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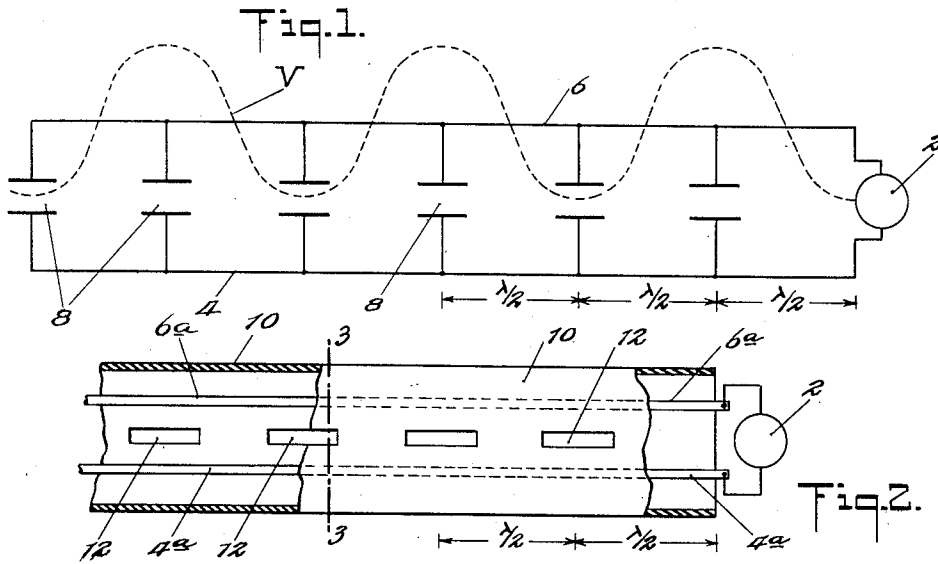
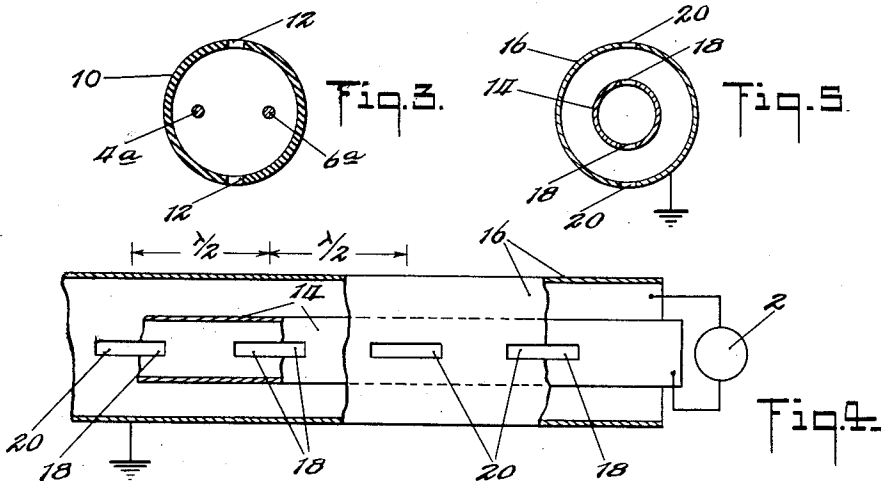
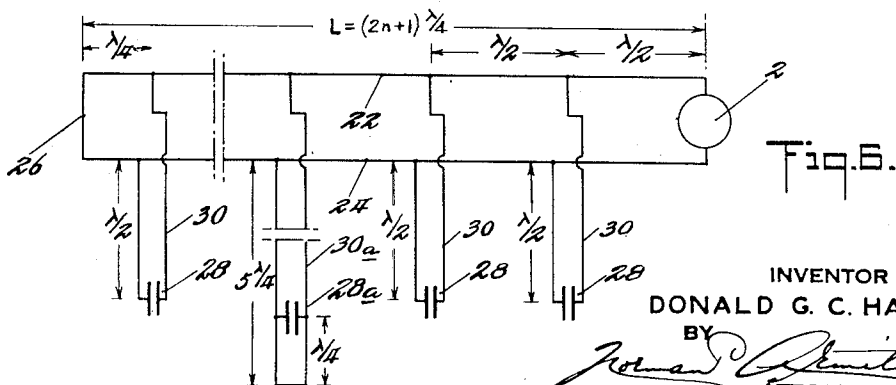
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2,562,911

DIELECTRIC HEATING SYSTEM

Filed Aug. 15, 1947

3 Sheets-Sheet 1



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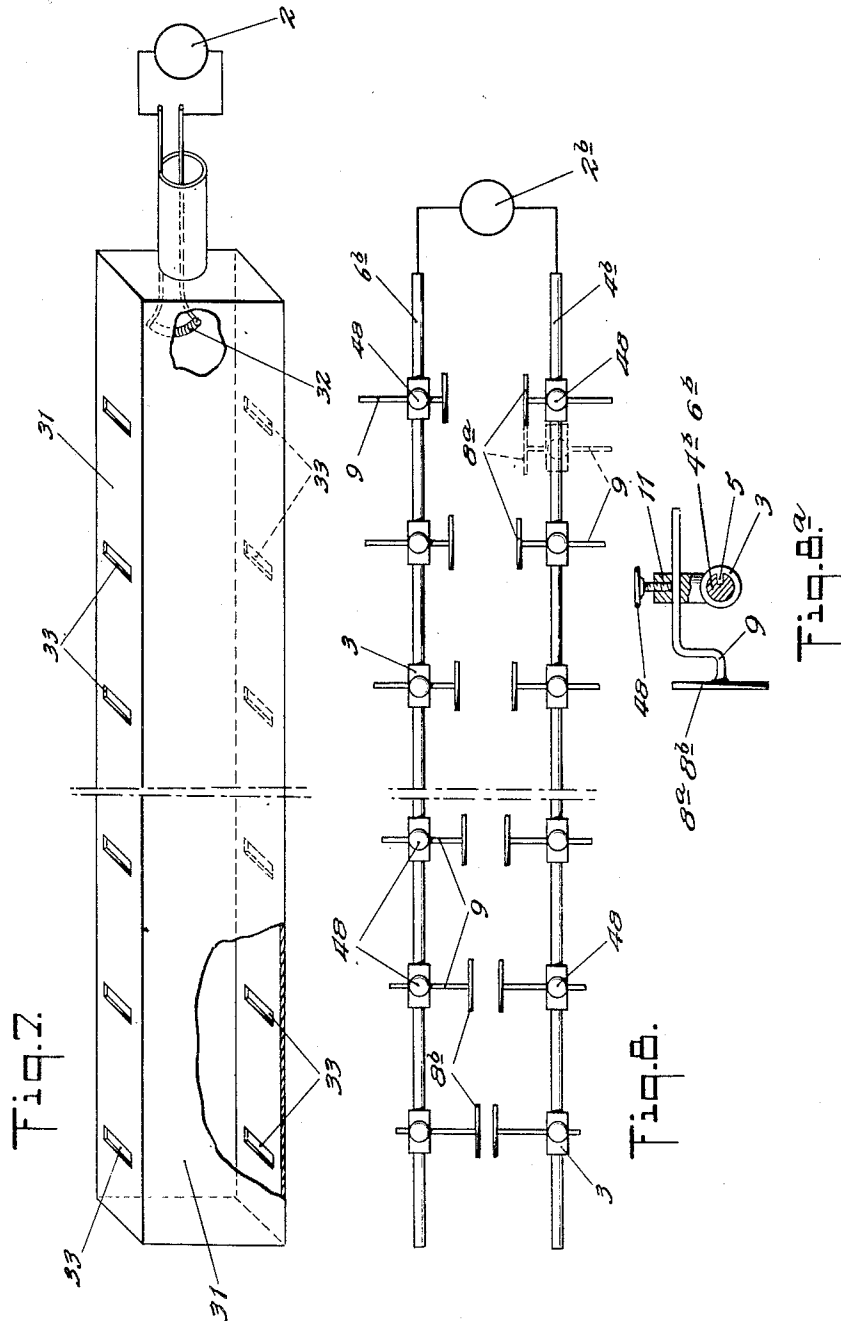
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DIELECTRIC HEATING SYSTEM

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3 Sheets-Sheet 2



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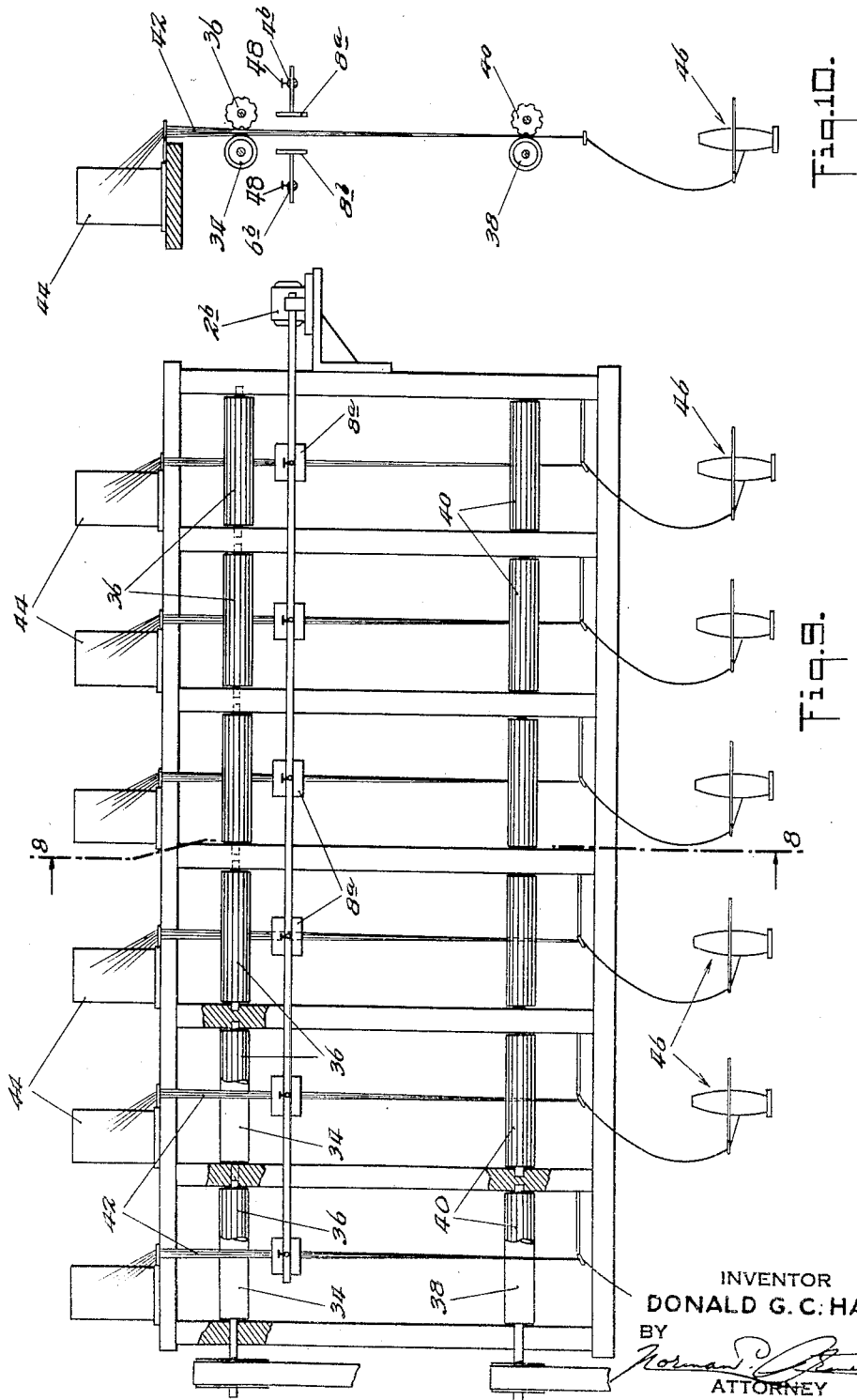
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DIELECTRIC HEATING SYSTEM

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3 Sheets-Sheet 3



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DIELECTRIC HEATING SYSTEM

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4 Claims. (Cl. 219—47)

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The present invention relates to dielectric heating and comprises novel means for simultaneously heating material at each of a plurality of spaced locations with energy derived from a common source. The advantages of dielectric over other types of heating are recognized in many industries, and new fields of application are continually being found. For example, dielectric heating has been used for drying adhesives in shoe manufacture, for drying printing inks, for drying wood and textiles and for heating organic and inorganic materials. In the usual practice of dielectric heating, the material to be heated is placed between electrodes, and the electrodes are connected across a generator of high, or ultra high, frequency current. At any given frequency, for maximum power absorption, that is, for maximum conversion of the high frequency energy into dielectric heat, the circuit should be tuned to resonate at the frequency of the generator. This can be effected relatively simply when heat is to be produced at one location only.

When, however, as is frequently desired, materials are to be simultaneously heated at each of a plurality of separate locations, the efficient conversion of energy from a single source into dielectric heat at the various locations, becomes more complicated because of the very high frequencies employed. At such high frequencies, unwanted capacitative or inductive coupling between the conductors or between one or another of the conductors and neighboring apparatus, have to be considered, as does the energy loss through radiation. Hence, to heat material efficiently at a plurality of heating stations, it is not sufficient merely to provide a plurality of pairs of electrodes, one pair for each station, and connect all the pairs in parallel across the generator.

The primary object of the invention, therefore, is to provide an efficient and relatively simple system, for converting high frequency electrical energy into heat at a plurality of separate locations.

Another object of the invention is to provide a system of the above type wherein the number of active stations may be varied at will, without interfering with the heating operations at the remaining stations.

A specific object of the invention, as related to the textile industry, is to provide a system for simultaneously heating tow in each of a plurality of stretch breaking mechanisms.

Other objects and features of the invention will become apparent as the description proceeds.

Of the accompanying drawings:

Fig. 1 is a circuit diagram representing one em-

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bodiment of the invention wherein heating stations are positioned one half electrical wave length apart along an open resonant line;

Fig. 2 is a top plan view, partly broken away, of a shielded line heating system representing a modification;

Fig. 3 is a vertical sectional view of the shielded line of Fig. 2, taken on the line 3—3 thereof;

Fig. 4 is a view similar to Fig. 2 but illustrating a tuned co-axial line having heating stations one-half wave length apart;

Fig. 5 is a vertical sectional view of the line of Fig. 4;

Fig. 6 is a circuit diagram of a heating system embodying the invention and incorporating a closed ended resonant line;

Fig. 7 is a perspective view of a heating system embodying the invention and including a hollow wave guide;

Fig. 8 is a diagrammatic view of a heating system similar to Fig. 1 but provided with means for compensating for variations in the number of active heating stations;

Fig. 8a is an enlarged detail view of the mounting of the heating station electrodes of Fig. 8;

Fig. 9 is a front view, partly broken away for greater clarity, of a tow spinning machine equipped with a heating system of the type of Figs. 1 and 8.

Fig. 10 is a vertical transverse section on the line 10—10 of Fig. 9.

In Fig. 1 a heating system embodying the invention is diagrammatically indicated as comprising an ultra high frequency generator 2, open transmission line comprising parallel conductors 4 and 6 and six heating stations 8 each comprising a pair of electrodes connected across the conductors 4 and 6. In accordance with the invention, the length of the line is correlated with the frequency of the generator 2 so as to be an integral number of electrical half wave lengths of the generated energy, and the electrodes of the heating stations 8 are connected to the respective conductors at points one-half wave length apart, the station nearest the generator 2 being one-half wave length, or an integral multiple thereof, from the generator. With this arrangement, the line comprising parallel conductors 4 and 6, is tuned and will have standing waves thereon, the voltage loops of which will be at the locations of the heating stations 8. The standing voltage wave on the open line is indicated graphically in Fig. 1 by the dotted line V. Thus, alternating electric fields of maximum intensity are set up between the electrodes at each station 8, and no separate

5 waveguide, or hollow conductor, type, in which, by reflection, standing waves may be set up. In such type of resonant line, as in the parallel conductor and co-axial types, the heating stations 10 will be located at the positions of electrical field maxima. In Fig. 7, which illustrates a heating system utilizing such type of line, a closed rectangular wave guide is indicated at 31. Standing electric and magnetic waves are set up with- 10 in the guide, as by means of the coupling coil 32 connected to the generator 2. Aligned slots 33 positioned at the maxima of the electric fields define the heating stations for material passed through the waveguides.

15 In the foregoing description of the diagrams of Figs. 1 through 7, although the station locations have been indicated as fixed and as separated by one-half electrical wave length of the frequency of the oscillator, it will be understood
20 that in any actual construction of a heating system embodying the invention, a station need not be located at each electric field maximum and provision would be made for adjustment of station spacing to compensate for changes in electrical wave length introduced when one or more
25 of the heating stations is inactive, that is, when dielectric material is not being passed there-through. In the systems of Figs. 2 to 4, the length of the aligned slots allows such adjustment of station separation when the material is small
30 compared to the length of the slot.

Also, to insure uniform heating at each station, means would preferably be provided for compensating for loss in the line with increase in distance from the generator. In Figs. 8 and 8a, a heating system, of the general type of Fig. 1, is shown in which the location along the line of the heating stations may be varied and in which means are provided for compensating for line loss. In Fig. 8, parallel conductors 4b and 6b of the resonant line are connected at one end to the oscillator 2b. A plurality of heating stations, each comprising a pair of electrodes 8a and 8b, are located along the line. The electrodes 8a and 8b are so supported from the respective conductors 4b and 6b as to be adjustable both longitudinally along the line and transversely thereof. For this purpose each electrode mounting includes a sleeve or collar 3 which is slidable on the associated conductor 4b or 6b but is keyed against rotation thereon by a finger 5 sliding in a longitudinal groove in the conductor. The electrode is carried by a rod 9 which extends through a lug 11 integral with the sleeve 3; a set screw 48 being provided to permit of adjustment of the distance of the electrode from the conductor. With the above described arrangement the location of the heating stations along the line may be adjusted to compensate for changes in the locations of voltage maxima with changes in oscillator frequency or with changes in the number of active heating stations or in the power absorbed thereby. Also, the spacing between electrodes may be adjusted so as to decrease the spacing with increasing distance from the generator, as shown in Fig. 8, to compensate for loss in the line. On the other hand, if unequal heating at the stations is desired, the electrode spacing can be adjusted accordingly, the greater the spacing between the electrodes, the less the heat generated in the dielectric.

In using the heating system of Fig. 8, the stations are initially positioned at distances from the oscillator substantially equal to integral multiples of some convenient length. The oscil-

lator is then adjusted to a frequency such that the electrical wave length of the standing waves on the line is equal to twice such length. Further adjustment of the position of one or more stations may then be effected, if necessary, to insure maximum heating, that is, to insure that the stations are at voltage maxima.

The invention has been thus far described without reference to any specific industrial application. One such application will now be described with reference to Figs. 9 and 10. In the conversion by stretch breaking, of continuous filaments such as rayon tow, to fibers of staple length, a more uniform product of superior characteristics is obtained if heat is applied to the tow during the stretch breaking. The heating system of the present invention can be advantageously employed in large scale practice of such heat treatment, as the present invention provides means whereby tow, in each of a plurality of drafting mechanisms where it is being stretch broken, may be simultaneously subjected to uniform heating. Fig. 9 illustrates heating systems of the type of Figs. 1 and 8 arranged for so heating the tow in a plurality of drafting mechanisms.

In Fig. 9, six sections of a multiple drafting machine in which tow may be stretch broken, drafted and spun directly into yarn is shown as equipped with individual heating stations for the tow in each section. Each section of the machine includes an upper pair of feed rolls 34 and 35 and a lower pair of draft rolls 38 and 40. Rolls 34 and 38 are driven rolls, and rolls 35 and 40 are idler rolls; rolls 38 being driven at a greater rate of speed than rolls 34 in order to stretch and break the tow and draft it into yarn. Tow 42, drawn from pirns 44 by the rotation of the feed rolls and fed thereby into the ratch defined by the two pairs of rolls, is nipped by the draft rolls and stretched, broken and drafted thereby. Upon emergence from the ratch, the staple product is spun into yarn on ring spinners 45. In accordance with the invention, a pair of plate electrodes 8a and 8b of the system of Fig. 8 are positioned high in the ratch of each section for passage of the tow therebetween, and these plate electrodes are connected to the parallel conductors 4b and 6b upon which standing waves of ultra high frequency are impressed by the generator 2b.

The generator 2b is positioned at a distance from the first heating station equal to the distance between adjacent stations, and its frequency adjusted so that this distance is equal to one-half an electrical wave length.

As discussed in connection with Fig. 8, uniform heating at each station is obtained by spacing the electrodes closer together as the distance from the generator increases. Adjustment of the electrode spacing may be made at each station, as by the screw means 48, to insure optimum heating conditions. Obviously, heating systems of the types of Figs. 2 to 7, instead of that of Figs. 1 and 8, could be readily adapted for use with the type of drafting mechanism illustrated in Figs. 9 and 10.

From the above description, it will be apparent that the invention provides, by the utilization of resonant lines, an efficient and relatively simple dielectric heating system whereby material at each of a plurality of stations is simultaneously subjected to high frequency electric fields. In the drawings, alternative types of resonant lines suitable for use in the heating system of the in-

vention have been diagrammatically indicated. The invention in its broadest aspects is not limited, however, to any particular type of resonant line as any line having standing waves thereon could be employed.

The following is claimed:

1. The combination with a plurality of adjacent tow stretch breaking units each including feed and draft rolls defining a ratch therebetween, of a heating system for heating the tow in the ratch of each unit comprising a source of high frequency oscillations and a resonant line connected to said source so as to have standing waves associated therewith, said line extending along said units and exposing the tow in each ratch to one of the maxima of electric field intensity and the distance from said source of the path of the tow in each unit being substantially an integral number of electrical half wave lengths of the standing wave associated with said resonant line.

2. The combination with a plurality of adjacent tow stretch breaking units each including feed and draft rolls defining a ratch therebetween, of a heating system for heating the tow in the ratch of each unit comprising a source of ultra high frequency oscillations and a tuned line connected to said source so as to have standing voltage waves thereon, said line extending along said units and exposing the tow in each ratch to high frequency electrostatic fields in the neighborhood of the loops of the standing voltage waves and the distance from said source of the path of the tow in each unit being substantially an integral number of electrical half wave lengths of the standing waves on said tuned line.

3. The combination according to claim 2 wherein said line is a pair of parallel conductors and wherein a pair of electrodes is provided in each ratch for passage of the tow therebetween, each pair of electrodes being connected to said conductors at a distance from said source equal to an integral number of electrical half wave lengths.

4. The combination according to claim 3 wherein the spacing between said electrodes decreases as the distance along said line from said source increases to compensate for dissipation of energy and provide uniform heating of tow in each ratch.

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