

[54] **MULTI-LINE GLUING OF
SUPERIMPOSED LEAVES**

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1969, Pat. No. 3,584,199.

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[58] Field of Search 34/1; 219/10.55

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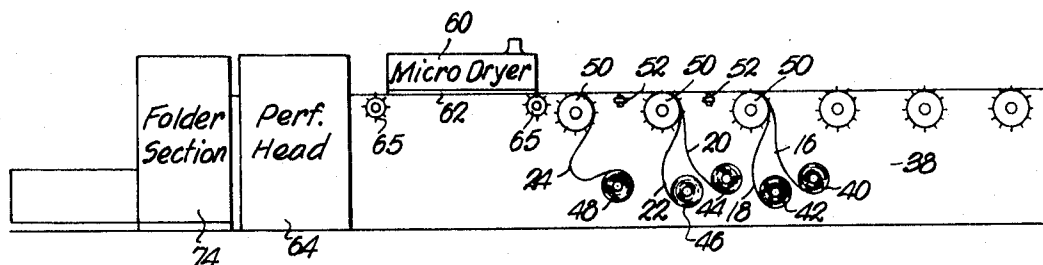
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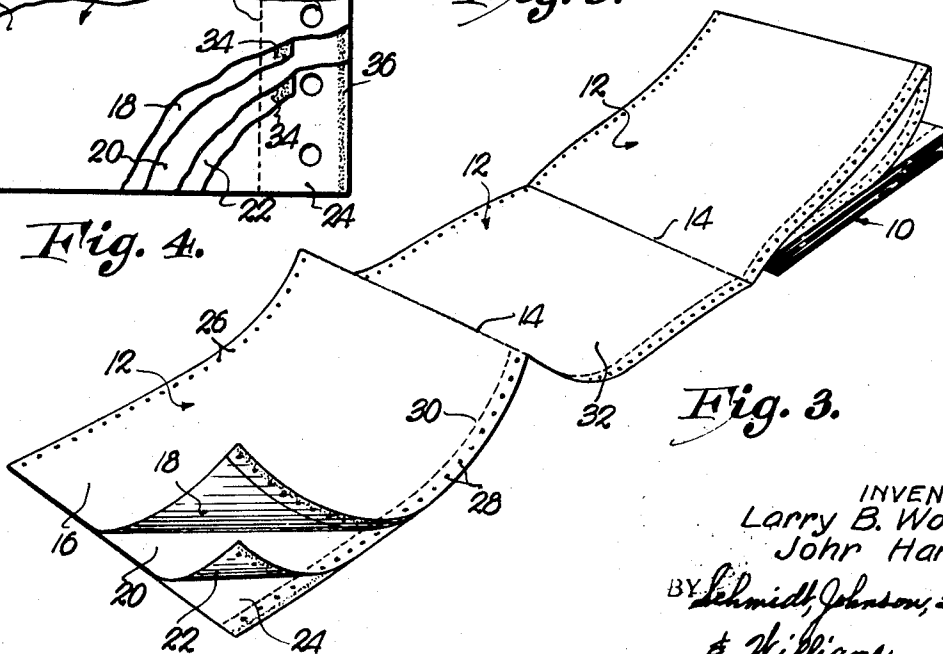
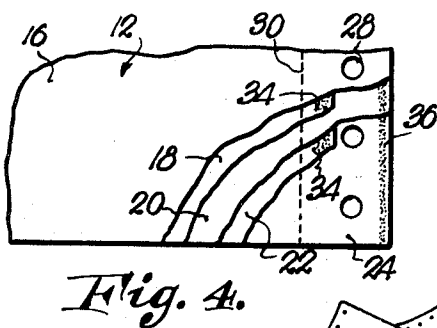
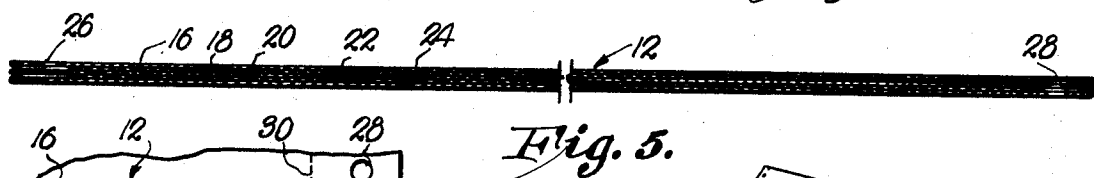
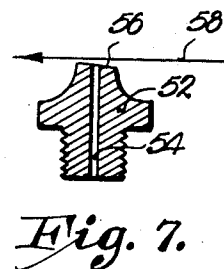
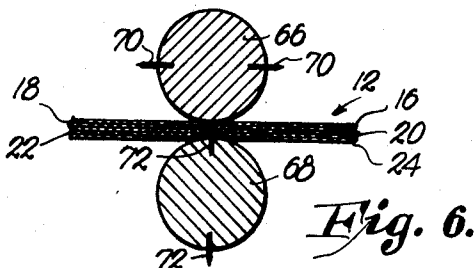
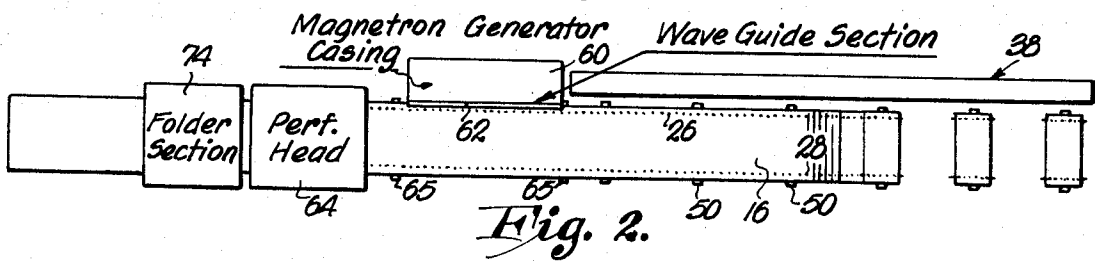
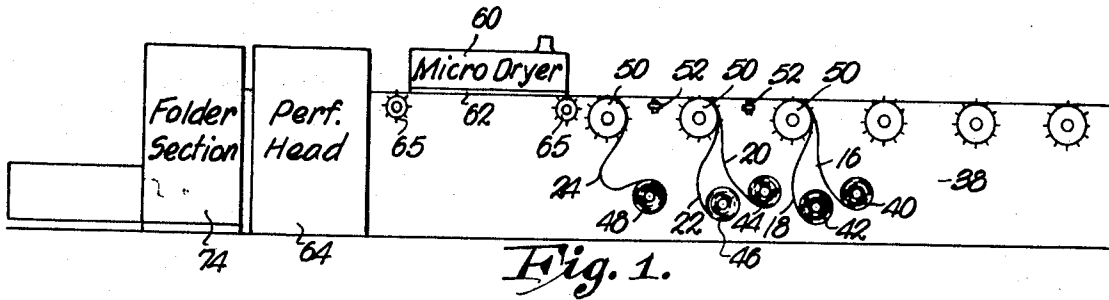
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ABSTRACT

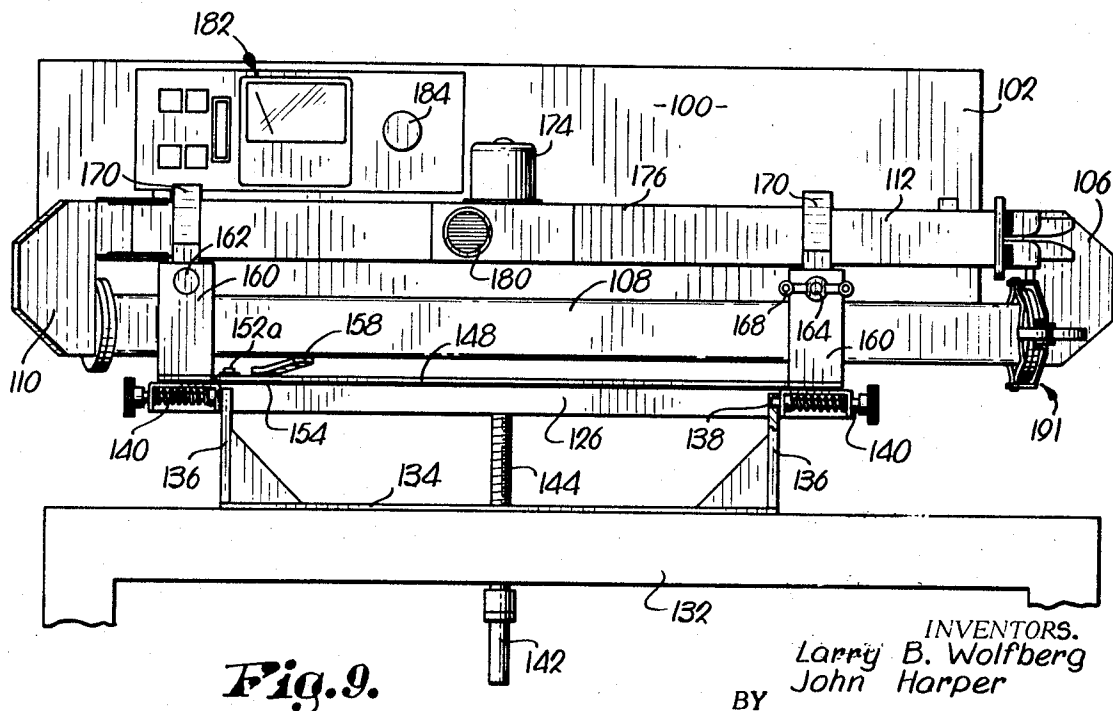
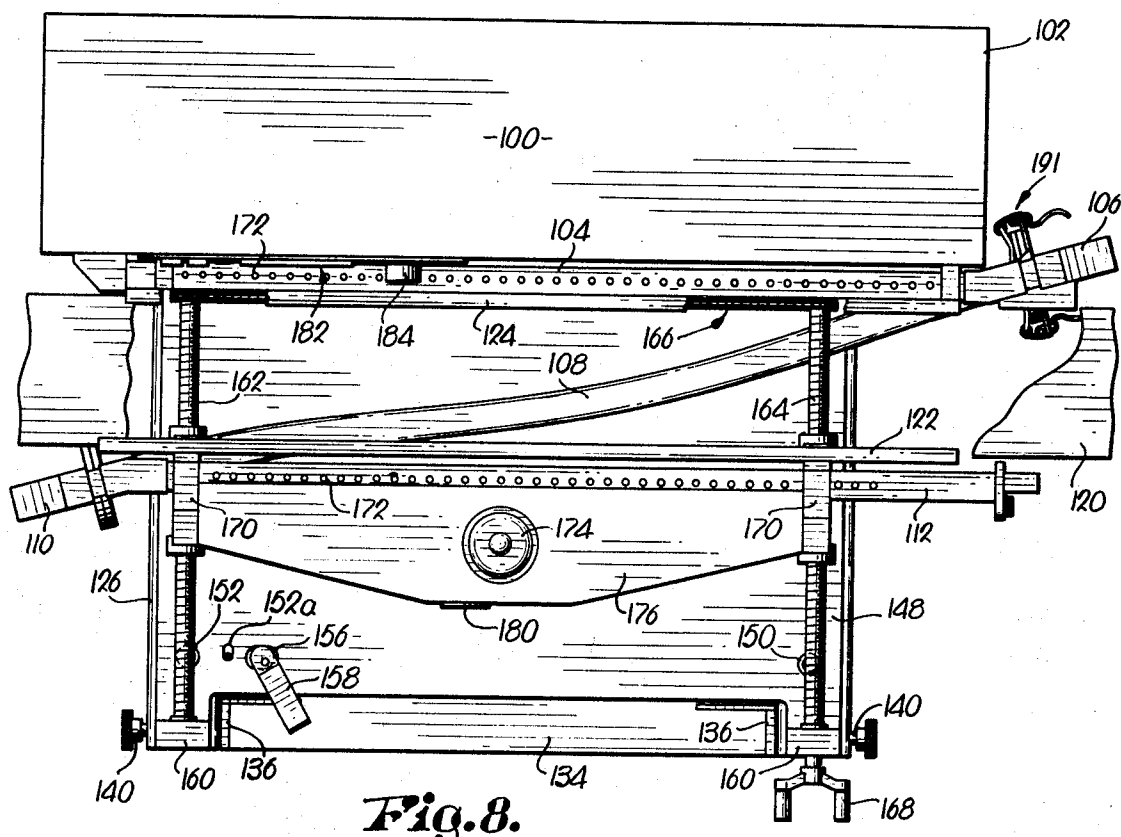
A series of spaced, transverse glue lines and/or one or more longitudinal glue lines, used to join certain of the face-to-face sheets of a continuous web along either or both of its marginal edges, are dried simultaneously, regardless of the width of the web or the spacing between its glue lines, by evaporation of the moisture content of the glue as the web is advanced. Heat energy is applied to the glue lines through use of wave guides that conduct electrical energy in the microwave region, and the amount of heat energy so applied is controlled in accordance with the number of glue lines being dried.

15 Claims, 16 Drawing Figures





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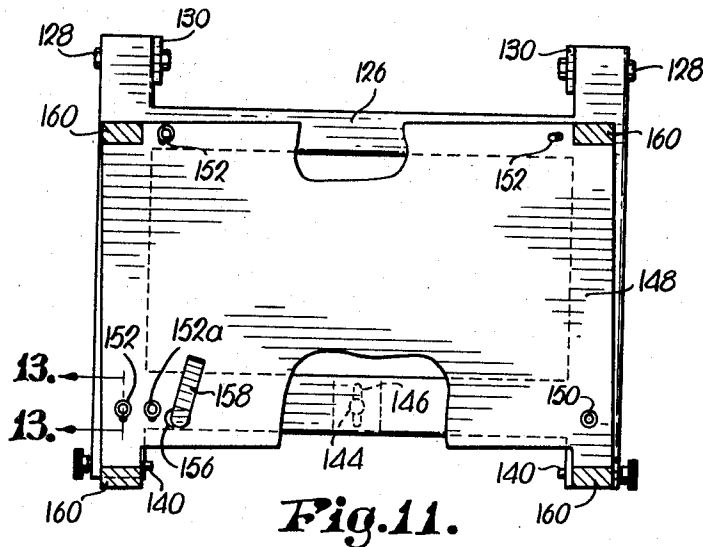


Fig. 11.

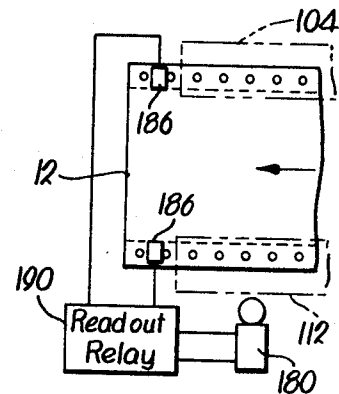


Fig. 15.

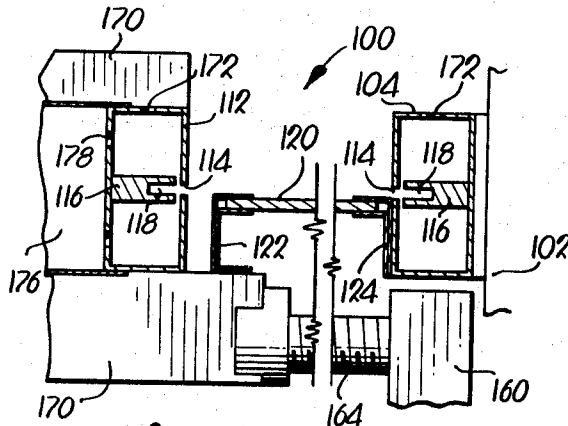


Fig. 12.

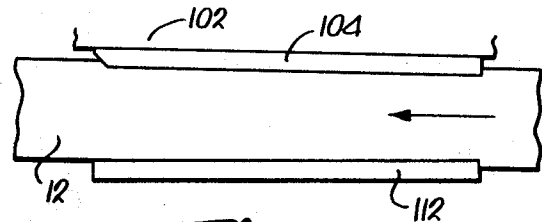


Fig. 14.

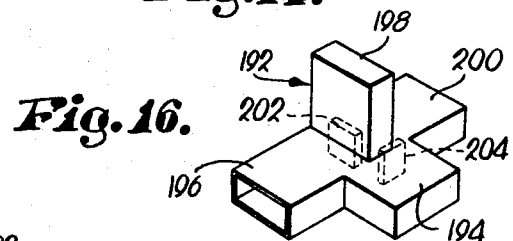


Fig. 16.

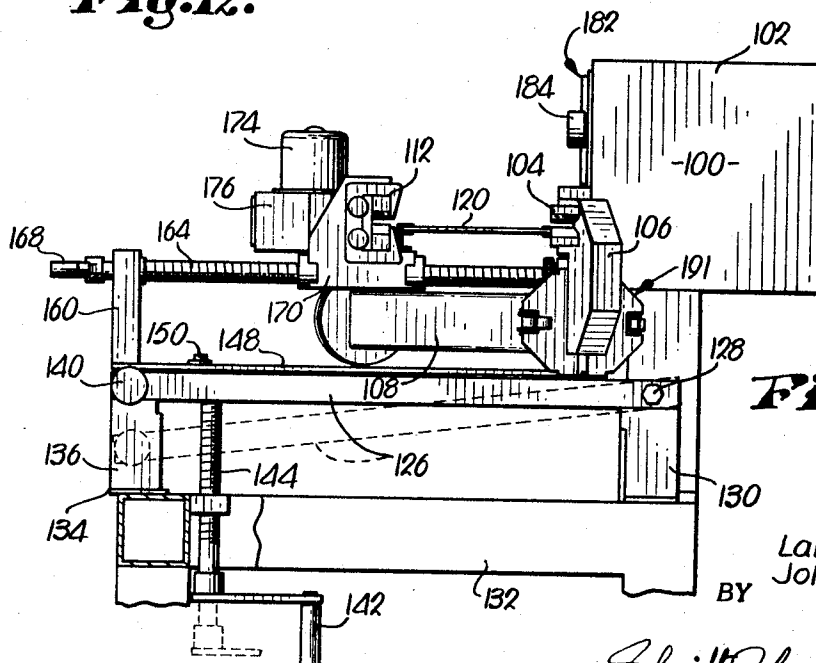


Fig. 10.

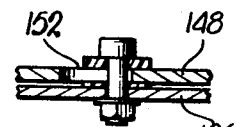


Fig. 13.

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MULTI-LINE GLUING OF SUPERIMPOSED LEAVES

This is a continuation-in-part of our co-pending application Ser. No. 882,256 filed Dec. 4, 1969 now U.S. Pat. No. 3,584,199 and entitled "GLUE FASTENING OF SUPERIMPOSED LEAVES."

In the manufacture of continuous business forms and the like it is extremely important that they be capable of use in automatic, computerized printers and other machines without creating any difficulty such as jamming, damage to the forms, malfunction of the machines or other problems. This necessitates high perfection in the production of the multilayered units whether in the nature of sheets or leaves used as business forms, stationery or otherwise.

By far the most difficult problem is in the line gluing of the sheets together. First of all, there must not be any undue bulkiness at the zone of the glue line. Secondly, the increase in thickness necessitated by the presence of the glue must be uniform and minimal. Thirdly, the glue line may be continuous, if so desired, in absence of spaces therealong where complete interconnection of the sheets cannot be effected. Fourthly, the interconnection must not give way and permit separation of the sheets at any point along the glue line either during production, or during storage and shipment, or during use in data processing printing machines or other equipment.

Conventionally, both the so-called hot and cold glues have been used for this purpose, including both animal and dextrin solutions. And various heating methods have been tried, including infrared thermal radiation to evaporate the liquid content of the glue and to, therefore, effect drying. But, except in cases of rather expensive, slow procedures, no prior method has been entirely successful regardless of the type of glue or heating methods employed.

Particularly aggravating has been the problem known as "tenting" and the problem of build-up bulk caused by the line of glue. The continuous, multicopy sheets to which the present invention relates are folded transversely at equally spaced intervals to present a finished pack which can not only be conveniently stored and shipped but which will unfold as the same is fed to computerized printers, typewriters and other machines. Defective gluing results in separation of the sheets at each line of fold, forming a small triangular bulge known as a "tent." Such condition cannot be tolerated primarily because of malfunction in the aforementioned machines with which the forms and the like are ultimately used.

Still another problem in the assembly and fastening of a number of continuous leaves of paper for use as above explained relates to maintaining the sheets in proper alignment. Consequently, each layer must be rather perfectly aligned, edge to edge, with proximal sheets thereabove and therebelow so that all material printed or typed on the original will be reproduced on the copies, by the effect of interleaved carbon, mechanical or chemical self-contained reproducing paper, in substantially the same location marginally as well as top to bottom. Conventional methods of assembly and interconnection of such continuous, superimposed leaves or sheets of paper through use of glue have not always solved this problem to the complete satisfaction of all users.

It is an important object of our present invention, therefore, to provide a drier and methods which will effectively, rapidly and properly remove the moisture from glue lines whether disposed along either or both of the marginal edges of the web and regardless of the number of such glue lines being dried simultaneously.

Another important object of the instant invention is the provision of a microwave drier and methods that utilize wave guides, through which the glue lines pass as the web is advanced continuously, in such manner as to permit control of the application of heat energy in accordance with the number of glue lines being dried.

Still another important object of the present invention is the provision of a drier in which the amount of electrical energy conducted by one of the wave guides is controlled in accordance with the number of glue lines passing therethrough, and the amount of heat energy applied by a second wave guide is also controlled according to the number of glue lines passing through the second wave guide.

A further object of our instant invention is to provide a drier in which the control of the heat energy applied by the wave guides is effected either by variance in the amount of electrical energy which they conduct or by varying the dwell time of the glue lines within the fields of the wave guides.

A still further object of the present invention is to provide a drier in which the amount of heat energy being applied along one marginal edge of the web with respect to the amount of heat energy being applied along the other marginal edge of the web may be varied in direct relationship to the number of glue lines passing through each of the wave guides, all without burning of the sheets or failure to remove sufficient moisture from any glue line.

Additional aims of our present invention include the provision of a drier wherein the distance between the two primary wave guides may be easily and quickly changed according to the width of the web being processed; wherein the primary wave guides are connected together by a flexible wave guide, permitting input to but one of the primary wave guides from the magnetron used to produce power at microwave frequencies; wherein the second primary wave guide may be shifted to an inoperative position when the web is provided with glue lines along but one of its marginal edges; wherein is provided a moisture detector or a temperature sensitive device to insure application of the correct amount of heat energy; and wherein provision is made for effectively removing the vapors from the wave guides.

FIG. 1 is a schematic, side elevational view of equipment capable of use in carrying out one method of glue fastening of superimposed leaves in accordance with the concepts of our present invention;

FIG. 2 is a schematic top plan view of the equipment illustrated in FIG. 1;

FIG. 3 is a perspective view of a pack of continuous business forms or the like, partially unfolded and with one corner pulled back for illustrating certain details of construction;

FIG. 4 is a fragmentary, top plan view of the forms shown in FIG. 3, the aforementioned corner being broken away for clearness;

FIG. 5 is a transverse cross-sectional view through the forms illustrated in FIG. 3;

FIG. 6 is a fragmentary, longitudinal cross-sectional view through the forms showing one type of cross perforator;

FIG. 7 is a cross-sectional view through one of the nozzles employed in the equipment shown by FIGS. 1 and 2 for depositing a line of glue onto the sheets as they are advanced through the collator;

FIG. 8 is a top plan view of a drier adapted for simultaneous drying of glue lines along either or both marginal edges of the web, parts being broken away for clearness;

FIG. 9 is a side elevational view of the drier shown in FIG. 8;

FIG. 10 is a view showing the inlet end thereof;

FIG. 11 is a fragmentary, horizontal cross-sectional view taken below the wave guides of the drier shown in FIGS. 8-10.

FIG. 12 is an enlarged, fragmentary, vertical cross-sectional view through the two primary wave guides;

FIG. 13 is an enlarged, fragmentary, detailed cross-sectional view taken on line 13-13 of FIG. 11;

FIG. 14 is a schematic view illustrating the step of varying the dwell time in one of the wave guides;

FIG. 15 is a schematic view showing the structure for detecting the correct amount of heat application; and

FIG. 16 is a perspective view of a "T" form type of coupling for the wave guides to control the application of heat energy in a manner different from the method of FIGS. 1-14.

For convenience, the methods of our present invention will hereinafter be described in connection with the production of a pack or web 10 of continuous business forms 12 having equally spaced transverse lines of perforation 14, and especially adapted for use in computerized or data processing printers and other comparable equipment. It is to be understood, however, that such terminology does not preclude advantageous use of our methods in connection with the glue fastening of superimposed leaves or sheets of paper having various other uses, including, therefore, stationery and other products.

The form chosen for illustration of our methods, broadly designated by the numeral 12 as aforesaid, includes a top sheet or leaf of paper 16, a sheet of carbon paper 18 attached to the sheet 16 therebelow, a second sheet of paper 20 beneath the carbon 18, a second sheet of carbon paper 22 beneath the sheet 20 and attached thereto, and a third or bottom sheet of paper 24 beneath the carbon 22. It is to be understood, however, that in accordance with the methods about to be described, the forms 12 may consist of any number of additional sheets as at 16, 20 and 24 with a corresponding number of carbons as at 18 and 22. Moreover, it is not necessary, within the principles of our invention, that the pack 10 include the carbons 18 and 22, or any carbons, as in the case of self-contained reproducing paper, nor do we deem ourselves limited to the lines of perforation 14 because such perforated lines 14 may be eliminated or the continuous sheet 16 and/or sheets 20 and 24 may be entirely severed at the lines indicated by the numeral 14.

Moreover, the product shown in FIGS. 3, 4 and 5 may have rows of holes or openings 26 and 28 adjacent the longitudinal edges of the sheets 16, 20 and 24, but since the carbons 18 and 22 do not extend the full width of the sheets 16, 20 and 24, the holes 26 and 28 do not pass through the carbon paper.

Furthermore, the product chosen for illustration is provided with a longitudinal line of perforations 30 which pass through all of the sheets 16, 18, 20, 22 and 24, presenting a marginal stub 32 which may be snapped away after processing through the printer, thereby separating all of the sheets 16, 18, 20, 22 and 24, and permitting desired distribution of the individual sheets 16, 20 and 24 when the same are torn apart along the lines of perforation 14.

To this end, therefore, and in accordance with the method to be described in connection with FIGS. 1-7 inclusive, the carbons 18 and 22 are attached to their corresponding sheets 16 and 20 respectively by longitudinal lines of glue 34 within the stub portions 32, i.e., outwardly of but adjacent the line of perforation 30. On the other hand, the sheet 16 is fastened to the sheet 20, and the sheet 20 is fastened to the sheet 24 by glue lines 36 extending continuously throughout the length of the stub 32 adjacent the outermost longitudinal edge thereof with the holes or openings 28 located between the glue lines 34 and 36. Our present invention relates essentially to the proper formation of the glue lines 36, as will hereinafter appear.

In FIGS. 1 and 2 of the drawing, a collator broadly designated by the numeral 38 supports the supply drums 40, 42, 44, 46 and 48 for the continuous sheets or leaves 16, 18, 20, 22 and 24 which are advanced horizontally (from right to left viewing FIGS. 1 and 2), to place such sheets in superimposed relationship, by rotatable drive rollers 50 which may or may not have radial pins at their peripheries for receiving the holes 26 and 28 of the sheets 16, 20 and 24.

Collator 38 is equipped with a number of special nozzles 52 for depositing a line of glue on the sheets during their advancement. Such nozzles 52 are especially formed in accordance with the present invention, preferably from a non-oxidizing, malleable or nonmalleable material of required dimensions, as illustrated in FIG. 7 in the drawing. It is extremely important that the nozzle direct a very fine stream of glue to the sheets, and while we have been successful in carrying out our methods by the selection of an orifice 54 for the nozzles 52 that has a size in the order of from 0.005 to 0.0937 inches, our invention is not necessarily restricted to such dimensions.

Moreover, in order to cause the glue to rise and string out before reaching the sheets, thus forming narrower glue lines 36 of minimum thickness than is made possible by a standard nozzle, we have cut the head 56 of the nozzle 52 at an angle of approximately 5°, the sheets traveling with respect to the head 56 in the direction of arrow 58 in FIG. 7.

We have found that the so-called hot glues universally used in many applications within this field are not entirely satisfactory for use in connection with our present method for many reasons including the fact that such glues must be reduced both in temperature and in moisture content before they effectively bond the sheets together and there is no satisfactory drying and cooling means for such glues which will permit high speed production at relatively low manufacturing costs. Moreover, the hot glues form a jelly on reduction of temperature, causing them to grab onto the fibers of the paper too quickly, thereby aggravating the problem of maintaining the sheets in proper alignment, i.e., with their holes 26 and 28 in full and direct register.

We have also determined that the conventional animal and dextrin glues are not entirely satisfactory because of the fact that solids are in suspension within the liquid content thereof such that glues of that type are too slow to set up and dry and not conducive to obtaining the rather large number of desired results made possible through use of our present method.

Therefore, in accordance with our invention, the glue to be dispensed from the nozzles 52 is desirably a cold glue that is easy to handle, requiring no heat to maintain it in a fluid condition and requiring no equipment for reduction of the temperature thereof, it being contemplated that the glue emanating from the nozzles 52 be at room temperature. In this connection we prefer to use an emulsion having a polyvinyl base with a water content of approximately 40 percent, including the usual plastercizers, and having the polyvinyl acetate solids emulsified therein, as distinguished from dextrin and animal solutions, wherein the solid particles are in ordinary suspension.

Depending upon the base resin, such glues tend to set rather quickly, particularly upon application of pressure, and thereupon are capable of rapid evaporation of their moisture content. Therefore, as soon as the sheets 20 and 24 come into engagement with the glue lines 36 thereabove, such glue tends to immediately grab onto the fibers of the papers and hold them against slippage relatively, but, by the same token, the selected glue is characterized by the fact that sufficient relative slippage between the sheets 16, 20 and 24 is permitted to maintain the holes 26 and 28 aligned and in register while the remaining steps of the process are carried out.

In accordance with our method also, we prefer to use pulsed microwave energy to generate internal heating of the glue in a concentrated area which may be confined to approximately $\frac{1}{8}$ inch wide or less, thereby causing rapid drying and bonding in the stub construction 32 of continuous as well as snap-apart business forms and stationary. Such microwave internal heating in a concentrated area, as distinguished from induced heating over the entire form area, can be produced through use of a magnetron 60 in which the flow of electrons is controlled by an externally applied magnetic field to generate power at microwave frequencies, such very short electromegnetic waves normally being between approximately 100 centimeters and one centimeter in wave length. Such microwaves, in the vicinity of about 2,400 megacycles, are capable of developing tremendous heat and energy, combined in a relatively small space conducted to the exact zone where heat is needed without introduction of undesired heat into those areas of the sheets where the paper and the carbon might be adversely affected, which has been a detriment to optimum results in all previous systems and methods. Accordingly, the wave guide section 62 of the magnetron generator 60 need not exceed more than approximately four feet in length thereby reducing the drying time to a minimum and permitting high speed production. Such internal heating of the glue to evaporate its moisture content prevents damage to the carbon papers 18 and 22 because their oil based carrying agent will not dry out, nor will there be any spoilage of the paper sheets 16, 20 or 24 by burning or scorching.

It has been found advisable also to use pinned drums, rollers or the like 64 at the drying section to move the superimposed sheets simultaneously along the section 62 and maintain them in proper alignment until such time as the glue is completely dry and full and effective bonding of the sheets together has been effected. As above mentioned, the glue which we have selected permits sufficient slippage of the sheets relatively to cause such proper alignment during first contact of the paper parts. Yet, because of the fast setting characteristics of the glue after water has been removed by microwave created heat, the complete, firm and final fastening of the sheets one to another is made possible during the very short period during which the glue lines 36 are subjected to the generator 60.

From the dryer 60 the sheets are advanced through a perforating head 64 to produce the transverse lines of perforation 14. It is of course possible to interpose the head 64 ahead of the dryer 60, but the step of perforating tends to shift the sheets out of alignment and we have, therefore, found it to be preferable to have complete and firm bonding of the sheets prior to subjecting them to the perforator 64.

In FIG. 6 of the drawing there is illustrated upper and lower perforating drums 66 and 68 provided with diametrically opposed perforating blades 70 and 72 respectively and timed in their rotation such as to alternately perforate the sheets along the lines 14 from the top and from the bottom. Such alternating function of the drums 66 and 68 of the head 64 is advantageous from the standpoint of proper folding in folder section 74 along the lines 12 to produce the pack 10 as shown in FIG. 3. Alternately, the drum 68 could be in the form of an anvil with all of the blades on the drum 66 such that formation of the lines 14 would be from the top only, but such arrangement causes a "back-fold" on every other cross perforation which limits the number of superimposed sheets to no more than eight and in turn is less desirable than drums of the kind illustrated at 66 and 68 in FIG. 6 of the drawing.

It is now apparent that with the sheets 16, 20 and 24 fully and properly bonded together along the glue lines 36, there will be no separation or tenting at the lines of fold along the perforation lines 14, eliminating, therefore, the problems of jamming and other malfunctions which are quite common in the use of a product of this nature in printing machines and other equipment.

In order to accomplish the desired results as hereinabove initially outlined, it is also extremely important that the glue lines 36 be very narrow and of minimal thickness for many reasons. By providing for only sufficient surface impregnation of the paper fibers such as to effect good bonding, the stub area 32 will not become unduly rigid and inflexible along the glue lines 36, not only making it possible to form the sheets into a compact stack 10, but reducing problems incident to the feeding of the forms through computerized printers and the like. Such minimum bulkiness at the glue lines 36 is made possible by applying the glue continuously and uniformly and by selection of a glue nozzle, as well as a drying process, which will eliminate zones of separation along the glue lines 36 and eliminate formation of dried glue crystals, lumps and the like which are incapable of holding the sheets properly bonded together.

It is to be understood also that our method is not limited to the use of the glue line 36 only along one longitudinal edge of the forms 12; in certain instances it is desirable or necessary to duplicate the glue applying and drying steps along that edge of the forms 12 having the openings or holes 26 therein. Our invention is also fully adaptable for use in making various types of snap-out forms, as above indicated. Moreover, it is not necessary to utilize the stub feature 32 with the line of perforations 30 in the manner and for the purpose above described.

Concentrated heating along the glue lines 36 is important because it avoids damage to the carbons 18 and 22. In some instances, processed carbons are used having the same width as the sheets 16, 20 and 25 with the holes 26 and 28 also passing through the carbon sheets. However, the marginal edges are kraft paper, not carbonized; hence, even in such instances our method will not damage the adjacent carbon areas.

Our invention also contemplates a complete and proper method of fastening the entire set of forms together by the application of the glue lines to the face and back of paper sheet 20, whereby the glue lines are applied so as to fasten the paper to the carbon below, and this carbon in turn is fastened to the sheet below it, thus accomplishing the manufacture of extremely flexible forms which will allow the complete set to pass easily around the platen of a typewriter or a computer printer which utilizes a small, round platen and, therefore, is more prone to jam when a bulky form is passed over and around the small platen. This is to be done by the use of processed carbon paper with the holes 26 and 28 also passing through the carbon sheets, thus allowing the pins on the drums to function in their capacity of moving the sheets forward while the gluing and drying functions are being performed. Under special conditions where a wider stub is permissible, this form of construction can be effected without the use of the holes 26 and 28 in the carbon, by moving the carbon away from the edge and applying the glue and microwave heat to the form on the inside areas of the pin feed device.

Important also is the fact that our method may be accomplished without the necessity of using slow speed zigzag type folders with tucker blades, thereby enabling the use of high speed folding equipment such as, but not limited to, spiral and/or air jet or vacuum type folders operating at their fullest rated speed and capacity.

While application of the adhesive is in the form of a continuous, elongated, narrow, thin line, which is preferred, our invention is also adaptable to spot gluing or to interrupted lines. In certain instances it may be desirable, for example, to omit the glue at the lines of fold.

Web 12 may also be used in connection with a drier 100 shown in FIGS. 8-13, with two or more sheets 16, 20, 24, etc., having one or more longitudinal glue lines 36 (or rows of glue spots) along each or both of the marginal edges of the web 12. That is to say, all of two or more sheets may be joined by glue lines 36 along either or along both marginal edges of the web 12, or there may be one or more glue lines 36 along one edge of web 12 and a greater or lesser number of glue lines 36 along the other edge of web 12, with or without carbons 18, 22, etc., and with or without stubs 32.

To this end then, there is provided a magnetron 102 for producing power at microwave frequencies and directing the electromagnetic waves so produced along a first primary, elongated tubular wave guide 104 that it parallel with the path of travel of the web 12. The electrical energy, received at one end of the main wave guide transmission line 104 is then directed from the opposite end of the latter to an elbow joint 106 coupling the wave guide 104 with a flexible, diagonally disposed wave guide 108. Another elbow joint or wave guide "U" 110 directs the energy into a second primary wave guide 112 that is shiftable into and out of parallelism with the wave guide 104, as well as into and out of the same horizontal plane as the wave guide 104. Manifestly, each of the junctures 106 and 110 has a curvature for preventing power loss through reflection and is otherwise properly designed in accordance with specifications well-known and understood by those skilled in the art of transmission of microwave energy to branch stubs.

While rectangular wave guides 104, 108 and 122 have been chosen for illustration, they may be circular in cross section if desired, e.g., coaxial cables, and the wave guides 104 and 112 are each provided with a longitudinal slot 114 (FIG. 12) along its inner face for clearing the marginal edges of the web 12 as it is advanced from right to left, viewing FIGS. 8, 9, 11, 14 and 15. Longitudinally extending reflectors 116 rigidly mounted within the wave guides 104, and 112, have longitudinal grooves 118 aligned with the slots 114 for receiving the corresponding marginal edges of web 12 to closely concentrate the electrical energy within the zones of the glue lines 36.

The web 12 is supported during its advancement through the drier 100 by a panel 120 between the wave guides 104 and 112 and above the wave guide 108. Oppositely facing channel brackets 122 and 124, the latter of which is carried by a wave guide 104, removably support any one of a number of panels 120 of differing widths, depending on the widths of the webs 12 being processed.

While wave guide 104 is rigidly supported by the magnetron 102, the wave guide 112 is carried by a polygonal frame 126 disposed beneath the wave guide 108 and swingable about horizontal pintles 128 carried by spaced upstanding standards 130 of a main frame 132 (FIGS. 10 and 11). Frame 132 also carries a U-shaped bracket 134 having upstanding legs 136 which have openings 138 (FIG. 9) for receiving spring loaded pins 140 on frame 126 that releasably hold the latter in its normal, horizontal, operating position. Raising and lowering of the frame 126 about pintles 128 is effected by turning a crank 142 of a screw 144 rotatably supported by frame 132 and depending from the frame 126. The upper end of screw 144 is rotatably attached to frame 126 within a slot 146 (FIG. 11).

Frame 126 supports a plate 148 for swinging movement about a normally vertical pin 150 there being a number of bolt-slot guides 152 for plate 148 (FIG. 11 and 13), one of which (designated 152a) may be used to releasably clamp the plate 148 to the frame 126. On release of such clamp 152a, an eccentrically mounted cam 154, carried by frame 126 within an oval slot 156 formed in plate 148, is used to swing the latter about pin 150 by oscillation of a handle 158 rigid to cam 154.

Plate 148 has four upstanding corner posts 160 which rotatably support a pair of screws 162 and 164 joined by a chain and sprocket wheel assembly 166, screw 164 being provided with a handle 168. The wave guide 112 is rigidly secured to follower blocks 170 threaded on the screws 162 and 164.

Wave guides 104 and 112 are each provided with a row of escape holes 172 for steam vapor but such vapors may also be withdrawn from the wave guide 112 by a suction blower 174 on a chamber 176 that is in turn supported by follower blocks 170. Chamber 176 communicates with vapor ports 176 in wave guide 112, and blower 174 is provided with a vapor outlet 180. A similar suction blower arrangement may be provided for the wave guide 104 if desired or needed.

In operation, as the web 12 is directed along the panel 120 in the direction of the arrow in FIG. 14, its marginal edges pass along the slots 114 of the wave guides 104 and 112 and the glue lines 36 pass along the grooves 118 of the reflectors 116, subjecting the glue lines to the action of the electrical energy concentrated in the grooves 118. The glue lines 36 absorb such electrical energy to thereby apply heat energy and thus raise the temperature of the glue lines 36, causing evaporation of the moisture thereof. In the event that an equal number of glue lines 36 is placed along each of the marginal edges of web 12, the amount of electrical energy input to the wave guides 104 and 112, and therefore the amount of heat energy applied to all of the glue lines 36 will normally be the same. A control panel 182 on the casing of the magnetron generator 102 is illustrated in FIG. 8-10, the controls including an automatic tuning assembly and a control knob 184 for adjusting the energy input to that end of wave guide 104 opposite to the juncture 106.

Manifestly, too much heat will tend to burn or scorch the web 12 or, if the remaining moisture content of the glue lines 36, after the web 12 leaves the drier 100 is too high, the glue lines 36 have not been sufficiently dried. Therefore, as an indication to the operator that adjustment of the input energy should be made, there are provided as shown in FIG. 15, moisture detecting devices or temperature sensitive devices 186 to read out the conditions existing at the trailing ends of the wave guides 104 and 112. Devices 186 are aligned with the corresponding energy fields and may be operably coupled with an alarm 188, such as a bell or buzzer, through a read-out relay 190.

The load to which the energy fields are subjected depends upon the number of sheets 20 passing therethrough, the nature of the paper or other materials from which the sheets 20 are made, the number of glue lines 36 and the temperature and humidity conditions, the speed of advancement of the web 12, and many other factors. Thus, by observing the web 12 as it passes beyond the devices 186 to detect any excess heating, and by listening for the alarm 188, the operator may quickly and easily make the proper adjustment by manipulation of the knob 184 or by adjusting the position of the glue line in relation to the energy field.

Drier 100 is also capable of handling webs 12 of various widths. It is but necessary to manipulate the handle 168 in order to shift the wave guide 112 toward and away from the wave guide 104. Rotation of screw 164 also rotates the screw 162 through assembly 166, caus-

ing the followers 170 to travel along the screws 162 and 164. The flexibility of wave guide 108 permits such adjustment, and panels 120 of suitable widths may be then interchanged in the brackets 122 and 124.

In the event that the load on the electrical energy passing along the wave guide 112 is less than the load on the electrical energy passing along the wave guide 104, as for example, a fewer number of glue lines 36 being dried by the wave guide 112, the application of heat energy within the wave guide 112 may be controlled separately from the wave guide 104. This is accomplished by varying the amount of electrical energy to which the glue lines 36 in wave guide 112 are subjected. It is but necessary to release the clamp 152a and turn the handle 158 in order to swing the plate 148 about the pivot pin 150, causing the wave guide 112 to swing out of parallelism with the wave guide 104 as illustrated in FIG. 14.

Thus, the glue lines 36 subjected to the energy field of wave guide 112 dwell therein for a lesser period of time than the glue lines 36 subjected to the energy field of wave guide 104. FIG. 14 illustrates the way in which the marginal edge of web 12 proximal to wave guide 112 emerges from within the latter before the opposite marginal edge of web 12 emerges from wave guide 104, thereby providing for the dwell time differential. After handle 158 has been rotated to the proper adjustment, clamp 152a is then again manipulated to hold the plate 148 rigidly attached to the frame 126. It is to be noted that the amount of movement of plate 148 is rather slight, permitting the bracket 122 to shift relative to panel 120 without releasing the latter.

In connection with the above, either or both of the wave guides 104 and 112 may be so adjusted for dwell time variance by merely providing the wave guide 104 with a swingable supporting plate 148 of the kind above described. Moreover, either or both of the wave guides 104 or 112 may be shifted through a manipulation of handle 168 by alteration of the structure specifically shown and described above.

Oftentimes, large runs over a considerable period of time are made with webs 12 having one or more glue lines along but one of its marginal edges, in which event it is desirable to move the wave guide 112 entirely out of the way. Retraction of wave guide 112 through use of the handle 168 and removal of panel 120, followed by a release of the pin 140 from within the openings 138 and manipulation of the crank 142 will cause screw 144 to swing the frame 126 downwardly about the pintles 128 (FIG. 10). This places the wave guide 112 essentially below the level of the advancing web 12. A releasable connection 191 is provided between the wave guides 104 and 108, permitting the latter to be swung out of the way into underlying relationship to wave guide 112, whereupon the end of wave guide 104 proximal to connection 191 is suitably capped.

Still another method of controlling application of heat energy in accordance with the number of glue lines being dried, by varying the amount of electrical energy to which the web 12 is subjected, may be provided by the use of a "T" form 192 of the kind shown in FIG. 16. Form 192 is commonly referred to as the "magic" or "hybrid" T and is provided with four arms 194, 196, 198 and 200 and with two matching devices 202 and 204. Form 192 may be used either as a sub-

stitute for the juncture 106 or the juncture 110, or may be installed between the magnetron 102 and the wave guide 104.

If the electrical energy is directed into arm 194 and the outer ends of arms 196 and 200 are effectively closed so as to eliminate reflection therein, no power will be carried by arm 198; all of the energy will pass into arms 196 and 200. On the other hand, if the wave is directed into arm 198 and the remaining arms are closed to absorb without reflection, no power will pass into arms 196 and 200.

But, if arms 194 and 198 are matched at their terminations so as to eliminate reflections, arm 196 is unmatched, and the energy is fed to arm 198, a reflection will be effected in arm 196. The reflected wave will return to the common juncture of the arms, producing power flow in arms 194, 198 and 200. If arms 196 and 200 are not matched at their closed ends, the energy directed to arm 198 will flow along arm 194.

Accordingly, if form 192 is used in lieu of juncture 106, the amount of energy from wave guide 104 to wave guide 108, and therefore, wave guide 112, may be adjusted in accordance with the heat energy requirements of the wave guide 112. The same results can be accomplished by using form 192 in lieu of the juncture 110. When used between the magnetron 100 and the wave guide 104, the form 192 may be employed as a heat sink or for the purpose of directing the energy from a single power supply 100 into two separate driers.

It can now be seen that components have been provided to enable either simultaneous gluing along both edges of web 12 in varying distances from the normal right hand lines 36 of glue, or, optionally, on either the "outboard" or "inboard" side or edge of the web 12. Because of the varying distances that the "outboard" glue lines 36 may be required from the regular "inboard" lines 36 of glue, there are provided practical methods of moving or otherwise controlling the confined narrow band of microwave energy conducted by wave guide 112. Inasmuch as the balance of the microwave energy on either or both "inboard" and "outboard" sides is important, as is the design and tolerance required within the wave guides themselves for conveying microwave energy throughout the wave guides, there is presented a drier 100 which may be successfully used with varying distances between the glue lines 36 and which also has a simple method of balancing the energy on either the "inboard" or "outboard" wave guide. Drier 100 permits adjustment wherein the "outboard" microwave energy may be applied 100 percent or varied below 100 percent of effectiveness as conditions require.

We have also found that it is desirable to provide for the aforementioned automatic tuning which tunes the microwave chambers to the most optimum resonance for drying the glue at any power setting. This is important for efficient operation of our novel methods, and when used in conjunction with the variable angle of the "outboard" wave guide 112 in relationship to correspond to the lines of glue 36, there are presented two novel features that are important to successful microwave drying of the lines of glue on computer forms.

The arrangement is such that the changeover from single to double glue lines 36 will not require more down time than is needed to bring the second stub drier 112 into position without the necessity of removing or adding any loose sections to the assembly. The wave guide 108 connecting the two assemblies 104 and 112 may be released without the use of bolts, screws or other inconvenient devices. This is accomplished by the use of the quick release clamp mechanism 191 which interconnects the wave guides 104 and 112 when needed, or properly terminates the wave guide 112 when using drier 100 for single stub mode only.

The generator 102 must be capable of maintaining stability over all operating conditions, and the regulating of power to the outboard side may be effected by the variation of angle of the stub 112 in relation to the inboard chamber 104 by the use of the plate 148 mounting of the wave guide 112, which is pivoted at 150 to allow the necessary variation of angle of approach, thus regulating the amount of heat without the necessity of requiring a double tuning system. In order to simplify the operator's requirements, the automatic tuning will compensate for varying loads passing through the machine 100 without the necessity of the operator having to retune to resonance as the conditions change. This will allow the operator to apply the required amount of heat to any given form 12 merely by setting the energy control 184, eliminating the necessity of tuning. This feature in conjunction with the variable angle or the variable energy flow of the wave guide 112 produces a commercially usable drier 100 with minimum amount of adjustment and changeover requirements. Also, in order to effect a clean configuration of the complete apparatus 100, the wave guide 112 is hinged at 128 in such manner as to descent into the area below the level of web 12 when wave guide 112 is not in use.

While the above description has been directed solely to longitudinal glue lines, and to the manufacture of more or less "regular" type business forms, our invention is also applicable to the drying of transverse glue lines as well as to the manufacture of "specialty" type business forms. For example, continuous webs of envelopes requiring remoist type glues may also be advanced through a microwave energy field in accordance with the concepts above set forth by use of a wave guide in the nature of a pair of spaced apart plates between which the web is advanced. In this manner, a series of longitudinally spaced glue lines disposed transversely of the web may be rapidly and effectively dried, keeping in mind proper dwell time and/or required energy control. Wave guides of such nature may be used also to dry one or more longitudinal glue lines simultaneously with or separately from the drying of a series of transverse glue lines.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively,

said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof; and

structure for controlling said application of the heat energy in accordance with the number of glue lines being dried,

said structure including means for shifting at least one of said wave guides to any one of a number of positions where the proximal edge of the web passes through only a portion of said one wave guide.

2. A drier as claimed in claim 1 wherein said one wave guide is normally parallel with said proximal edge and wherein said shifting means positions the one wave guide into angular relationship to said proximal edge.

3. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively,

said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof,

there being a source of said electrical energy coupled with one of said wave guides,

the other of said wave guides receiving its electrical energy from said one wave guide through a third wave guide coupling the one wave guide with said other wave guide; and

structure for controlling said application of the heat energy in accordance with the number of glue lines being dried,

said structure including means for varying the amount of the electrical energy input to said other wave guide,

said means including a detachable coupling for said third wave guide.

4. A drier as claimed in claim 2 wherein is provided a support, said shifting means including a member swingable on the support and having means mounting said one wave guide thereon.

5. A drier as claimed in claim 4 wherein said mounting means is movable on the member for varying the distance between the wave guides.

6. A drier as claimed in claim 2 wherein a source of said electrical energy is coupled with one of said wave guides, and the other of said wave guides receives its electrical energy from said one wave guide through a third wave guide coupling the one wave guide with said other wave guide, wherein said wave guides are provided with a detachable connection for conduction of said electrical energy therebetween, and wherein said third wave guide is swingable to an inoperative position when said connection is detached.

7. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively,

said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof;

a source of said electrical energy being coupled with one of said wave guides,

the other of said wave guides receiving its electrical energy from said one wave guide through a third wave guide coupling the one wave guide with said other wave guide; and

means for varying the distance between said one wave guide and said other wave guide in accordance with the distance between the glue lines along one of said edges and the glue lines along the other of said edges,

said third wave guide being flexible.

8. A drier as claimed in claim 6 wherein said structure includes means for varying the amount of electrical energy input to said other wave guide.

9. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively,

said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof,

there being a source of said electrical energy coupled with one of said wave guides,

the other of said wave guides receiving its electrical energy from said one wave guide through a third wave guide coupling the one wave guide with said other wave guide; and

structure for controlling said application of the heat energy in accordance with the number of glue lines being dried,

said structure including a first means for varying the amount of electrical energy input to said one wave guide, and a second means for varying the amount of electrical energy input to said other wave guide.

10. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively, said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof, there being a source of said electrical energy coupled with one of said wave guides, the other of said wave guides receiving its electrical energy from said one wave guide through a third wave guide coupling the one wave guide with said other wave guide; and structure for controlling said application of the heat energy in accordance with the number of glue lines being dried, said structure including means for varying the amount of electrical energy input to said other wave guide, said structure including means for varying the amount of electrical energy from said one wave guide to said third wave guide.

11. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively, said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof, there being a source of said electrical energy coupled with one of said wave guides, the other of said wave guides receiving its electrical energy from said one wave guide through a third wave guide coupling the one wave guide with said other wave guide; and structure for controlling said application of the heat energy in accordance with the number of glue lines being dried, said structure including means for varying the amount of electrical energy input to said other wave guide, said structure including means for varying the amount of electrical energy from said third wave guide to said other wave guide.

12. A method of removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, said method including the steps of:

advancing the web along a path of travel parallel with said edges; subjecting said edges to a field of electrical energy in the microwave region flowing along each of said edges respectively as the web is advanced,

whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof; and

varying the dwell time of one of said edges in one of said fields with respect to the dwell time of the other of said edges in the other of said fields whereby to control said application of the heat energy along said one edge in accordance with the number of glue lines being dried along said one edge.

13. A method as claimed in claim 12, and varying the amount of electrical energy input to said other field in accordance with the number of glue lines being dried by said other field.

14. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively, said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof,

there being a source of said electrical energy coupled with one of said wave guides,

the other of said wave guides receiving its electrical energy from said one wave guide through a third wave guide coupling the one wave guide with said other wave guide; and

structure for controlling said application of the heat energy by each wave guide respectively in accordance with the relationship of the number of glue lines along one of said edges to the number of glue lines along the other of said edges.

15. A drier for removing moisture from one or more glue lines extending longitudinally along each or both marginal edges of a web of continuous sheets, arranged in face-to-face relationship, as the web is advanced along a predetermined path of travel, said drier including:

an elongated wave guide adapted for conduction of electrical energy in the microwave region and disposed along each of said edges respectively, said wave guides having longitudinal clearance slots for passage of said edges therealong and through the wave guides as the web is advanced, whereby the glue lines absorb said electrical energy to thereby apply heat energy and raise the temperature of the glue lines, causing evaporation of said moisture thereof; and

structure for controlling said application of the heat energy in accordance with the number of glue lines being dried,

said structure including means for varying the dwell time of one of said edges within one of said wave guides independently of the dwell time of the other of said edges within the other of said wave guides.

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