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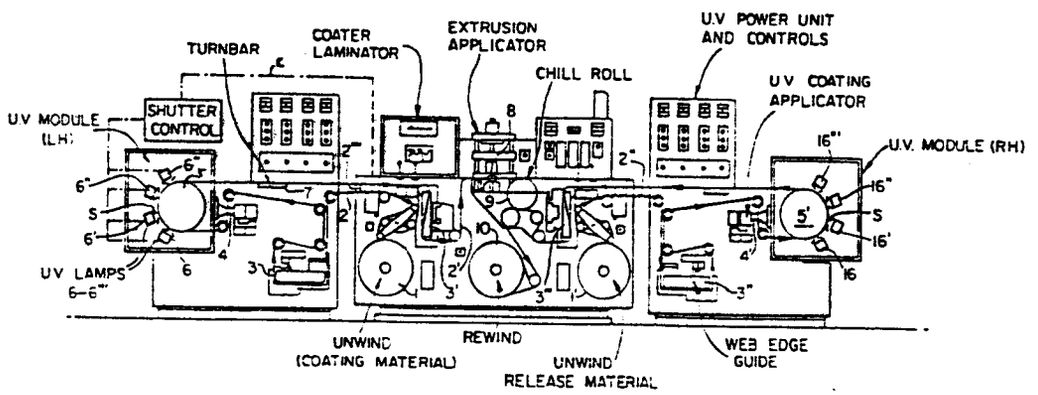
(54) **Method of and apparatus for producing adhesive-coated sheet material usable with radiation-cured silicone release coatings.**

(57) A method and apparatus are disclosed for enabling integrated in-line synchronous hotmelt or similar adhesive coatings of web materials and simultaneously radiation-cured silicon coatings for use therewith, as for release purposes, through the use of coating and curing stations controlled with web speed and compatably with the adhesive application and hardening steps.

FIG. 1.



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METHOD OF AND APPARATUS FOR PRODUCING ADHESIVE-COATED SHEET MATERIAL USABLE WITH RADIATION-CURED SILICONE RELEASE COATINGS

The present invention relates to methods of and apparatus for coating sheet material with hot or cold-melt adhesives and the like, and for enabling such sheet material to be rolled or otherwise stacked with the aid of intermediate radiation-cured silicone coatings which prevent adhesion of adjacent surfaces of the adhesive-coated layers on the sheet material.

Considering, for example, the area of coated tapes, in the current paper-converting industry, hot-melt coating application is applied to a film or paper product which has been previously coated, as on the reverse side, with a silicone emulsion or solvent material. The practical aspects of combining a solvent or an emulsion silicone coating system with a hot-melt coating line reside in the incompatible production speed limitations of the emulsion or solvent system. The normal running speed of a solvent silicone system is approximately 150 feet (45.72m) per minute maximum; whereas, in contrast, the hot-melt application has capability of running up to 1,000 feet (304.8m) per minute, more or less. Typical current solvent emulsion coater systems for applying silicone coatings today are produced by, for example, Max Kroenert Maschinenfabrik (West Germany), Polytype (Switzerland), Faustal (Wisconsin,

United States), and Bolton Emerson (Massachusetts).

Hot melt applications, however, do not have the capability of providing in-line silicone coatings, as well, particularly radiation-cured coatings of various weights and viscosities (UV-ultraviolet, or EB-electron beam cured coatings, for example). So long as the coating of such different material must be effected in multiple different steps or processes, and with separate apparatus, the costs of energy, of converting, of equipment, of labour, etc. provide distinct disadvantage.

For prior art details of typical systems for providing radiation cured silicone coated sheet material and pressure-sensitive adhesive coated sheet material, the former for protecting the adhesive layer on the latter before use, reference may be had to European Patent No 0006705 and UK Patent No 1541311.

An object of the present invention, is to provide a new and improved method of producing sheet material carrying an adhesive coating, as of hot (or cold) melt and the like, and adapted for in-line use with sheet material carrying radiation-cured silicone coatings for enabling release of the sheet material in stacking, such as rolling and the like, that obviates the multiple-step requirements of the prior art and provides the advantages above stated.

A further object is to provide novel coating apparatus for the in-line type of more general utility as well.

According to one aspect of the invention there is

provided a method of producing sheet material carrying an adhesive coating on one surface and adapted for use with radiation-cured silicone for enabling release of the sheet material in stacking, that comprises, applying uncured silicone coating material to one surface of one sheet synchronously as the sheet travels in web form; radiation-curing said silicone coating during travel of the web to provide a cross-linked release coating; synchronously applying adhesive to one surface of a second sheet travelling in web form at the same speed as that of the said one sheet and hardening the same; feeding the said one and second sheets together at the same speed with their respective cured silicone and adhesive coatings in contact and stacking the same together as by rolling.

According to another aspect of the invention there is provided apparatus for producing sheet material carrying an adhesive coating on one surface and adapted for use with radiation-cured silicone coatings for enabling release of the sheet material, comprising means for applying uncured silicone to one surface of one sheet synchronously as the sheet travels in web form; means following the applying means for radiation curing the silicone coating to provide a cross-linked release coating; means for applying adhesive to one surface of a second sheet travelling in web form at the same speed as that of the said one sheet and hardening the same; and means for rolling the first and second sheets together to stack the same with the respective cured silicone and adhesive coatings in

contact.

The invention will now be described by way of example with reference to the accompanying drawing wherein;

Figure 1 is a combined mechanical and block diagram in side elevation illustrating the invention in preferred form;

Figure 2 is a top elevation of the system of Figure 1; and

Figure 3 is a diagram similar to part of Figure 1 showing a modification in accordance with which a silicone-cured barrier coating is provided on the surface that is ultimately to receive the hot or cold melt for adhesive coating.

As used in this specification, the term "coating" or similar terms are intended generically to embrace continuous layers or patterned layers of various sorts, as are well known in the industry. Suitable and preferred hot melt and related adhesive dispensing and nozzle apparatus, as hereinafter described, are, for example, of the type described in United States Letters Patent Nos 3,595,204, 4,202,194 and 4,277,301 of the Acumeter Laboratories, Inc., the assignee of the present application. A suitable electron beam or "curtain" (EB) radiation-curing apparatus that may be used with the in-line system of the present invention is that of Energy Sciences, Inc., as described for example in US Letters Patent Nos 3,702,417 and 3,745,396. Suitable ultra-violet (UV) radiation lamps and the like

may be of the type made by CanRad Hanovia in New Brunswick, New Jersey, though appropriately modified to embody the improvements hereinafter as later described in connection with control of the UV radiation in accordance with the web speed. The term "silicone", while deliberately intended to embrace the various types of UV and EB and related radiation-curable silicones, is generically used herein to cover the wide range of formulations of this type--all being generically embraced within this term as used in the specification and claims.

Referring to Fig. 1, the center module contains a pair of unwind mechanisms 1 and 1', a center rewind 10, and a coating module 8 for hot melt. To the left- and right-hand sides of the center web module radiation-curable silicone coating and UV-curing stations are illustrated having edge guides which maintain web alignment either with a second web or coating stations, as desired. In Fig. 1 the unwind for the silicone coating (as for the making of pressure sensitive tape-type products, for example) passes the web from the

center coating module section to the left-hand UV system. As it emerges at 2, the web passes on to an edge guide 3 and then into the UV silicone coating module station 4 and then into a UV lamp drum chamber having successive lamps 6, 6', 6'', 6''' containing a rearward chill-roll 5. The purpose of the chill roll is to provide web integrity and position around or in front of the UV lamps and also to provide a heat sink to maintain thermal stability in the web, whether it be paper or plastic, as it winds past the arc of radiation lamps. The web with the cross-linked cured silicone release or other coating then passes from the UV module back into the center web module, continuing through an additional edge guide and then passing at the synchronous line speed through the hot-melt coating station 8. The hot melt coating is hardened by passage around another chill roll, thence becoming wound at line travel speed into a roll or other stack. As the cross-linked cured silicone-coated web exits from the UV curing chamber, the web (tape) material must be turned over by the turn bar 7 so as to apply the

hot-melt adhesive onto the non-silicone coated side.

The system of Fig. 1 also enables the use of hot-melt or similar adhesive coated webs with additional webs of silicone or other coatings, again in a synchronous in-line integrated apparatus. For the making of label pressure-sensitive type materials, for example, containing two different web materials with adhesives and silicone coatings, the procedure in Fig. 1 is as follows. The left-hand UV module is not used in this situation, but the right-hand UV module is used together with the center module. The center module contains a label paper web 1 which passes at 2' through edge guide 3' to the coating station 8 with chill roll 9. At this point, unwind 1' delivers the web of uncoated silicone paper at 2'' into an edge guide 3'', entering the silicone coating station 4' and then the UV curing chamber with its arc of lamps 16 through 16'''. This web having the cured silicone coating now on its top side, passes out of the UV module

and returns into the center coating web module through an edge guide 3''' and laminates at the chill roll 9 with the hot-melt adhesive-coated web previously described. The laminate web containing the two webs, respectively carrying contacting hardened hot melt adhesive and radiation-cured silicone is then immediately passed into a rewind roll or stack.

As another example of the flexibility of this integrated apparatus, a barrier-coated product may be readily fabricated with a silicone coating as follows. Such a barrier coating may be desired, for example, to provide resistance to plasticizer migration that occurs with many hot-melt adhesives and which can eventually cause a deterioration in the final product. To overcome such undesirable results, a second UV coating and curing station adjacent to the first station is employed, as shown in Fig. 3. The center coating and web module is located to the extreme right in Fig. 3 with the web of tape material passing through

an edge guide into the UV coating head and curing chamber 6 through 6''', with its backup chill roll 5. The web exits the UV module at its right side and then enters into the second UV module passing downward into an edge guide 3'' and then through the second UV coating station which is now designed for providing the barrier coating. With the barrier coating applied at 4', the web then passes into the UV curing chamber or tunnel with its lamps 16 through 16''' and then exits and passes over a turn-bar section 7' that reverses the web exposing the barrier coating directly to the in-line synchronous application of the hot-melt adhesive at 8. The adhesive is solidified at chill roll 9 and then enters into the rewind system 10.

Returning to further details of the integrated apparatus of Fig. 1, portions of which are also embodied in Fig. 3 as above explained, auxiliary parts are more clearly shown in the top view of Fig. 2. To the extreme left-hand side in the rear section are shown the silicone fluid

delivery systems to be used, identified at 4. Directly behind the center web and coating module section is an adhesive system for the hot melt which delivers adhesive to coating station 8. And to the extreme right is a duplicate of the silicone delivery system for coating station 4'.

The integrated coating method and apparatus of the invention have the capability of producing packaging tapes encompassing plastic film materials, such as polypropolene and high-density polyethylene, and base paper products such as craft papers, reinforced or otherwise, as well. Suitable adhesives for general purposes, as for use at room temperature or slightly above or below the same, include the HM1500 adhesives of L. W. Fuller, the P1585 of Malcolm Nichol Company, and Duratac 34 of National Adhesives. These products all use resins and plasticizers and copolymers and natural rubbers, including the product called Krayton of Shell Chemical of Houston, Texas. The silicone materials

may be of the UV-curable type 7002 of Shinetsu of Japan or coatings of type G901 International Coatings Company of California, preferably applied by nozzle equipment of the type described in said patent no. 3,595,204, in approximately 2 to 4 grams per square meter, depending upon the application. In test operation with the Acumeter Laboratories Model CL-306.5, one such equipment, operation at web speeds of 330 feet (100.58m) per minute with limited web widths of 7 inches (17.78 cms) was conducted. This apparatus contained a pair of UV lamps and the one hot-melt coating station, having all of the basic ingredients of the integrated sytem of Figs 1 and 2. Ultraviolet radiation curing was effected at a speed of between 50 feet (15.24m) per minute to 75 feet (22.86m) per minute with two mercury-filled UV lamps, operating at a 300 watt per inch of illuminated length.

In the preferred UV curing stations 6, etc. and 16, etc. of Fig 1, four UV lamps of 300 watts per linear inch of illuminated length are used, each having shutters which are closed during down-time of the machine and thus prevent continued curing or over-curing of a coating while the web is at rest position. Upon start-up of web movement in the machine line, the successive shutters S on the four lamps will open to render the lamps effective at successive increased speed stages such as 0-50 feet (0-15.24m) per minute for the shutter of lamp 6 to open; 50-100 feet (15.24-30.48m) per minute, for the shutter

of lamp 6' to open, and consecutively up through, for example, to 200 feet (60.96m) a minute for the shutter of lamp 6'''. In the reverse process, as the web system slows down, either by automatic command or by operator command, the shutter of lamp 6''' will close when it reaches its minimum speed bracket, and so on for the other lamps until the web has come to a complete rest. The objective of having shutters open and close at successive speed brackets is to provide a reasonable amount of cure without overcuring or without creating an undercured product as line speed is increased. While silicones can take considerable dosages of radiation, there are regions where the release

properties are lost if the speed is too slow for the intense radiation--the control of radiation with web speed provided by the invention obviating such problems.

This shutter control is schematically shown effected by the control line C from the web-speed motor control to a shutter control solenoid device operating the successive shutters S of the UV or other radiation sources 6, 6', 6'', 6''', etc.

Further modifications will occur to those skilled in this art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

CLAIMS

1. A method of producing sheet material carrying an adhesive coating on one surface and adapted for use with radiation-cured silicone for enabling release of the sheet material in stacking, that comprises, applying uncured silicone coating material to one surface of one sheet synchronously as the sheet travels in web form; radiation-curing said silicone coating during travel of the web to provide a cross-linked release coating; synchronously applying adhesive to one surface of a second sheet travelling in web form at the same speed as that of the said one sheet and hardening the same; feeding the said one and second sheets together at the same speed with their respective cured silicone and adhesive coatings in contact and stacking the same together as by rolling.

2. A method as claimed in claim 1 and in which the degree of radiation-curing is controlled in accordance with web travel speed.

3. A method as claimed in claim 2 and in which said radiation curing is by UV radiation from a plurality of UV sources, the number of sources rendered effective being varied in response to web travel speed to ensure adequate curing without overcure.

4. Apparatus for producing sheet material carrying an adhesive coating on one surface and adapted for use with radiation-cured silicone coatings for enabling release of the sheet material, comprising means

for applying uncured silicone to one surface of one sheet synchronously as the sheet travels in web form; means following the applying means for radiation curing the silicone coating to provide a cross-linked release coating; means for applying adhesive to one surface of a second sheet travelling in web form at the same speed as that of the said one sheet and hardening the same; and means for rolling the first and second sheets together to stack the same with the respective cured silicone and adhesive coatings in contact.

5. Apparatus as claimed in claim 4 and in which means is provided for controlling the degree of radiation curing in accordance with web travel speed, and said radiation is selected from the group comprising UV and electron radiation.

6. Apparatus as claimed in claim 5 and in which said radiation is produced by a plurality of UV lamps provided with means for shuttering successive lamps in accordance with web travel speed.

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FIG. 1.

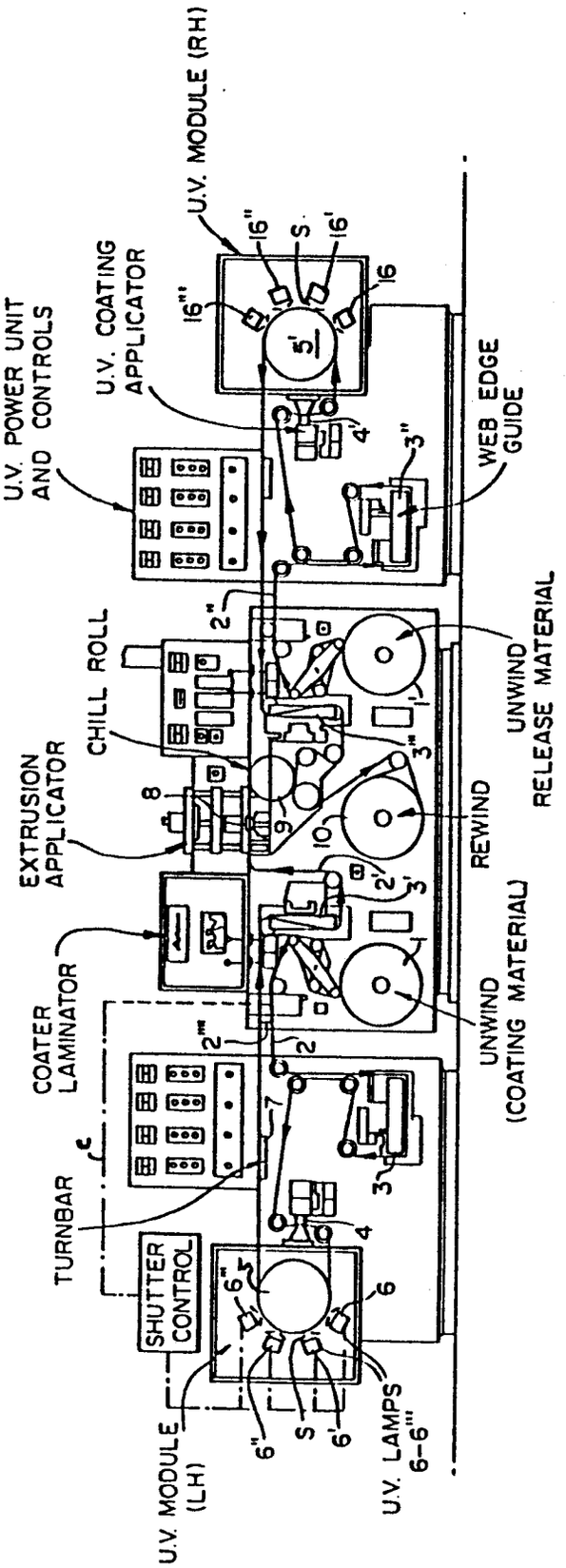
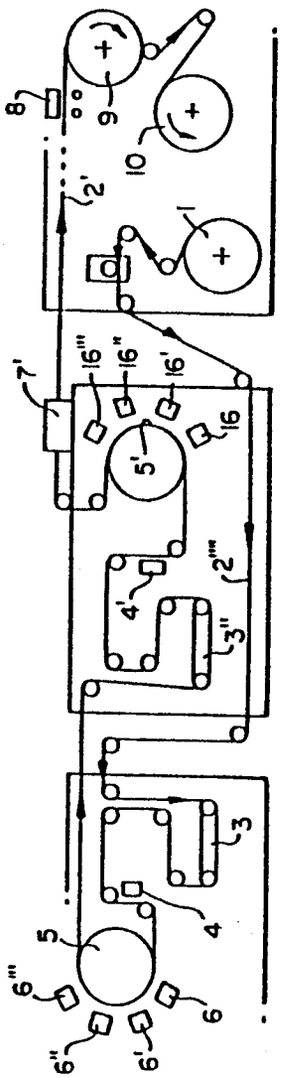


FIG. 3.



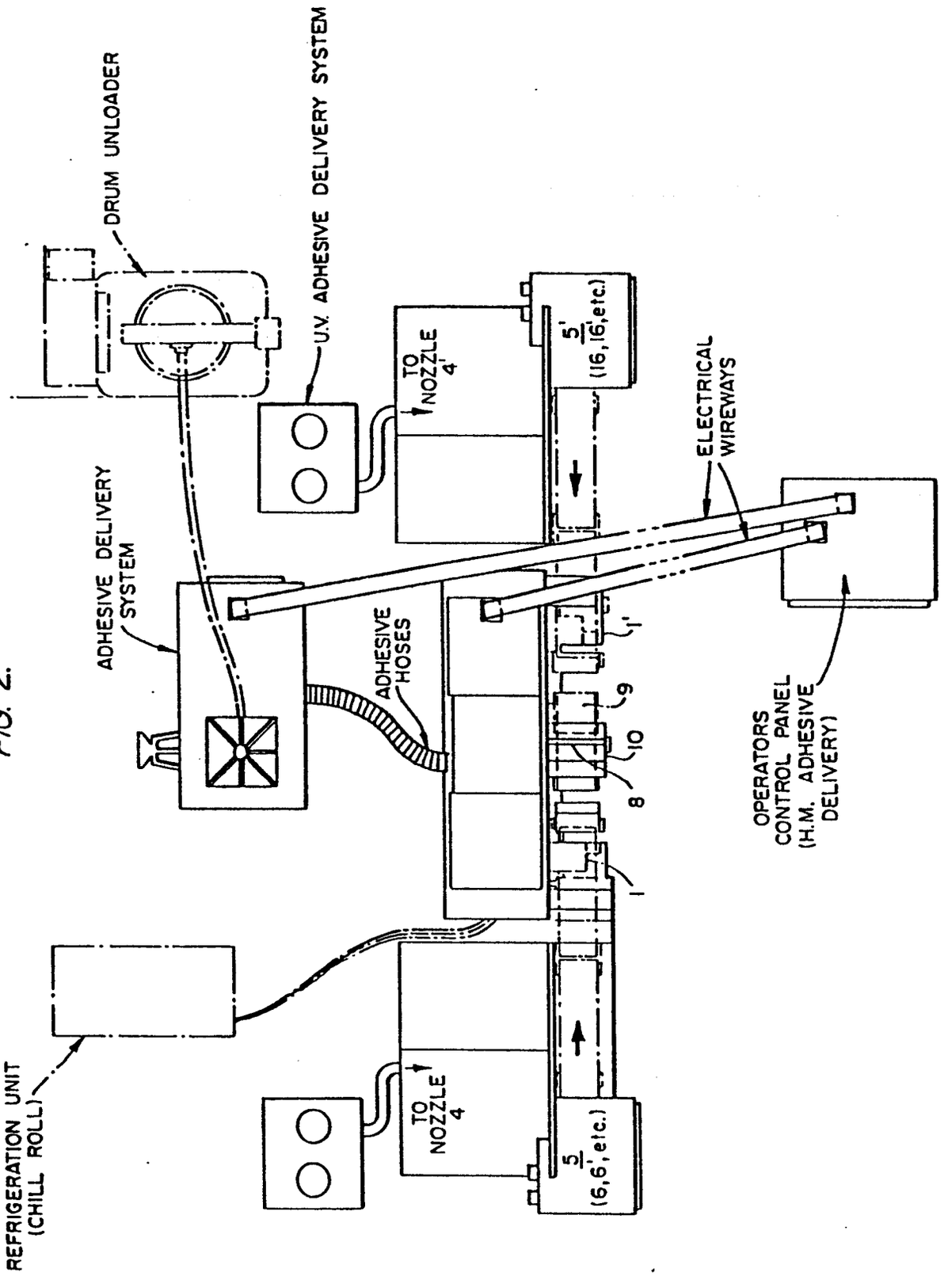

DRUM UNLOADER
U.V. ADHESIVE DELIVERY SYSTEM
TO NOZZLE 4'
5' (16, 16, etc.)
ELECTRICAL WIREWAYS
ADHESIVE DELIVERY SYSTEM
ADHESIVE HOSES
1'
9
10
8
1
OPERATORS CONTROL PANEL (H.M. ADHESIVE DELIVERY)
REFRIGERATION UNIT (CHILL ROLL)
TO NOZZLE 4
5 (6, 6', etc.)

FIG. 2.