollers, since these are not brought in contact with portions of the work which are softened by the action of the heat generated by the high-frequency oscillations. The areas of the work which are heated by the high frequency field are subjected only to the relatively light squeezing action of the resilient means tending to maintain the circular form of the electrodes. This force, as indicated above, may be made relatively small. A quite positive feed may

be insured by the friction created between the high pressure feed rollers and the work.

A still further object of the invention has been to provide an arrangement in which objectionable arcing is eliminated even though the electrodes are permitted to come into direct engagement with each other and are then separated while the power is turned on. It has been found that the dielectric material may be fed into and out of the path of the feed rollers and the flexible electrodes without producing serious arcing difficulties. Apparently this is due in part to the lower voltages permitted and in part to the fact that as the work is fed between the electrodes the latter remain in direct contact with each other until the work has advanced to or beyond the plane extending through the axes of the two feed rollers. As the material advances through this plane the electrodes are separated, and a certain amount of arcing takes place, but the interval of time involved is so small that no substantial harm is done. The arc is formed for only an instant. When rigid electrode rollers are employed, on the other hand, the arcing continues for a sufficient period to injure the surfaces of the electrodes.

An additional object of the invention has been to provide electrodes which serve to produce their heating effect more uniformly over the width of the seam. Electrodes as heretofore constructed have had a tendency to concentrate a greater portion of the field, and hence the heating effect, at the corners or edges of the rotary electrodes with resultant weakening of the seams at these points. This tendency has been overcome by the provision of flexible electrodes and by providing a special configuration to the periphery of the same. It has been found that the field generated between the improved rotary electrodes does not have the same tendency to concentrate at the corners or edges as do prior electrodes. The distribution of the field over a broader area, due to the flattening of the work engaging portions, as explained above, apparently contributes largely to this result. The heat being transmitted through the material over a longer period of time, and therefore being of lesser intensity at any given instant, has an opportunity to become more evenly distributed over the width of the seam.

While the invention is applicable to machines for either continuous or intermittent feeding of the work, it is particularly advantageous in relation to machines having an intermittent feed. The intermittent feeding of the work, which is produced, for example, through the rotation of the feed wheels through successive small increments corresponding with stitch lengths, enables the operator to turn the work in relation to the feed rollers and electrodes at times when the rollers are stationary. It has been found that work may be turned on a relatively small radius of curvature, at such times, when the intermittent feed action is provided. The formation of seams of small radius is more difficult when a continuous feed is provided. Moreover, the present invention enables the formation of an uninterrupted seam even though the feed is intermittent. This is not possible when rigid rotary electrodes are employed.

Other objects, features, and advantages of the invention will appear from the detailed description of an illustrative form of the same, which will now be given in conjunction with the accompanying drawings, in which:

Fig. 1 is a view, partly in front elevation and partly in vertical section through a machine embodying the invention;

Fig. 2 is an end elevation of the machine as viewed from the left in Fig. 1, a cover for the end of the overhanging arm being removed to disclose the interior mechanism;

Fig. 3 is an end elevation of the machine as viewed from the right in Fig. 1, a portion of the frame being broken away to disclose the interior construction and certain of the shafts being shown in section;

Fig. 4 is a bottom view of the machine, a portion of the cover plate for the lower end of the standard being broken away to show the interior mechanism;

Fig. 5 is an enlarged detail view in section along the line 5—5 of Fig. 1;

Fig. 6 is an enlarged detail view, in end elevation with some of the parts broken away, showing the work feeding rollers and the rotary electrodes;

Fig. 7 is a vertical sectional view through the feed rollers and electrodes, taken along the line 7—7 of Fig. 6;

Fig. 8 is a transverse section through one of the electrode bands in the course of formation;

Fig. 9 is a detail view in section through a portion of the periphery of one of the electrodes; and

Fig. 10 is a diagrammatic view showing a suitable electrical circuit employed in the use of the invention.

Referring now to the drawings, the illustrative machine comprises a main frame having a work supporting member 10, a vertical standard 11, and an overhanging arm 12 terminating in an enlarged head 13. The work supporting member 10, it will be understood, is adapted to be mounted in a suitable table (not shown) which is preferably adapted to carry the entire electronic seaming apparatus. In the outer end wall of the vertical standard there is mounted, in suitable needle bearings 14, a shaft 15 carrying at its outer end a combined hand wheel and pulley 16 adapted to be connected by a V-belt or the like with any suitable source of power, such as a pulley driven by an electric motor. In axial alignment with the shaft 15 is a shaft 17 having a reduced end 17a adapted to fit into the bore provided at the inner reduced end portion 18 of the shaft 15. Secured to the reduced portion 18 of the shaft is an eccentric 19, preferably having a spherical surface, arranged to cooperate with a strap 20 which is connected by a pitman 21 and a similar strap 22 with a spherical portion of a pin 23 adjustably mounted in an elongated slot 24 in an arm 25. The latter projects from a driving element 26 of a one-way clutch. This clutch is, in general, one of the type shown in the patent to Long et al., No. 1,692,130, granted on November 20, 1928. It will be understood that by adjustment of the pin 23 along the slot 24 the stroke of the arm 25 may be varied and the angle through which driving member 26 of the clutch is oscillated may be correspondingly varied. Operation of the member 26 in a clockwise direction (Fig. 3) will impart a like movement to a driven clutch member 27 secured to a driven shaft 28. This is accomplished through the roller and cam clutch elements illustrated in the Long et al. patent above mentioned. Operation of the driving member 26 in the opposite direction, however, will not impart rotation in that direction to the driven member of the clutch

due to the action of a stationary member 29 cooperating, through similar roller and cam members, to prevent reverse rotation. Plate 29 is secured to the end wall of the standard by means of screws 30. Shaft 28 is carried by a bearing sleeve 31 and extends therefrom to and through another bearing sleeve 32 at the left end of the work support.

Outwardly of the sleeve 32 there is secured to the end of the shaft 28 a unit 33 which comprises a feed roller and rotary electrode to be presently described in detail. The unit 33 has a central sleeve with an enlarged, collar-like head 34 secured to the shaft 28 by means of a set screw 35. On a reduced portion 36 of the sleeve there is mounted a pair of members 37 and 38 adapted to form a feed roller having spaced work engaging cylindrical surfaces 39 and 40. The members 37 and 38 are preferably formed of a relatively hard and non-yielding material having good dielectric properties. They may suitably be formed of a type of silicone rubber corresponding with ordinary hard rubber but having greater resistance to high temperatures. Any other material having similar characteristics may be used for the production of these parts. Between the parts 37 and 38 there is clamped a disc-like or washer-like element 41 formed of a suitable soft rubber-like material having good dielectric properties and capable of withstanding relatively high temperatures up to say 500° F. It has been found that a silicone rubber of the type commercially sold under the trade name "Silastic," type No. 167, is quite satisfactory for the purpose. This has properties of elasticity and compressibility corresponding with those of ordinary rubber and, at the same time, it is capable of withstanding higher temperatures without deterioration or injury. It also has a high dielectric constant. Around the periphery of the element 41 there is provided a ring or band 42 formed of material having good electrical conductivity and having high flexibility and resilience. This ring may suitably be formed of an aluminum bronze alloy and have a wall thickness of, say, .010 of an inch. Preferably the edges of the ring are bevelled at an angle of 45°, as shown at 43 and 44 in Fig. 8, and the bevelled edges are, in the course of producing the intermediate or electrode member of the unit, spun downwardly over the outer faces of the rubber like element 41. The band 42 is arranged to have good press fit over the element 41 and is adapted to yield readily in response to any radial pressure. The resilience of the band, together with the resilience and yieldability of the rubber-like element 41, tends to maintain the band and element in truly circular form whenever the radial pressure is released. To retain the parts 37, 38 and 41 in assembled relation, a nut 45 is provided, this cooperating with a reduced threaded end 46 of the central sleeve. Nut 45 serves to urge part 38 against element 41 and the latter against part 37 which, in turn, is urged against the shoulder provided by the enlarged portion 34 of the sleeve. As shown in Fig. 7 the element 41 preferably fits over a shoulder provided by a reduced portion of the member 37 and it is of slightly greater thickness than the length of this shoulder to permit it to be squeezed slightly in the assembly of the parts.

The band 42 is of slightly greater outside diameter than the cylindrical surfaces 39 and 40. It has been found desirable to make the latter about 1.75 inches in diameter and the band is preferably about .040" greater in diameter than said

surfaces, although it may be more or less than this. Depending upon the diameter of the surfaces 39 and 40, the nature of the work to be done, and possibly other factors, the band may suitably have a diameter which is between .020 and .050" greater than that of said surfaces. As a result of this the band 42 is flattened out slightly at the point of engagement of the unit with the work, as the feed roller (parts 37 and 38) is urged against the work in the manner to be explained hereinafter. This flattening of the band is readily permitted by its flexibility and by the yielding character of the element 41. It will be noted also (Fig. 7) that a substantial clearance is provided between the element 41 and the outer portions or parts 37 and 38.

Cooperating with the lower unit 33, which extends upwardly through a suitable opening in the upper surface of the work support 10, is a similar unit 47 mounted above the work support. Unit 47 comprises a pair of relatively rigid and unyielding members 48 and 49 formed of dielectric material, such as hard silicone rubber, and having between them a yielding, relatively soft, rubber-like element 50, preferably formed of silicone rubber such as that sold under the trade name Silastic, type No. 167. Surrounding the element 50 is a metal band 51 formed of a good electrical conductor, such as aluminum bronze, and having suitable flexibility and resilience, as explained in connection with the band 42. The outer periphery of the band 51 is slightly larger in diameter, say to the extent of 20 to 50 thousandths of an inch, than the cylindrical peripheral surfaces 52 and 53 of the members 48 and 49. The unit 47 comprises a central sleeve or collar 54 formed integrally with a bevel gear 55. To the outer end of the collar 54 there is secured, as by screws 56, a disc 57 which serves to clamp the members 48, 49 and 50 against the shoulder provided by the inner surface of the bevel gear 55. The arrangement is such that upon the tightening of the screws 56, the members 48, 49, and 50 will be firmly clamped in place and will be caused to turn as a unit with the bevel gear 55.

If the collar 54 is made of the same diameter as the sleeve portion 36 of the lower unit, the parts 48, 49 and 50 may be made identical with the parts 37, 38 and 41, respectively. However, the collar 54 may be of somewhat greater diameter than the part 36 and, in that event, the opening at the centers of the parts 48 and 49 will be correspondingly enlarged. They may, for example, be of the same diameter as the opening through the element 50 and the shoulder on the part 48, on which the element 50 is shown mounted in Fig. 7, may be eliminated.

It will be noted that as in the case of unit 33, the yielding element 50 has substantial lateral clearance at its outer portion in relation to the rigid feed roller parts 48 and 49. This clearance in both units facilitates the desired flexing of the bands and the consequent compression and yielding of the elements 41 and 50.

The unit 47 is mounted upon a stud 58 which projects laterally from a bracket 59 and is secured in the bracket by a set screw 60. Any suitable means may be provided for retaining the unit 47 on the stud 58 for rotation thereon. The latter may, for example, be provided with an enlarged head at its outer end for this purpose. If desired, the bevel gear and its collar 54 may be provided with a bearing sleeve or bushing to cooperate with the stud 58. Bracket 59, as best

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shown in Fig. 6, is secured to the lower end of a rod 61 which extends upwardly through suitable bearings in the head 13 of the frame and may be reciprocated axially therein. A spring 62, surrounding the bar 61, cooperates at its lower end with a collar 63 secured to the bar and at its upper end with the bottom of an adjustable screw-threaded sleeve 64. The spring thus serves to urge the bar 61 downwardly under a force which may be suitably adjusted. Sleeve 64 may be turned by means of its knurled head 65 (Fig. 2) to vary the tension of the spring 62. Downward movement of the bar 61 by the spring is limited by the engagement of the under surface of a collar 66, secured to the bar, with a knife edge 67 on a washer 68 resting upon the lower bearing for the rod. Collar 66 is so positioned on the bar 61 as to arrest the downward movement of the bar at or about the point at which the surfaces 52 and 53 on members 48 and 49 are brought into engagement with the surfaces 39 and 40 on members 37 and 38. It is desirable generally to limit the downward movement of the upper unit so that the work feeding surfaces of the rollers are held spaced apart, when no work is present, to the extent of about half the thickness of the work being seamed. Thus if two films of 4 mils thickness are being united, said surfaces should be held about 4 mils apart. The top points of the work feeding surfaces 39 and 40 fall preferably at or slightly above the plane of the work supporting surface of the member 10. When the surfaces 52 and 53 are substantially engaged with the surfaces 39 and 40, the bands 51 and 42 will be in engagement and will have their peripheries, at the point of engagement, flattened so as to provide a surface contact having a length, in a circumferential direction, of between about $\frac{1}{8}$ and $\frac{1}{4}$ of an inch.

A sleeve 69, slidably mounted on the bar 61, has an arm 70 (Fig. 2) extending rearwardly and arranged to cooperate with a slot 71 formed in the rear wall of the head 13. To another portion of the sleeve 69 there is secured a link 72 extending downwardly from the free end of a lever 73 which is pivotally mounted at 74 on the overhanging arm 12 of the frame. The opposite end of the lever 73 is connected with the upper end of a vertically extending rod 75, the lower end of which is connected with a rock member 75a (Fig. 4) carried by part 10 of the frame below the work supporting surface. This rock member is connected, in a manner well understood in the art, with a foot treadle or knee operated member or other means operable at the will of the operator. It will be understood that downward movement of the rod 75 will rock the lever 73 and lift the link 72 and sleeve 69. The initial upward movement of the sleeve will be idle, but it will then engage the under surface of the collar 63 and raise the latter and the bar 61 against the action of spring 62. This may be done whenever it is desired to introduce a new piece of work between the feeding and electrode units 33 and 47. A spring 76, connected at one end to the lever 73 and at the other end to a point on the frame, serves to rock the lever normally into the position indicated in Fig. 2.

An upwardly and laterally extending arm (Figs. 2 and 7) of the bracket 59 provides a bearing for a vertical shaft 78 carrying at its lower end a bevel pinion 79 arranged to mesh with the bevel gear 75. A collar 80, formed integrally with the bevel pinion 79, is secured by set screw 81 to the

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shaft 78. A collar 82 (Fig. 2) secured to the shaft 78 above the arm 77 serves to retain the shaft 78 and bevel pinion 79 in fixed axial position in relation to the bracket 59. Shaft 78 is mounted for rotation and axial movement within bearing sleeves 83 and 84 carried by the lower and upper portions of the head 13. As the bracket 59 is raised and lowered, in response either to the upward movement of the bar 61 by the lever 73, in the manner explained, or to the upward and downward movements of the unit 47 as the latter passes over work of varying thickness, the shaft 78 will slide axially within the bearing sleeves 83 and 84.

Rotation is imparted to the shaft 78 by means of a bevel pinion 85 which has a splined connection with the shaft. Pinion 85 meshes with a bevel gear 86 secured to the end of shaft 17, the latter extending into the head 13 through a bearing sleeve 87 (Fig. 1) in a partition wall between the head and overhanging arm. Pinion 85 is held against axial movement by the lower end of the bearing sleeve 84 and by cooperation with the bevel gear 86. The shaft 78 therefore slides within the bevel pinion in response to the upward and downward movements of the shaft as explained above. Shaft 17 carries a sprocket 88 which is connected by a chain 89 with a sprocket 90 secured to the lower shaft 28. Thus, shaft 17 partakes of the intermittent, successive increments of movement that are given to the shaft 28 by the one way clutch above described. The arrangement is such that the roller units 33 and 47 are rotated at the same peripheral speeds to advance the work across the work support step by step through successive increments corresponding with the stitch length of a conventional sewing machine. Each movement may be between $\frac{1}{32}$ and $\frac{5}{64}$ of an inch, depending upon the adjustment of the ball joint in the slot 24 of the arm 25 of the one-way clutch. Any suitable means, such as an idler 91, may be employed for taking up the slack in the chain 89 and maintaining the latter in effective driving relation to the sprockets 88 and 90.

As best shown in Figs. 1 and 3, the portion of the frame which encloses the various driving connections between the shaft 15 and the shafts 17 and 28 carries lubricant in a reservoir provided at the bottom and this lubricant is whipped into a spray by the parts which dip into it, thereby effectively lubricating the various surfaces which require lubrication.

The electrical system of the illustrative apparatus may be of any suitable character adapted to convert ordinary electrical current, either A.-C. or D.-C., into high frequency electrical energy or oscillations and to deliver this to the two bands 42 and 51, so as to produce a high frequency field through the dielectric material passing between these bands. This system and its control means may be of the type disclosed in detail in my pending application, Serial No. 739,073, filed April 3, 1947. For further details as to the construction, arrangement, and operation of the electrical devices, reference may be had to said pending application. Only a brief description of these devices will be given herein.

As best shown in Figs. 1, 2 and 4, there is mounted beneath the work supporting surface of the member 10 of the frame a tuning stub 92, the outer tubular conductor of which is preferably provided with a slant cut end 92a as described in said pending application. This effects automatic compensation for varying thicknesses of

material. It will be understood that the tubular conductor of the stub 92 has within it a coaxial conductor, the projecting end of which is indicated at 93 in Fig. 4. The inner conductor and a short-circuiting element provided at the slant-cut end of the stub are provided with corresponding inclined faces. The projecting end of the conductor 93 has secured thereto a carrier 93a having contact elements 94 thereon arranged to engage the edges of the flexible band 42 of the lower unit. Elements 94 are formed preferably of bronze to provide the desired resilience and springiness. The point at which the band is engaged by the elements 94 is removed some distance from the work engaging surface so that the flattening of the band 42, in the manner hereinbefore explained, will not affect the contour of the band in the region of the contact elements. Within the tubular conductor of the stub 92, and surrounding the coaxial conductor is a slidable sleeve 95 (Fig. 4) to which is connected, at 96, one end of a two-piece rod 97 provided with an extensible connection 98 between the sections of the rod and having its opposite end engaged with an eccentric pin or screw 99 of a suitable control member. The pin 99 is carried eccentrically by a shaft 100 journaled in a bushing 101 carried by the work supporting member. At its upper end, the shaft carries a control knob 102 which may be turned to alter the position of the eccentric pin 99 and thereby cause shifting of the sleeve 95 within the stub. This permits manual tuning of the stub at the commencement of an operation in accordance with the nature and type of material to be seamed. The end of the stub is grounded to the work support by means of a conductor 103 which may suitably be welded or soldered to the outer face of the stub and secured by screws or the like to the under surface of the work support. A brush or contact element 104, formed preferably of bronze and secured to the upper surface of the work support, has spring fingers 105 arranged for yielding engagement with the edges of the upper flexible band 51 at a suitable distance from the point of engagement of the latter with the work.

Referring now to Fig. 10, high frequency oscillations are generated by an oscillator 106 arranged to receive current from any suitable source. The oscillations, preferably having a frequency of the order of 200 megacycles, are delivered to the stub 92 and coaxial conductor 93 by lines 107 and 108, which, it will be understood, are parts of a coaxial cable. Shifting of the sleeve 95 provides a variable condenser effect, such as indicated at 109 in Fig. 10. The condenser action of the bands 42 and 51 is illustrated in broken lines at 110. By the means indicated, a high frequency field is created through the dielectric material passing between the electrode bands.

In the operation of the machine the sections of dielectric material to be bonded together are fed from the right (Fig. 2) and are introduced between the feeding and electrode rollers. The high frequency oscillations may be delivered to the electrodes 42 and 51 continuously. As the work is introduced the rollers may be separated slightly by operation of the treadle, or the like, connected with the rod 75. This separation of the rollers may be sufficient only to disengage the rigid portions 48 and 49 of the upper roller from the corresponding portions 37 and 38 of the lower roller, although the bands 51 and 42 may be separated also, if desired. In either event, the arcing due to separation of the electrode elements

is sufficiently brief to cause no serious objection. It has been found that no harm is done to the electrode bands and the small power loss due to the engagement of the bands, with the power on, is so small as not to be objectionable. The action in separating the electrodes appears to be akin to that resulting from the operation of a quick acting circuit breaker.

As the work sections are fed between the rollers of units 33 and 47 and are advanced by the latter, a high frequency field is generated through the dielectric material so that the thermoplastic substances presented between the electrodes are rendered adhesive and produce a bond between the work sections in successive increments. It will be understood that power is supplied to the pulley 16 at this time to drive the one-way clutch and shafts 17 and 28. Such power may be derived from any suitable source, not shown, such as an electric motor. A clutch may be provided in the connection between the motor and the pulley so that the latter may be driven at will. Due to the flattening of the bands 42 and 51, and the elongated contact thus provided with the work, a parallel condenser effect is produced which results in effective transmission of the high frequency oscillations and the production of a continuous seam. Thus, in spite of the intermittent feeding action, the seam is uninterrupted. Also, turning of the work by the operator is facilitated during the periods when the feed rollers are stationary so that relatively sharp curves may be followed in the seaming operation.

While an illustrative form of the invention has been disclosed in considerable detail, it will be understood that numerous changes may be made in the construction and arrangement of the various parts without departing from the general principle and scope of the invention. For example, the units 33 and 47 may be formed of materials other than those specified. The bands 42 and 51 may be formed of any resilient, flexible material which is a good conductor of electricity and may be flexed and then restored to its normal cylindrical form, as required. Elements 41 and 50 may be formed of any rubber-like material which may be readily compressed and then restored to its initial circular form in response to the flexing and restoration of the electrode bands. This material must also be capable of withstanding the relatively high temperatures to which the electrodes are subjected without substantial deterioration or change in its characteristics. Parts 37, 38, 48 and 49 may be formed of any material which has good electrical resistance and is rigid and capable of withstanding a relatively high compression force without distortion or deterioration at the relatively high temperatures required for the bonding of the thermoplastic work sections contemplated. The dimensions indicated for the various parts may be varied within appropriate limits. While the units 33 and 47 are preferably of the same diameter they may be of different diameters, if appropriate provisions are made for driving them at the same peripheral speeds or if only one unit is positively driven while the other is driven frictionally through the work. Other structural modifications will suggest themselves to those skilled in the art. The details of the electrical system may also be varied widely in accordance with the teachings of the art. The invention is adapted for use with any of the high frequency oscillations commonly employed for the purposes indicated.

What I claim is:

1. An electronic seaming machine comprising a work supporting member, a plurality of rotary members adapted to engage the opposite faces of the work, means for driving at least one of said rotary members for advancing the work on said work supporting member, electrodes associated with said rotary members and disposed in a plane adjacent thereto, said electrodes being arranged to engage the opposite faces of the work for delivering high-frequency electrical oscillations thereto, at least one of said electrodes comprising a flexible metal ring mounted to yield in a radial direction when subjected to localized inward pressure but held against any appreciable lateral displacement, means for rotating said ring with the associated rotary member, and means for delivering high frequency electrical oscillations to said electrodes.

2. An electronic seaming machine comprising a work supporting member, a plurality of rotary members adapted to engage the opposite faces of the work, means for driving at least one of said rotary members for advancing the work on said work supporting member, electrodes associated with said rotary members and disposed in a plane adjacent thereto, said electrodes being arranged to engage the opposite faces of the work for delivering high-frequency electrical oscillations thereto, at least one of said electrodes comprising a flexible metal ring mounted on one of said rotary members for rotation therewith and arranged to yield in a radial direction when subjected to localized inward pressure but held against any appreciable lateral displacement, and means for delivering high frequency electrical oscillations to said electrodes.

3. An electronic seaming machine comprising a work supporting member, a plurality of rotary members adapted to engage the opposite faces of the work, means for driving at least one of said rotary members for advancing the work on said work supporting member, electrodes associated with and disposed adjacent said rotary members arranged to engage the opposite faces of the work for delivering high-frequency electrical oscillations thereto, at least one of said electrodes comprising a flexible metal ring mounted on one of said rotary members for rotation therewith and arranged to yield in a radial direction when subjected to localized inward pressure, said ring having an outside diameter slightly greater than that of the rotary member on which it is mounted, and means for delivering high frequency electrical oscillations to said electrodes.

4. An electronic seaming machine which comprises a member having a work supporting surface, a pair of rollers arranged to engage the opposite faces of flat work pieces to be united, means for yieldingly urging said rollers together, driving means for rotating at least one of said rollers, an electrode adjacent each of said rollers and rotatable therewith, said electrodes having flexible, normally circular, metallic rims adapted to engage the opposite faces of the work and transmit high frequency electrical oscillations therethrough, each of said rims being of slightly greater diameter than its associated roller and being arranged to yield in a radial direction when subjected to localized inward pressure, and means for delivering high frequency electrical oscillations to said rims.

5. An electronic seaming machine which comprises a member having a work supporting sur-

face, a pair of rollers arranged to engage the opposite faces of flat work pieces to be united, means for yieldingly urging said rollers together, driving means for rotating at least one of said rollers intermittently through successive small increments, an electrode adjacent each of said rollers and rotatable therewith, said electrodes having flexible, normally circular, metallic rims adapted to engage the opposite faces of the work and transmit high frequency electrical oscillations therethrough, each of said rims being of slightly greater diameter than its associated roller and being arranged to yield in a radial direction when subjected to localized inward pressure, and means for delivering high frequency electrical oscillations to said rims.

6. An electronic seaming machine which comprises a member having a work supporting surface, a pair of rollers arranged to engage the opposite faces of flat work pieces to be united, means for yieldingly urging said rollers together, driving means for positively driving both of said rollers, an electrode adjacent each of said rollers and rotatable therewith, said electrodes having flexible, normally circular, metallic rims adapted to engage the opposite faces of the work and transmit high frequency electrical oscillations therethrough, each of said rims being of slightly greater diameter than its associated roller and being arranged to yield in a radial direction when subjected to localized inward pressure, and means for delivering high frequency electrical oscillations to said rims.

7. An electronic seaming machine which comprises a member having a work supporting surface, a pair of rollers arranged to engage the opposite faces of flat work pieces to be united, means for yieldingly urging said rollers together, driving means for positively driving both of said rollers intermittently through successive small increments, an electrode adjacent each of said rollers and rotatable therewith, said electrodes having flexible, normally circular, metallic rims adapted to engage the opposite faces of the work and transmit high frequency electrical oscillations therethrough, each of said rims being of slightly greater diameter than its associated roller and being arranged to yield in a radial direction when subjected to localized inward pressure, and means for delivering high frequency electrical oscillations to said rims.

8. An electronic seaming machine which comprises a member having a work supporting surface, a pair of rollers arranged to engage the opposite faces of flat work pieces to be united, means for yieldingly urging said rollers together, driving means for rotating at least one of said rollers, an electrode adjacent each of said rollers and rotatable therewith, said electrodes having flexible, normally circular, metallic rims adapted to engage the opposite faces of the work and transmit high frequency electrical oscillations therethrough, each of said rims being of slightly greater diameter than its associated roller and being arranged to yield in a radial direction when subjected to localized inward pressure, and means for delivering high frequency electrical oscillations to said rims including resilient contact elements engaging said rims.

9. A work feeding and electrode unit for an electronic seaming machine which comprises a rigid roller formed of non-conducting material and having spaced circular work engaging faces, and a flexible band formed of material having good electrical conductivity yieldingly mounted

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between said spaced faces and arranged to yield in a radial direction when subjected to localized inward pressure, said band having a slightly greater diameter than said faces and being sufficiently rigid to resist any appreciable lateral deflection.

10. A work feeding and electrode unit for an electronic seaming machine which comprises a rigid roller formed of non-conducting material, said roller being formed in two parts providing spaced circular work engaging faces, and a flexible band formed of material having good electrical conductivity yieldingly mounted between said spaced faces, said band being mounted on a rubber like core clamped between said parts of the roller to permit said band to yield in a radial direction when subjected to localized inward pressure, and said band having a slightly greater diameter than said faces.

11. An electronic seaming machine which comprises a member having a work supporting surface, a pair of rollers arranged to engage the opposite faces of flat work pieces to be united, means for yieldingly urging said rollers together, driving means for positively driving both of said rollers, one of said rollers being spring urged toward the other and being movable toward and from the latter, an electrode adjacent each of said rollers and rotatable therewith, said elec-

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trodes having flexible, normally circular, metallic rims adapted to engage the opposite faces of the work and transmit high frequency electrical oscillations therethrough, each of said rims being of slightly greater diameter than its associated roller and being arranged to yield in a radial direction when subjected to localized inward pressure, and means for delivering high frequency electrical oscillations to said rims.

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