

now been accomplished using the process and capsule improvements that are the subject of the present invention.

SUMMARY OF THE INVENTION

It is an object of the present invention to ameliorate one or more disadvantages of the prior art.

According to one aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machine, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using a capsule machines having capsule body pins and capsule cap pins as molds, comprising the steps of: heating the pins; dipping the pins into the solution to cause the solution to gelatinize on the surface of the pins thus forming a gelatinized solution; drying the gelatinized solution on the surface of the pins to form capsule bodies and capsule caps; and removing the capsule bodies and capsule caps from the pins; wherein drying the gelatinized solution includes moving the pins through an enclosure and moving air over the pins within the enclosure, the air moving in a direction opposed to the direction of movement of the pins; such that, during an early stage of drying, the gelatinized solution on the pins encounters humid air; and during a later stage of drying encounters drier air.

According to another aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules suitable for filling by capsule filling machine, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using a capsule machines having capsule body pins and capsule cap pins as molds, comprising the steps of: gelatinizing solution on the pins, including dipping each pin in the solution to a dip line, to form on each pin a capsule part of thermally gelatinized solution; drying the gelatinized solution on the pins to form capsule bodies and capsule caps; and removing the capsule bodies and capsule caps from the pins; wherein drying the gelatinized

solution includes moving the pins through an enclosure and moving air over the pins within the enclosure, the air moving in a direction opposed to the direction of movement of the pins; such that, during an early stage of drying, the gelatinized solution on the pins encounters humid air; and during a later stage of drying encounters drier air.

According to still another aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, each part having a dome, from an aqueous solution of a thermogelling cellulose ether composition, using a capsule machine having capsule body pins and capsule cap pins as molds, and using a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, comprising the steps of: heating the pins; dipping the pins into the solution to cause the solution to gelatinize on the surface of the pins; further gelatinizing the gelatinized solution, in humid air inside a kiln, on the surface of the pins by applying radiant heat from a dome-setter radiant heater mounted within the kiln and facing the plane of a planar array of domes; drying the gelatinized solution on the surface of the pins to form capsule bodies and capsule caps; and removing the capsule bodies and capsule caps from the pins.

According to still another aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using capsule body pins and capsule cap pins as molds, and using a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, comprising the steps of: a) dipping hot pins into the solution such that heat from a pin causes solution to gelatinize on the surface of the pin; b) drying gelatinized solution on the surface of the pins of a drying group of pinbars to form capsule bodies and capsule caps; c) differentially heating the pins of the drying group of pinbars in accordance with the expected differential heat loss between differentially heating and dipping; d) removing

the capsule bodies and capsule caps from the pins; e) greasing the pins; and f) moving the pins in a closed loop so as to repeat steps a) through e); further comprising the step of providing supplemental heat to the pins, after removing capsule bodies and capsule caps from the pins and before dipping the pins, by non-contact heating such that the pins have a predetermined dip temperature at dipping.

According to still another aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using capsule body pins and capsule cap pins as molds, and using a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, comprising the steps of: a) greasing the pins; b) dipping hot pins into the solution such that heat from a pin causes solution to gelatinize on the surface of the pin; c) drying gelatinized solution on the surface of the pins of a drying group of pinbars to form capsule bodies and capsule caps; d) differentially heating the pins of the drying group of pinbars in accordance with the expected differential heat loss between differentially heating and dipping, such that pins have a predetermined dip temperature at dipping; e) removing the capsule bodies and capsule caps from the pins; and f) moving the pins in a closed loop so as to repeat steps a) through e).

According to still another aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, in a capsule machine using capsule body pins and capsule cap pins as molds, and using a plurality of pinbars, each pinbar have a bar with a plurality of pins mounted to the bar, comprising the steps of: a) greasing the pins to form a layer of grease on a pin; b) heating the pins of a dipping group of pinbars, as a group, to a predetermined dip temperature, by non-contact heating after greasing so the layer of grease on a pin is not

disturbed; c) dipping the hot pins of the dipping group of pinbars, as a group, into the solution so that heat from a pin causes solution to gelatinize on the surface of the pin; d) drying the gelatinized solution on the surface of the pins to form capsule bodies and capsule caps; e) removing the capsule bodies and capsule caps from the pins; and f) moving the pins in a closed loop so as to repeat steps a) through e); such as to minimize cellulose capsule wall thickness variation caused by pin temperature differences at dipping and by disturbance to a layer of grease on a pin.

According to still another aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, comprising the steps of: gelatinizing solution on a pin, including dipping a pin in the solution to a dip line, to form on the pin a capsule part of gelatinized solution; drying the capsule part on the pin; removing the capsule part from the pin; transporting a plurality of pins through the steps of gelatinizing, drying and removing, in a closed path; using a cellulose-capsule forming pin having a cut-point diameter that is smaller than a corresponding cut-point diameter of a corresponding gelatin-capsule forming pin used for manufacturing a corresponding gelatin capsule part of the given size-number; and sizing the cellulose capsule forming pin so as to make a cellulose capsule part that has substantially the same overall diameter as the corresponding gelatin capsule part of the given size-number and a greater wall thickness than the wall thickness of the corresponding gelatin capsule part of the given size-number.

According to still another aspect of the present invention there is provided a method of manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling

cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, each cellulose-capsule forming pin having an elongated pin body, a domed head located at one end of the pin body, and a substantially cylindrical sidewall surrounding the pin body and extending from the domed head, the substantially cylindrical sidewall having a diameter, the method comprising the steps of: gelatinizing solution on a pin, including dipping a pin in the solution to a dip line, to form on the pin a capsule part of gelatinized solution; drying the capsule part on the pin; removing the capsule part from the pin; transporting a plurality of pins through the steps of gelatinizing, drying and removing, in a closed path; and using a cellulose-capsule forming pin that is undersized with respect to a corresponding gelatin-capsule forming pin used for manufacturing a gelatin capsule part of the given size number, the diameter of the substantially cylindrical sidewall of the cellulose-capsule forming pin being smaller than a corresponding diameter of a substantially cylindrical sidewall of the corresponding gelatin-capsule forming pin, the cellulose-capsule forming pin sized so as to make a cellulose capsule part that has substantially the same overall diameter as a corresponding gelatin capsule part of the given size-number.

According to still another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, comprising: a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar; greaser means for greasing the pins; dipper means for dipping hot pins into the solution to cause solution to gelatinize on the surface of the pins; dryer means for drying gelatinized solution on the surface of the pins of a drying group of pinbars, as a group, to form capsule bodies and capsule caps; differential heater means for differentially heating the pins of the drying group; automatics means for removing the capsule parts from the pins; and transport means for moving the pinbars in a closed loop path through the greaser means, the dipper means, the dryer means, the

differential heater means, and the automatics means; wherein the differential heater means is positioned to receive the drying group of pinbars as a group, and includes means for differentially heating the pins of the drying group of pinbars in accordance with the expected differential heat loss from the pins as the pins move from the differential heater means through the automatic means and through the greaser means to the dipper means.

According to still another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, comprising: a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, each pin having a dome; dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins; dryer means for drying the gelatinized solution on the surface of the pins of a drying group of pinbars to form capsule bodies and capsule caps, the dryer means having a pin-entry end; automatics means for removing the capsule parts from the pins; and transport means for moving the pinbars through the dipper means, the dryer means and the automatics means; wherein the dryer means includes a dome-setter radiant heater, proximate to the pin-entry end, disposed to radiate heat onto gelatinized solution on the domes of the pins of the drying group of pinbars axially with respect to the pins so as to further gelatinize the solution on the surface of the domes.

According to still another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, using pins as molds, comprising: dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins; dryer means for drying gelatinized solution on the surface of the pins to form capsule bodies and capsule caps;

automatics means for removing the capsule parts from the pins; and transport means for moving the pins in a closed loop path through the dipper means, the dryer means and the automatics means; wherein the dryer means includes an elongated duct enclosing a portion of the transport means, the duct having a pin-entry and an air outlet proximate to the pin-entry, and a pin-exit and an air inlet proximate to the pin exit, the transport means adapted to move pinbars with pins carrying gelatinized solution through the duct from the pin-entry to the pin-exit, the dryer means having means for moving counterflow air within the duct from the air inlet to the air outlet, such that air flows first over gelatinized solution on an earlier-dipped pin and the same air later flows over gelatinized solution on a later-dipped pin.

According to still another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, using pins as molds, comprising: dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins; dryer means for drying gelatinized solution on the surface of the pins to form capsule bodies and capsule caps; automatics means for removing the capsule parts from the pins; and transport means for moving the pins in a closed loop path through the dipper means, the dryer means and the automatics means; wherein the dryer means includes an elongated duct enclosing a portion of the transport means, the duct having a pin-entry and an air outlet proximate to the pin-entry, and a pin-exit and an air inlet proximate to the pin-exit, the transport means adapted to move pinbars with pins carrying gelatinized solution through the duct from the pin-entry to the pin-exit, the dryer means having means for moving air within the duct from the air inlet to the air outlet, such that air moving within the duct moves successively over gelatinized solution on increasingly later-dipped pins.

According to still another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for

filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, comprising: a plurality of pins; greaser means for greasing the pins; dipper means for dipping the pins into the solution to a dip line and gelatinizing solution on the pins; dryer means for drying gelatinized solution on the pins to form capsule parts; automatics means for removing the capsule parts from the pins; and transport means for moving the pins in a closed loop path through the greaser means, the dipper means, the dryer means, and the automatics means; wherein the automatics means includes a gripper adapted to grip a capsule part in a pin and break adhesion between all adhering surfaces of the capsule part and the pin to facilitate removal of the capsule part from the pin, and actuator means for driving the gripper; and wherein the gripper, the actuator means and the pin are movably mounted with respect to each other to permit alignment such that the gripper may grip the capsule part while the capsule part is on the pin.

According to still another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, the body and cap each having an open end, the body and cap formed from an aqueous solution of a thermogelling cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, comprising: dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins; dryer means for drying gelatinized solution on the surface of the pins to form capsule parts; and automatics means for removing the capsule parts from the pins; each cellulose-capsule forming pin having: an elongated pin body; a domed head located at one end of the pin body; and a cylindrical sidewall surrounding the pin body and extending from the domed head, the sidewall having a diameter which varies along the length of the pin body such as to provide a taper with narrower dimension toward the head end of the pin body, and a cut-point defining a cut-point diameter at a position along the length of the pin body at which

the capsule part may be cut to form the open end; wherein the given size number is selected from among size numbers 00, 0, 1, 2, 3, and 4; and wherein each cellulose-capsule forming pin is an undersized pin with respect to a corresponding conventional gelatin-capsule forming pin used for manufacturing a gelatin capsule part of the given size number, the cut-point diameter of the undersized pin being smaller than the cut-point diameter of the corresponding conventional gelatin-capsule forming pin.

According to still another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, the body and cap each having an open end, the body and cap formed from an aqueous solution of a thermogelling cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, comprising: dipper means for dipping the pins into the solution and gelatinizing solution on the pins to form on each pin a capsule part of gelatinized solution; dryer means for drying gelatinized solution on the pins to form capsule parts; and automatics means for removing the capsule parts from the pins; each cellulose-capsule forming pin having: an elongated pin body; a domed head located at one end of the pin body; and a substantially cylindrical sidewall surrounding the pin body and extending from the domed head; wherein the given size number is selected from among size numbers "000", "00", "0", "1", "2", "3", "4" and "5"; wherein the diameter of the substantially cylindrical sidewall of a cellulose-capsule forming pin is smaller than a corresponding diameter of a substantially cylindrical sidewall of a corresponding gelatin-capsule forming pin used for manufacturing a gelatin capsule part of the given size number.

According to yet another aspect of the present invention there is provided an apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether

composition, comprising: a plurality of pinbars each pinbar having a bar with a plurality of pins mounted to the bar; greaser means for greasing the pins; dipper means for dipping hot pins into the solution to cause solution to gelatinize on the surface of the pins; dryer means for drying gelatinized solution on the surface of the pins to form capsule bodies and capsule caps; automatics means for removing the capsule parts from the pins; and transport means for moving the pinbars through the greaser means, the dipper means, the dryer means and the automatics means; wherein the dipper means includes a dipper dish for capsule bodies and a dipper dish for capsule caps, each dipper dish sized to accept the pins of a dipping group; and wherein the apparatus further comprises non-contact heater means, located between the greaser means and a dipper dish, for heating the pins of the dipping group, as a group, by non-contact heating.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Figs 1A, 1B and 1C show a prior art capsule body and cap.

Fig. 2 shows the elements of the traditional (prior art) capsule manufacturing machine.

Fig. 3 shows pins mounted on a pinbar (prior art).

Fig. 4 shows a pin dipped to a dip line (prior art).

Fig. 5 shows a prior art stripper pushing a capsule part off a pin.

Fig. 6 shows a prior art stripper.

Fig. 7 shows a knife trimming the rough edge of the capsule (prior art).

Fig. 8A shows a schematic embodiment of the present invention, including a preheat section and a kiln enclosure.

Fig. 8B is a schematic cross-sectional elevation view of the drying kiln showing the enclosure and air flow.

Fig. 8C shows location of the heating elements and fans in the enclosure of Fig. 8B.

Fig. 8D shows a schematic plan view of all sections between the split deck and the spinners.

Figs. 8E and 8F show two elevation views of the convection preheat system.

Fig. 8G shows the insulation box for the table section.

Fig. 9 shows a schematic embodiment of the present invention, including locations of the several preheat sections.

Figs. 10A and 10B show temperature sensors and under-deck heaters associated with the split deck.

Fig. 10C shows a group of cap pinbars and the corresponding group of body pinbars.

Fig. 10D shows the split deck layout for the bars of Fig. 10C.

several sections of deck beneath a given pinbar are thermally isolated one from another. Cap pinbars move in groups of twenty from station to station approximately every 40-70 seconds in the drying kilns and body pinbars do likewise. The direction of movement of the pinbars is shown by the arrows in Fig. 10C. Such a group of pinbars has a length of 22 inches (56 cm), the length of one pinbar, and a width of 17 inches (43 cm), the width of twenty pinbars. Supporting the pinbars in the last station of the drying kiln is the split deck shown in plan view in Fig. 10D. The thermal isolators 102 and the portions of the deck 101 enclosed by the thermal isolators are also shown in cross-section elevation view in Fig. 10A. Selective heating of different portions of twenty pinbars to compensate for pre-dip dwell time and for temperature gradient in the machine is achieved by controllers 105 controlling each of the several enclosed deck portions at a predetermined temperature. A temperature profile for a preferred embodiment of the present invention is given for each enclosed deck portion 101 of Fig. 10D in Table 6A for the cap side and Table 6B for the body side. The dimensions of the enclosed deck portions 101 in Fig. 10D are given in Table 7.

	A °F (°C)	B °F (°C)	C °F (°C)	D °F (°C)
1	306 (152)	251 (122)	235 (113)	267 (131)
2	181 (82.8)	178 (81.1)	153 (67.2)	174 (78.9)
3	193 (89.4)	165 (73.9)	135 (57.2)	142 (61.1)

TABLE 6A - CAP SIDE SPLIT DECK TEMPERATURE PROFILE

CLAIMS

1. A method of manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using a capsule machine having capsule body pins and capsule cap pins as molds, comprising the steps of:

heating the pins;

dipping the pins into the solution to cause the solution to gelatinize on the surface of the pins thus forming a gelatinized solution;

drying the gelatinized solution on the surface of the pins to form capsule bodies and capsule caps; and

removing the capsule bodies and capsule caps from the pins;

wherein drying the gelatinized solution includes moving the pins through an enclosure and moving air over the pins within the enclosure, the air moving in a direction opposed to the direction of movement of the pins;

such that, during an early stage of drying, the gelatinized solution on the pins encounters humid air; and

during a later stage of drying encounters drier air.

2. A method of manufacturing pharmaceutical cellulose capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using a capsule machine having capsule body pins and capsule cap pins as molds, comprising the steps of:

gelatinizing solution on the pins, including dipping each pin in the solution to a dip line, to form on each pin a capsule part of thermally gelatinized solution;

drying the gelatinized solution on the pins to form capsule bodies and capsule caps; and

removing the capsule bodies and capsule caps from the pins;

wherein drying the gelatinized solution includes moving the pins through an enclosure and moving air over the pins within the enclosure, the air moving in a direction opposed to the direction of movement of the pins;

such that, during an early stage of drying, the gelatinized solution on the pins encounters humid air; and

during a later stage of drying encounters drier air.

3. A method according to claim 2, wherein moving air in a direction opposed to the direction of movement of the pins includes moving air over capsule body pins at one rate and moving air over capsule cap pins at a different rate.
4. A method according to claim 2, further comprising the step of controlling the humidity of air entering the enclosure.
5. A method according to claim 4, further comprising the step of controlling the humidity of air entering the enclosure within a range 0.006-0.012 lb water/lb air (0.6-1.2 percent).
6. A method according to claim 2, further comprising the step of controlling the temperature of air entering the enclosure within a range 125°F-180°F (52°C-82°C).
7. A method according to claim 2, further comprising the step of heating the pins within the enclosure to achieve a predetermined air temperature profile within the enclosure.
8. A method according to claim 2, further comprising the step of controlling the flow of air within the enclosure to achieve a predetermined humidity profile within the enclosure.
9. A method according to claim 2, wherein drying the gelatinized solution on the pins includes heating a pin via a bar in an early stage of drying such that heat applied via the bar and the pin at an inner surface of a capsule part in combination with humid air surrounding the capsule part causes the capsule part to dry slowly from the inside-out.
10. A method according to claim 2, wherein drying the gelatinized solution on the pins includes heating a pin by radiant heat in an early stage of drying such that the radiant

heat at an inner surface of a capsule part in combination with humid air surrounding the capsule part causes the capsule part to dry slowly from the inside-out.

11. A method according to claim 5, further including the step of controlling the temperature of air entering the enclosure within a range of 125°F-180°F (52°C-82°C).

12. A method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, each part having a dome, from an aqueous solution of a thermogelling cellulose ether composition, using a capsule machine having capsule body pins and capsule cap pins as mods, and using a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, comprising the steps of:

heating the pins;

dipping the pins into the solution to cause the solution to gelatinize on the surface of the pins;

further gelatinizing the gelatinized solution, in humid air inside a kiln, on the surface of the pins by applying radiant heat from a dome-setter radiant heater mounted within the kiln and facing the plane of a planar array of domes;

drying the gelatinized solution on the surface of the pins to form capsule bodies and capsule caps; and

removing the capsule bodies and capsule caps from the pins.

13. A method according to claim 12, wherein further gelatinizing the gelatinized solution includes placing a group of pinbars, pins pointing up, below the dome setter radiant heater.

14. A method according to claim 12, wherein further gelatinizing the gelatinized solution includes heating the pins via the bars.

15. A method according to claim 12, wherein further gelatinizing the gelatinized solution includes setting the solution, while spinning the pins within a spinner enclosure, by radiant heat from radiant heaters mounted within the enclosure, and by air blown over the pins.

16. A method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using capsule body pins and capsule cap pins as molds, and using a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, comprising the steps of:

- a) dipping hot pins into the solution such that heat from a pin causes solution to gelatinize on the surface of the pin;
- b) drying gelatinized solution on the surface of the pins of a drying group of pinbars to form capsule bodies and capsule caps;
- c) differentially heating the pins of the drying group of pinbars in accordance with the expected differential heat loss between differentially heating and dipping;
- d) removing the capsule bodies and capsule caps from the pins;
- e) greasing the pins; and
- f) moving the pins in a closed loop so as to repeat steps a) through e);

further comprising the step of providing supplemental heat to the pins, after removing capsule bodies and capsule caps from the pins and before dipping the pins, by non-contact heating such that the pins have a predetermined dip temperature at dipping.

17. A method according to claim 16, wherein providing supplemental heat to the pins includes heating the pins by thermal convection.

18. A method according to claim 16, wherein providing supplemental heat to the pins includes heating the pins by radiant energy.

19. A method according to claim 16, wherein providing supplemental heat to the pins includes heating a group of pins conductively via a bar after greasing the pins.

20. A method according to claim 16, wherein providing supplemental heat to the pins includes heating a group of pins conductively via a bar before greasing the pins.

21. A method according to claim 16, wherein the step of providing supplemental heat occurs before greasing.

22. A method according to claim 16, wherein the step of providing supplemental heat occurs during greasing.
23. A method according to claim 16, wherein the step of providing supplemental heat occurs after greasing.
24. A method according to claim 16, having a predetermined body pin dip temperature of approximately 152°F (66.7°C).
25. A method according to claim 16, having a predetermined body pin dip temperature in the range of 144°F-156°F (62.2°C-68.9°C).
26. A method according to claim 16, wherein differentially heating the pins includes exposing the pins to a predetermined temperature profile having temperatures greater than the predetermined pin dip temperature.
27. A method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using capsule body pins and capsule cap pins as molds, and using a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, comprising the steps of:
- a) greasing the pins;
 - b) dipping hot pins into the solution such that heat from a pin causes solution to gelatinize on the surface of the pin;
 - c) drying gelatinized solution on the surface of the pins of a drying group of pinbars to form capsule bodies and capsule caps;
 - d) differentially heating the pins of the drying group of pinbars in accordance with the expected differential heat loss between differentially heating and dipping, such that pins have a predetermined dip temperature at dipping;
 - e) removing the capsule bodies and capsule caps from the pins; and
 - f) moving the pins in a closed loop so as to repeat steps a) through e).

28. A method according to claim 27, wherein body pins have a predetermined dip temperature of approximately 152°F (66.7°C) and cap pins have a predetermined dip temperature of approximately 151°F (66.°C).

29. A method according to claim 27, wherein body pins have a predetermined dip temperature in the range of 144°F-156°F (62.2°C-68.9°C) and cap pins have a predetermined dip temperature in the range 149°F-156°F (65.0°C-68.9°C).

30. A method according to claim 27, wherein step d) includes differentially heating on a split deck having a predetermined temperature profile.

31. A method according to claim 30, wherein the predetermined temperature profile is shaped to compensate for differential cooling of pins resulting from different pinbars having different wait times between heating and dipping.

32. A method according to claim 30, wherein the predetermined temperature profile is shaped to compensate for different pins, within a group of pins mounted to a bar, having different cooling rates according to position on the bar.

33. A method according to claim 27, further including the step of:

heating the pins of the dipping group, as a group, by non-contact heating between the greasing the pins and dipping the pins.

34. A method of manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, in a capsule machine using capsule body pins and capsule cap pins as molds, and using a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, comprising the steps of:

- a) greasing the pins to form a layer of grease on a pin;
- b) heating the pins of a dipping group of pinbars, as a group, to a predetermined dip temperature, by non-contact heating after greasing so the layer of grease on a pin is not disturbed;

c) dipping the hot pins of the dipping group of pinbars, as a group, into the solution so that heat from a pin causes solution to gelatinize on the surface of the pin;

d) drying the gelatinized solution on the surface of the pins to form capsule bodies and capsule caps;

e) removing the capsule bodies and capsule caps from the pins; and

f) moving the pins in a closed loop so as to repeat steps a) through e);

such as to minimize cellulose capsule wall thickness variation caused by pin temperature differences at dipping and by disturbance to a layer of grease on a pin.

35. A method according to claim 34, wherein non-contact heating includes heating by thermal conduction via a bar.

36. A method according to claim 34, wherein the step of heating the pins occurs in an extended dipper section prior to dipping.

37. A method of manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, comprising the steps of:

gelatinizing solution on a pin, including dipping a pin in the solution to a dip line, to form on the pin a capsule part of gelatinized solution;

drying the capsule part on the pin;

removing the capsule part from the pin;

transporting a plurality of pins through the steps of gelatinizing, drying and removing, in a closed path;

using a cellulose-capsule forming pin having a cut-point diameter that is smaller than a corresponding cut-point diameter of a corresponding gelatin-capsule forming pin used for manufacturing a corresponding gelatin capsule part of the given size-number; and

sizing the cellulose capsule forming pin so as to make a cellulose capsule part that has substantially the same overall diameter as the corresponding gelatin capsule part of the given size-number and a greater wall thickness than the wall thickness of the corresponding gelatin capsule part of the given size-number.

38. A method according to claim 37, using a body-side cellulose capsule forming pin having a cut-point diameter in the range 0.2775 - 0.2815 inch (7.05 - 7.15 mm) to make a cellulose capsule body for an "0" size capsule.

39. A method according to claim 37, using a cap-side cellulose capsule forming pin having a cut-point diameter in the range 0.2905 - 0.2945 inch (7.38 - 7.48 mm) to make a cellulose capsule cap for an "0" size capsule.

40. A method according to claim 37, using a body-side cellulose capsule forming pin having a cut-point diameter in the range 0.3105 - 0.3173 inch (7.89 - 8.06 mm) to make a cellulose capsule body for an "00" size capsule.

41. A method according to claim 37, using a cap-side cellulose capsule forming pin having a cut-point diameter in the range 0.3276 - 0.3332 inch (8.32 - 8.46 mm) to make a cellulose capsule cap for an "00" size capsule.

42. A method according to claim 37, using a body-side cellulose capsule forming pin having a cut-point diameter in the range 0.2503 - 0.2557 inch (6.36 - 6.50 mm) to make a cellulose capsule body for a "1" size capsule.

43. A method according to claim 37, using a cap-side cellulose capsule forming pin having a cut-point diameter in the range 0.2622 - 0.2667 inch (6.66 - 6.77 mm) to make a cellulose capsule cap for a "1" size capsule.

44. A method according to claim 37, using a body-side cellulose capsule forming pin having a cut-point diameter in the range 0.2289 - 0.2339 inch (5.81 - 5.94 mm) to make a cellulose capsule body for a "2" size capsule.

45. A method according to claim 37, using a cap-side cellulose capsule forming pin having a cut-point diameter in the range 0.2397 - 0.2438 inch (6.09 - 6.19 mm) to make a cellulose capsule cap for a "2" size capsule.

46. A method according to claim 37, using a body-side cellulose capsule forming pin having a cut-point diameter in the range 0.2095 - 0.2140 inch (5.32 - 5.44 mm) to make a cellulose capsule body for a "3" size capsule.

47. A method according to claim 37, using a cap-side cellulose capsule forming pin having a cut-point diameter in the range 0.2202 - 0.2240 inch (5.60 - 5.69 mm) to make a cellulose capsule cap for a "3" size capsule.

48. A method according to claim 37, using a body-side cellulose capsule forming pin having a cut-point diameter in the range 0.1900 - 0.1941 inch (4.83 - 4.93 mm) to make a cellulose capsule body for a "4" size capsule.

49. A method according to claim 37, using a cap-side cellulose capsule forming pin having a cut-point diameter in the range 0.1997 - 0.2031 inch (5.07 - 5.16 mm) to make a cellulose capsule cap for a "4" size capsule.

50. A method of manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, from an aqueous solution of a thermogelling cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, each cellulose-capsule forming pin having an elongated pin body, a domed head located at one end of the pin body, and a substantially cylindrical sidewall surrounding the pin body and extending from the domed head, the substantially cylindrical sidewall having a diameter, the method comprising the steps of:

... gelatinizing solution on a pin, including dipping a pin in the solution to a dip line, to form on the pin a capsule part of gelatinized solution;

drying the capsule part on the pin;

removing the capsule part from the pin;

transporting a plurality of pins through the steps of gelatinizing, drying and removing, in a closed path; and

using a cellulose-capsule forming pin that is undersized with respect to a corresponding gelatin-capsule forming pin used for manufacturing a gelatin capsule part of the given size number, the diameter of the substantially cylindrical sidewall of the cellulose-capsule forming pin being smaller than a corresponding diameter of a substantially cylindrical sidewall of the corresponding gelatin-capsule forming pin, the cellulose-capsule forming pin sized so as to make a cellulose capsule part that has substantially the same overall diameter as a corresponding gelatin capsule part of the given size-number.

51. A method according to claim 50, using a cellulose-capsule forming pin to make a cellulose capsule cap for an "0" size capsule, the cellulose-capsule forming pin undersized by an amount in the range of approximately 0.002 - 0.006 inch (0.05 - 0.15 mm).

52. A method according to claim 50, the cellulose-capsule forming pin sized so as to make a cellulose capsule part that has substantially the same overall diameter as the corresponding gelatin capsule part of the given size-number and a greater wall thickness than a corresponding wall thickness of the corresponding gelatin capsule part of the given size-number.

53. A method according to claim 54, for forming a thick wall cellulose capsule body, wherein the diameter of the substantially cylindrical sidewall of the cellulose-capsule forming pin is smaller than the diameter of the substantially cylindrical sidewall of the corresponding conventional gelatin-capsule forming pin by approximately 1.3 percent.

54. A method according to claim 54, for forming a thick wall cellulose capsule cap, wherein the diameter of the substantially cylindrical sidewall of the cellulose-capsule forming pin is smaller than the diameter of the substantially cylindrical sidewall of the corresponding conventional gelatin-capsule forming pin by approximately 1.6 percent.

55. A method according to claim 50, wherein gelatinizing solution includes dipping a hot pin into the solution.

56. A method according to any claims 50 - 55, for making a cellulose capsule part of any one of sizes "000", "00", "1", "2", "3", "4" and "5", the cellulose-capsule forming pin undersized proportionally.

57. An apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, comprising:

a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar;

greaser means for greasing the pins;

dipper means for dipping hot pins into the solution to cause solution to gelatinize on the surface of the pins;

dryer means for drying gelatinized solution on the surface of the pins of a drying group of pinbars, as a group, to form capsule bodies and capsule caps;

differential heater means for differentially heating the pins of the drying group;

automatics means for removing the capsule parts from the pins; and

transport means for moving the pinbars in a closed loop path through the greaser means, the dipper means, the dryer means, the differential heater means, and the automatics means;

wherein the differential heater means is positioned to receive the drying group of pinbars as a group, and includes means for differentially heating the pins of the drying group of pinbars in accordance with the expected differential heat loss from the pins as the pins move from the differential heater means through the automatics means and through the greaser means to the dipper means.

58. An apparatus according to claim 57, wherein the differential heater means includes a split deck having thermally isolated heating elements disposed to heat the pins of the drying group by thermal conduction via the bars.

59. An apparatus according to claim 57, wherein the dryer means includes a duct having a pin-exit end, and the differential heater means is located within the duct at the pin-exit end.
60. An apparatus according to claim 58, further including means for sensing and controlling temperature so as to maintain a predefined temperature profile over the split deck.
61. An apparatus according to claim 58, the split deck adapted to apply heat selectively to points along the length of a bar.
62. An apparatus according to claim 57, further including supplemental heater means, located between the automatics and the dipper means, for heating the pins by thermal convection.
63. An apparatus according to claim 57, further including a radiant heater located between the automatics and the dipper means.
64. An apparatus according to claim 57, wherein the dipper means includes a dipper dish for capsule bodies and a dipper dish for capsule caps, each dipper dish sized to accept the pins of a dipping group; the apparatus further including non-contact heater means, located between the greaser means and a dipper dish, for heating the pins of the dipping group, by thermal conduction via the bars of the dipping group.
65. An apparatus for manufacturing pharmaceutical capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, comprising:
- a plurality of pinbars, each pinbar having a bar with a plurality of pins mounted to the bar, each pin having a dome;
 - dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins;

dryer means for drying the gelatinized solution on the surface of the pins of a drying group of pinbars to form capsule bodies and capsule caps, the dryer means having a pin-entry end;

automatics means for removing the capsule parts from the pins; and

transport means for moving the pinbars through the dipper means, the dryer means and the automatics means;

wherein the dryer means includes a dome-setter radiant heater, proximate to the pin-entry end, disposed to radiate heat onto gelatinized solution on the domes of the pins of the drying group of pinbars axially with respect to the pins so as to further gelatinize the solution on the surface of the domes.

66. An apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, using pins as molds, comprising:

dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins;

dryer means for drying gelatinized solution on the surface of the pins to form capsule bodies and capsule caps;

automatics means for removing the capsule parts from the pins; and

transport means for moving the pins in a closed loop path through the dipper means, the dryer means and the automatics means;

wherein the dryer means includes an elongated duct enclosing a portion of the transport means, the duct having a pin-entry and an air outlet proximate to the pin-entry, and a pin-exit and an air inlet proximate to the pin exit, the transport means adapted to move pinbars with pins carrying gelatinized solution through the duct from the pin-entry to the pin-exit, the dryer means having means for moving counterflow air within the duct from the air inlet to the air outlet, such that air flows first over gelatinized solution on an

earlier-dipped pin and the same air later flows over gelatinized solution on a later-dipped pin.

67. An apparatus according to claim 66, wherein the dryer means is adapted to provide counterflow air within the duct substantially overall.

68. An apparatus for manufacturing pharmaceutical capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, using pins as molds, comprising:

dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins;

dryer means for drying gelatinized solution on the surface of the pins to form capsule bodies and capsule caps;

automatics means for removing the capsule parts from the pins; and

transport means for moving the pins in a closed loop path through the dipper means, the dryer means and the automatics means;

wherein the dryer means includes an elongated duct enclosing a portion of the transport means, the duct having a pin-entry and an air outlet proximate to the pin-entry, and a pin-exit and an air inlet proximate to the pin-exit, the transport means adapted to move pinbars with pins carrying gelatinized solution through the duct from the pin-entry to the pin-exit, the dryer means having means for moving air within the duct from the air inlet to the air outlet, such that air moving within the duct moves successively over gelatinized solution on increasingly later-dipped pins.

69. An apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, comprising:

a plurality of pins;

greaser means for greasing the pins;

dipper means for dipping the pins into the solution to a dip line and gelatinizing solution on the pins;

dryer means for drying gelatinized solution on the pins to form capsule parts;

automatics means for removing the capsule parts from the pins; and

transport means for moving the pins in a closed loop path through the greaser means, the dipper means, the dryer means, and the automatics means;

wherein the automatics means includes a gripper adapted to grip a capsule part in a pin and break adhesion between all adhering surfaces of the capsule part and the pin to facilitate removal of the capsule part from the pin, and actuator means for driving the gripper; and

wherein the gripper, the actuator means and the pin are movably mounted with respect to each other to permit alignment such that the gripper may grip the capsule part while the capsule part is on the pin.

70. An apparatus according to claim 69,

wherein the automatics means includes trimmer means for trimming a capsule part at a trim line after removal of the capsule part from the pin; and

wherein the gripper, the actuator means and the pin are movably mounted with respect to each other to permit alignment such that the gripper may grip the capsule part between the trim line and the dip line.

71. An apparatus for manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, the body and cap each having an open end, the body and cap formed from an aqueous solution of a thermogelling cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, comprising:

dipper means for dipping the pins into the solution and gelatinizing solution on the surface of the pins;

dryer means for drying gelatinized solution on the surface of the pins to form capsule parts; and

automatics means for removing the capsule parts from the pins;

each cellulose-capsule forming pin having:

an elongated pin body;

a domed head located at one end of the pin body; and

a cylindrical sidewall surrounding the pin body and extending from the domed head, the sidewall having a diameter which varies along the length of the pin body such as to provide a taper with narrower dimension toward the head end of the pin body, and a cut-point defining a cut-point diameter at a position along the length of the pin body at which the capsule part may be cut to form the open end;

wherein the given size number is selected from among size numbers 00, 0, 1, 2, 3, and 4; and

wherein each cellulose-capsule forming pin is an undersized pin with respect to a corresponding conventional gelatin-capsule forming pin used for manufacturing a gelatin capsule part of the given size number, the cut-point diameter of the undersized pin being smaller than the cut-point diameter of the corresponding conventional gelatin-capsule forming pin.

72. An apparatus according to claim 71, wherein the cut-point diameter of the undersized pin is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule forming pin by an amount in the range of approximately 0.7 - 2.0 percent.

73. An apparatus according to claim 72, wherein the cut-point diameter of the undersized pin is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule forming pin by approximately 1.3 percent.

74. An apparatus according to claim 71, wherein the cut-point diameter of the undersized pin for forming a "0" size capsule part is smaller than the cut-point diameter

of a corresponding conventional gelatin-capsule "0" size forming pin by an amount in the range of approximately 0.002 - 0.006 inch (0.05 - 0.15 mm).

75. An apparatus according to claim 74, wherein the cut-point diameter of the undersized pin for forming a "0" size cellulose capsule part is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule "0" size forming pin by approximately 0.004 inch (0.10 mm).

76. An apparatus according to claim 71, for forming a thick wall cellulose capsule cap, wherein the cut-point diameter of the undersized pin for forming a thick wall cellulose capsule cap is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule forming pin by an amount in the range of approximately 1.0 - 2.3 percent.

77. An apparatus according to claim 76, for forming a thick wall cellulose capsule cap, wherein the cut-point diameter of the undersized pin for forming the thick wall cellulose capsule cap is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule forming pin by approximately 1.6 percent.

78. An apparatus according to claim 71, for forming a thick wall "0" size cellulose capsule cap, wherein the cut-point diameter of the undersized pin for forming the thick wall "0" size cellulose capsule cap is smaller than the cut-point diameter of a corresponding conventional gelatin-capsule "0" size forming pin by an amount in the range of approximately 0.003 - 0.007 inch (0.08 - 0.18 mm).

79. An apparatus according to claim 78, for forming a thick wall "0" size cellulose capsule cap, wherein the cut-point diameter of the undersized pin for forming the thick wall "0" size cellulose capsule cap is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule "0" size forming pin by approximately 0.005 inch (0.13 mm).

80. An apparatus according to claim 71, for forming a thick wall cellulose capsule body, wherein the cut-point diameter of the undersized pin for forming the thick wall cellulose capsule body is smaller than the cut-point diameter of the corresponding

conventional gelatin-capsule forming pin by an amount in the range of approximately 1.4 - 2.7 percent.

81. An apparatus according to claim 80, for forming a thick wall cellulose capsule body, wherein the cut-point diameter of the undersized pin for forming the thick wall cellulose capsule body is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule forming pin by approximately 2.0 percent.

82. An apparatus according to claim 71, for forming a thick wall "0" size cellulose capsule body, wherein the cut-point diameter of the undersized pin for forming the thick wall "0" size cellulose capsule body is smaller than the cut-point diameter of a corresponding conventional gelatin-capsule "0" size forming pin by an amount in the range of approximately 0.004 - 0.008 inch (0.10 - 0.20 mm).

83. An apparatus according to claim 82, for forming a thick wall "0" size cellulose capsule body, wherein the cut-point diameter of the undersized pin for forming the thick wall "0" size cellulose capsule body is smaller than the cut-point diameter of the corresponding conventional gelatin-capsule "0" size forming pin by approximately 0.006 inch (0.15 mm).

84. An apparatus according to claim 71, wherein the size number is "0", and the body-side undersized pin has a cut-point diameter in the range 0.2795 - 0.2835 inch (7.10 - 7.20 mm).

85. An apparatus according to claim 71 for making a thick wall cellulose capsule, wherein the size number is "0", and the body-side undersized pin has a cut-point diameter in the range 0.2775 - 0.2815 inch (7.05 - 7.15 mm).

86. An apparatus according to claim 71 for making a thick wall cellulose capsule, wherein the size number is "00", and the body-side undersized pin has a cut-point diameter in the range 0.3105 - 0.3173 inch (7.89 - 8.06 mm).

87. An apparatus according to claim 71 for making a thick wall cellulose capsule, wherein the size number is "1", and the body-side undersized pin has a cut-point diameter in the range 0.2503 - 0.2557 inch (6.36 - 6.50 mm).

88. An apparatus according to claim 71 for making a thick wall cellulose capsule, wherein the size number is "2", and the body-side undersized pin has a cut-point diameter in the range 0.2289 - 0.2339 inch (5.81 - 5.94 mm).

89. An apparatus according to claim 71 for making a thick wall cellulose capsule, wherein the size number is "3", and the body-side undersized pin has a cut-point diameter in the range 0.2095 - 0.2140 inch (5.32 - 5.44 mm).

90. An apparatus according to claim 71 for making a thick wall cellulose capsule, wherein the size number is "4", and the body-side undersized pin has a cut-point diameter in the range 0.1900 - 0.1941 inch (4.83 - 4.93 mm).

91. An apparatus for manufacturing pharmaceutical cellulose capsules of a given size number, the capsules suitable for filling by capsule filling machines, each capsule consisting of two parts, a capsule body and a capsule cap, the body and cap each having an open end, the body and cap formed from an aqueous solution of a thermogelling cellulose ether composition, using cellulose-capsule body-side forming pins and cellulose-capsule cap-side forming pins as molds, comprising:

dipper means for dipping the pins into the solution and gelatinizing solution on the pins to form on each pin a capsule part of gelatinized solution;

dryer means for drying gelatinized solution on the pins to form capsule parts; and

automatics means for removing the capsule parts from the pins;

each cellulose-capsule forming pin having:

an elongated pin body;

a domed head located at one end of the pin body; and

a substantially cylindrical sidewall surrounding the pin body and extending from the domed head;

wherein the given size number is selected from among size numbers "000", "00", "0", "1", "2", "3", "4" and "5";

wherein the diameter of the substantially cylindrical sidewall of a cellulose-capsule forming pin is smaller than a corresponding diameter of a substantially cylindrical

sidewall of a corresponding gelatin-capsule forming pin used for manufacturing a gelatin capsule part of the given size number.

92. An apparatus according to claim 91, wherein the diameter of the substantially cylindrical sidewall of the cellulose-capsule forming pin is smaller than the diameter of the substantially cylindrical sidewall of the corresponding gelatin-capsule forming pin by approximately 1.3 percent.

93. An apparatus according to claim 91, wherein the cellulose-capsule body-side forming pins and the cellulose-capsule cap-side forming pins are sized to form thick wall cellulose capsule parts.

94. An apparatus according to claim 93, wherein the diameter of the substantially cylindrical sidewall of the cellulose-capsule forming pin is smaller than the diameter of the substantially cylindrical sidewall of the corresponding gelatin-capsule forming pin by approximately 1.6 percent.

95. An apparatus for manufacturing pharmaceutical cellulose capsules, the capsules suitable for filling by capsule filling machines, each capsule consisting of a capsule body and a capsule cap formed from an aqueous solution of a thermogelling cellulose ether composition, comprising:

a plurality of pinbars each pinbar having a bar with a plurality of pins mounted to the bar;

greaser means for greasing the pins;

dipper means for dipping hot pins into the solution to cause solution to gelatinize on the surface of the pins;

dryer means for drying gelatinized solution on the surface of the pins to form capsule bodies and capsule caps;

automatics means for removing the capsule parts from the pins; and

transport means for moving the pinbars through the greaser means, the dipper means, the dryer means and the automatics means;

wherein the dipper means includes a dipper dish for capsule bodies and a dipper dish for capsule caps, each dipper dish sized to accept the pins of a dipping group; and

wherein the apparatus further comprises non-contact heater means, located between the greaser means and a dipper dish, for heating the pins of the dipping group, as a group, by non-contact heating.

96. An apparatus according to claim 95, wherein the dipper dish for capsule bodies and the dipper dish for capsule caps are spaced apart to accommodate the pre-dip heater means.

97. An apparatus according to claim 95, wherein non-contact heating includes heating by thermal conduction via the bars of the dipping group.

METHOD AND APPARATUS FOR THE MANUFACTURE OF PHARMACEUTICAL CELLULOSE CAPSULES

ABSTRACT

A method and apparatus for manufacturing pharmaceutical capsules use an aqueous solution of a thermogelling cellulose ether composition and use capsule body pins and capsule cap pins as molds. The method involves heating (94) the pins, dipping (22) the pins into the solution to cause the solution to gelatinize on the surface of the pins, removing the pins and drying (24) the gelatinized solution on the surface of the pins to form capsule bodies and capsule caps. Pins are heated pre-dip and post-dip to facilitate gelating. Counterflow air is applied to provide drying from the inside. Capsule parts are removed by gripping. Capsule parts may have a thick wall and a stiffening ring.

Fig. 9

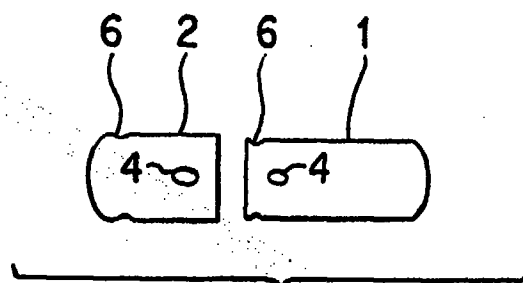


FIG. 1A (PRIOR ART)

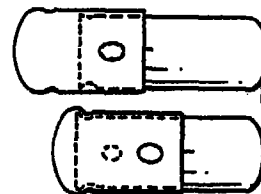


FIG. 1B (PRIOR ART)



FIG. 1C (PRIOR ART)

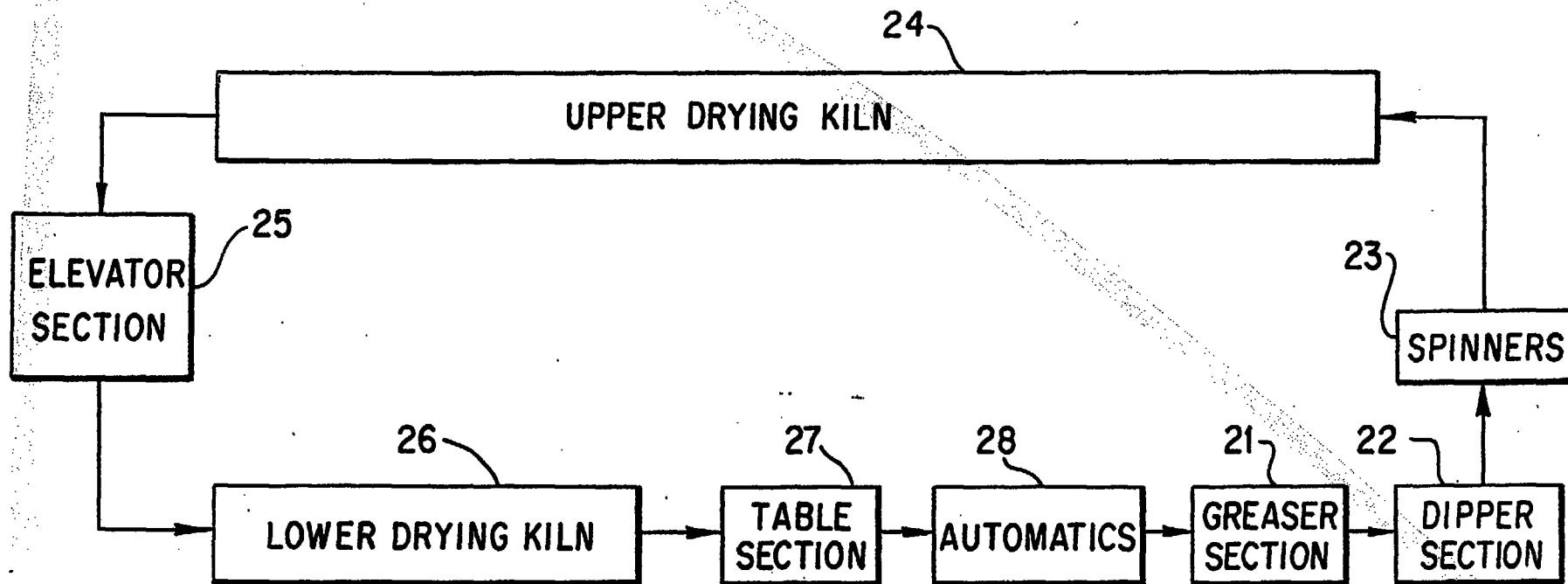


FIG. 2
(PRIOR ART)

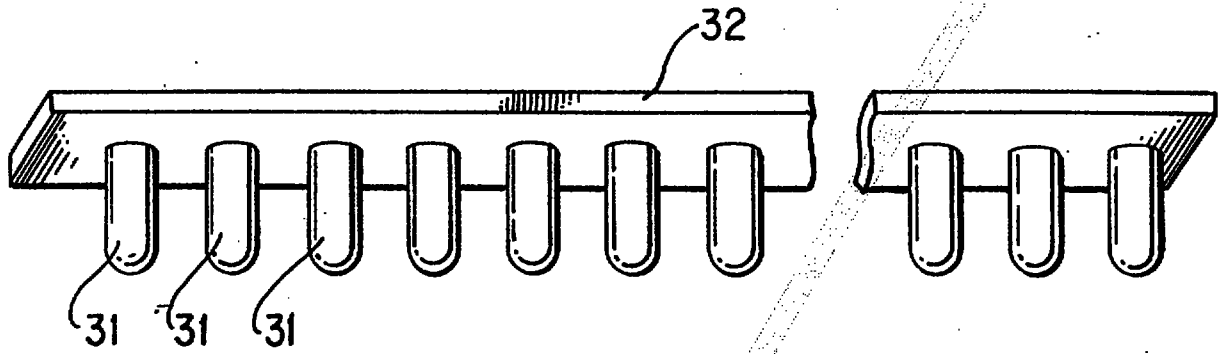


FIG. 3
(PRIOR ART)

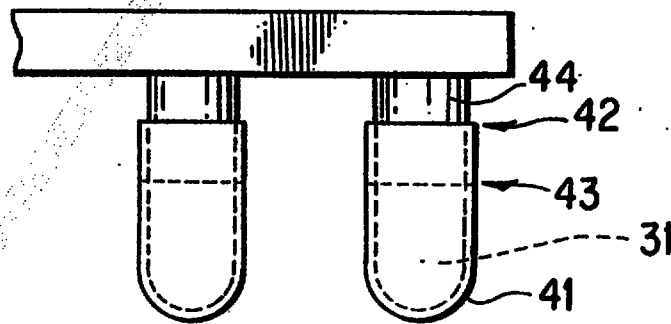


FIG. 4
(PRIOR ART)

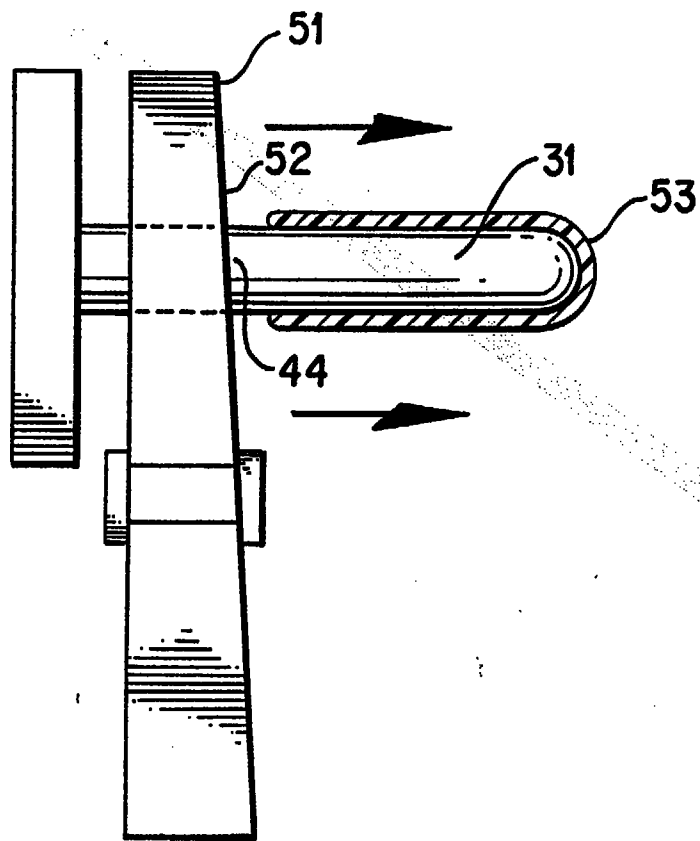


FIG. 5
(PRIOR ART)

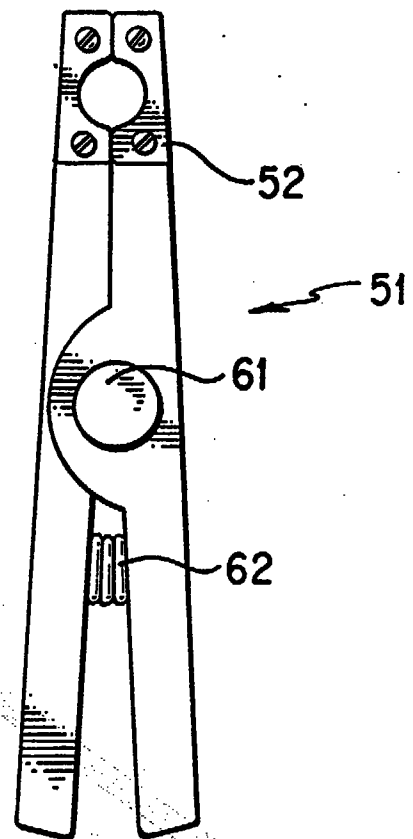


FIG. 6
(PRIOR ART)

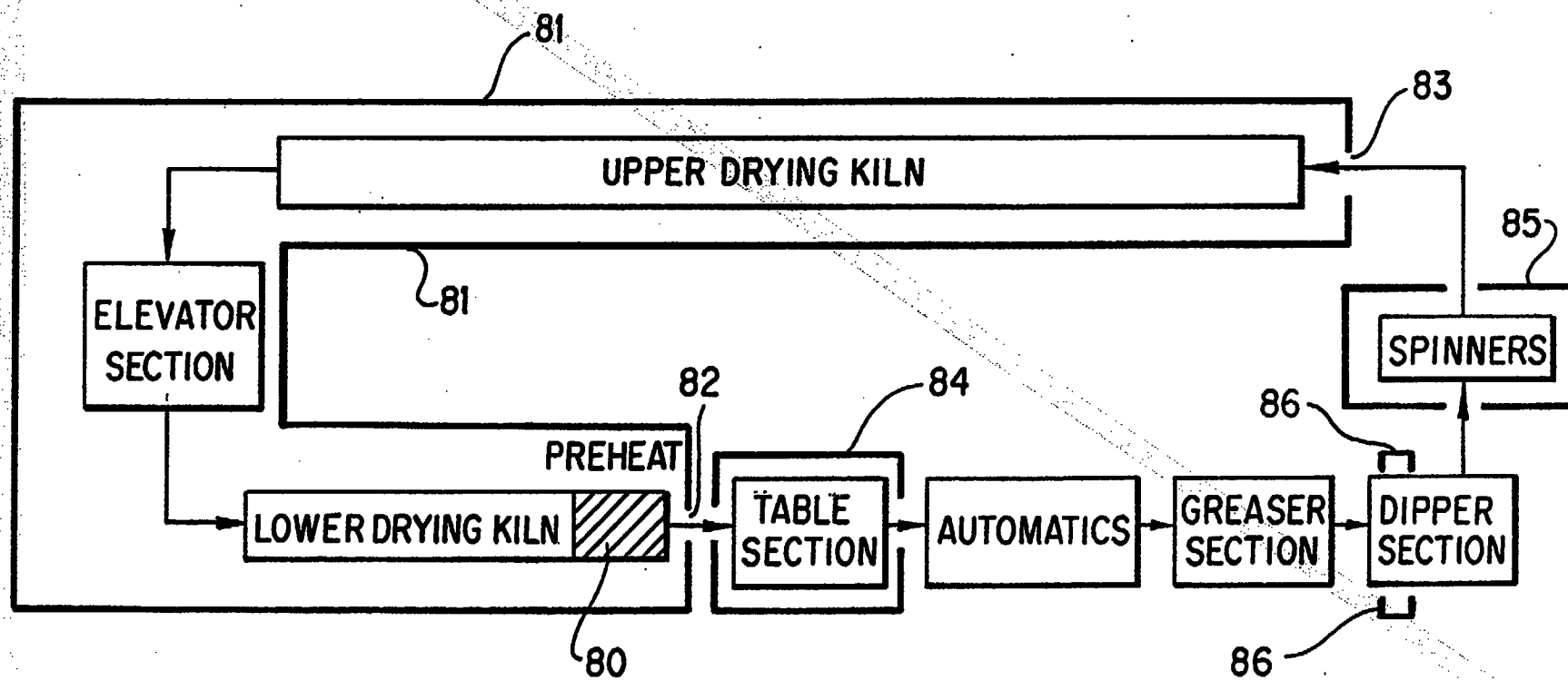
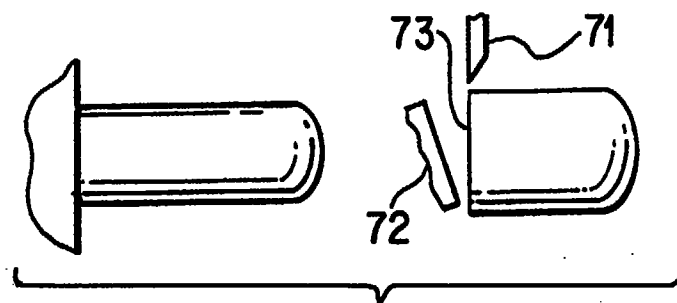


FIG. 8A

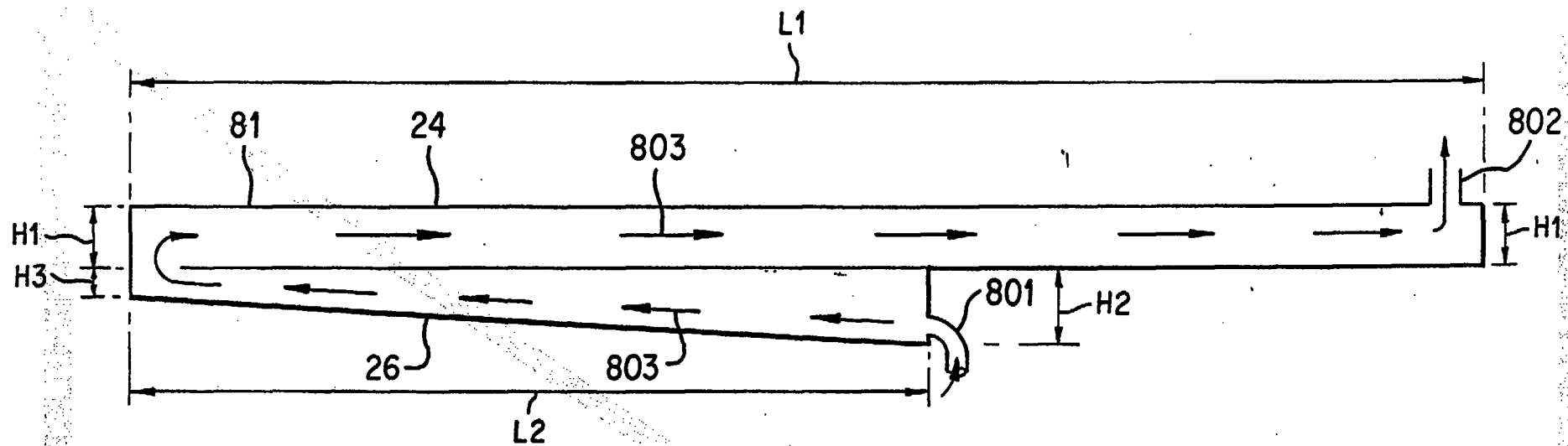


FIG. 8B

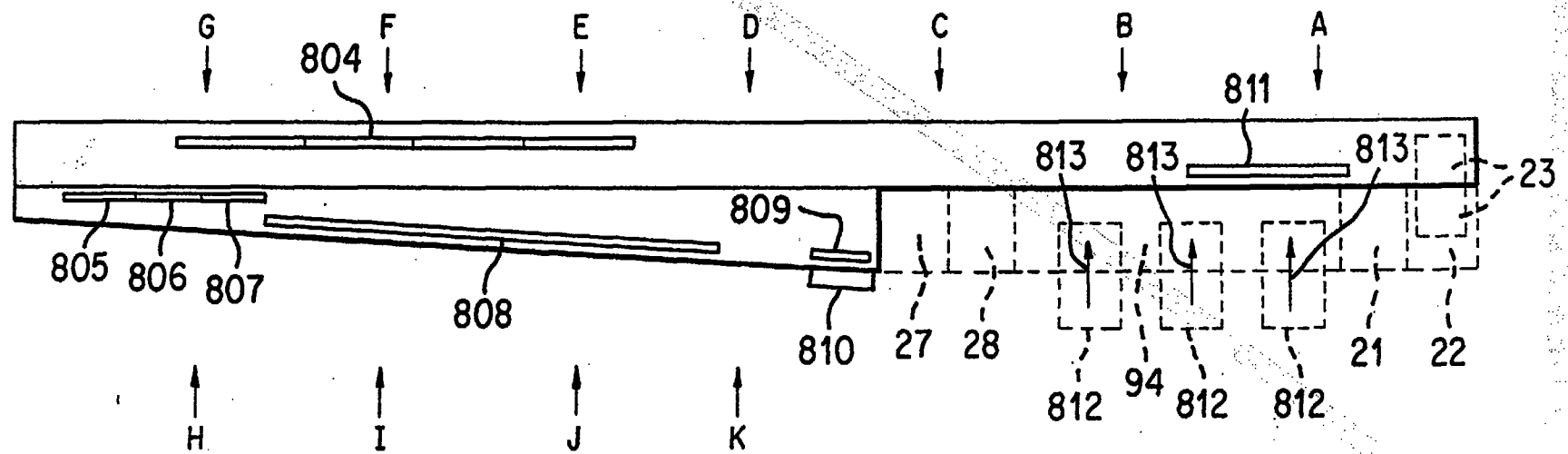


FIG. 8C

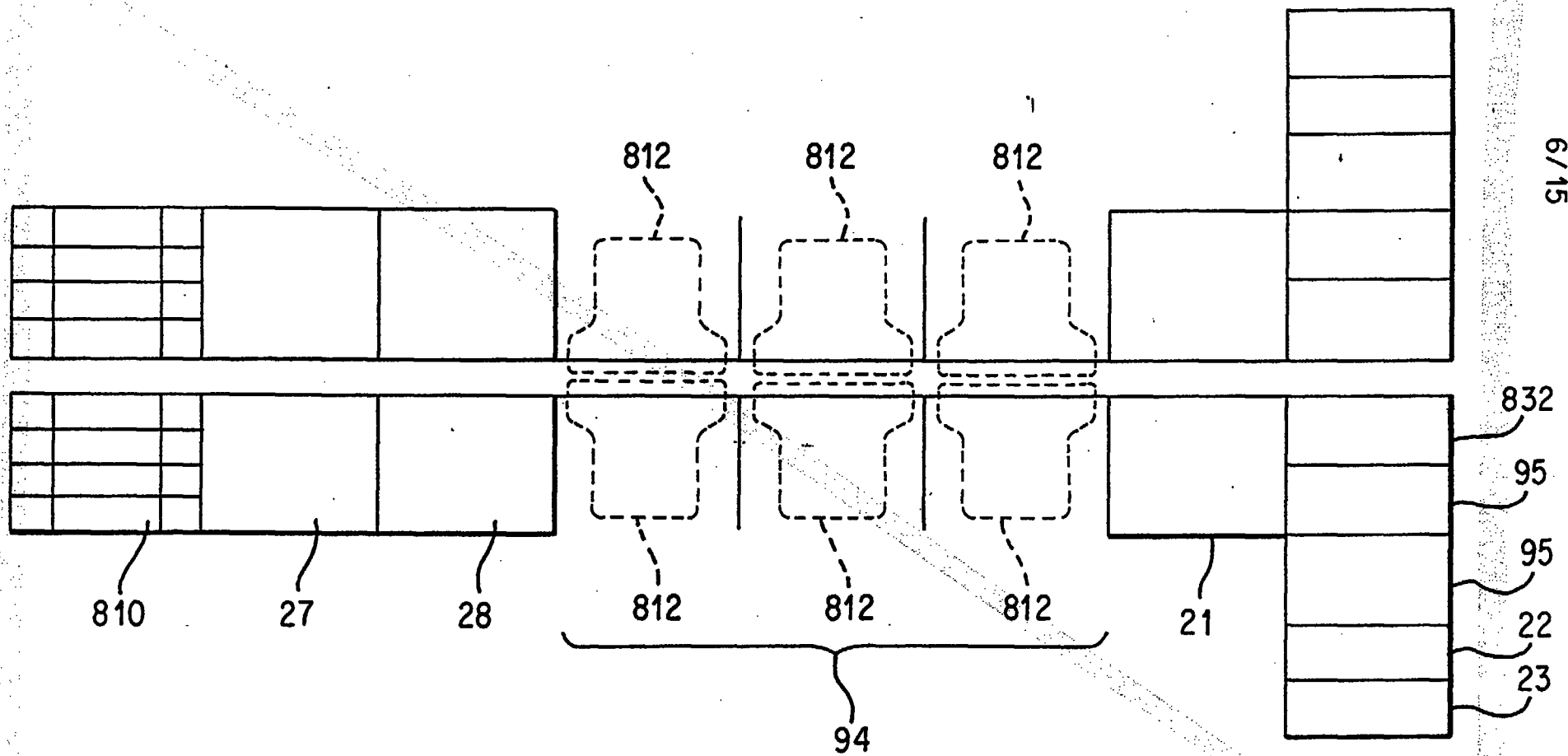


FIG. 8D

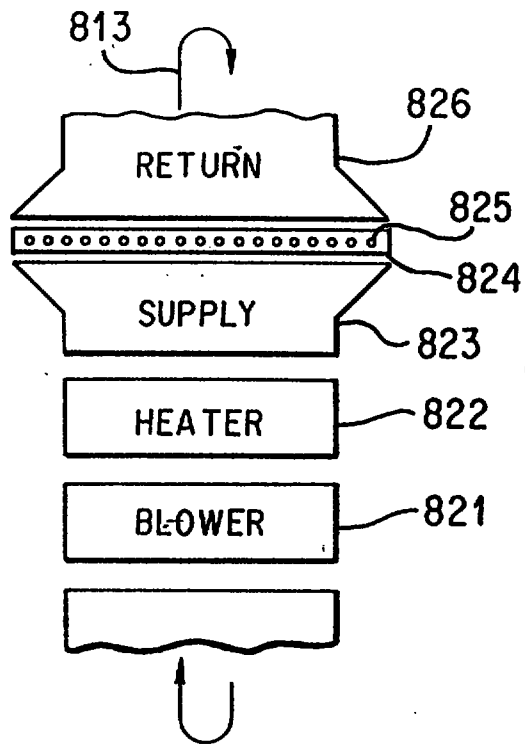


FIG. 8E

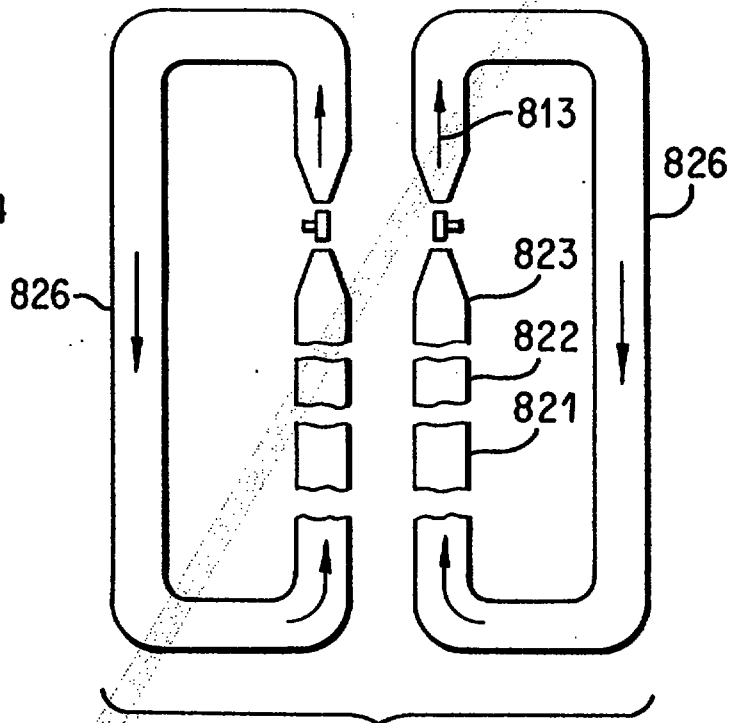


FIG. 8F

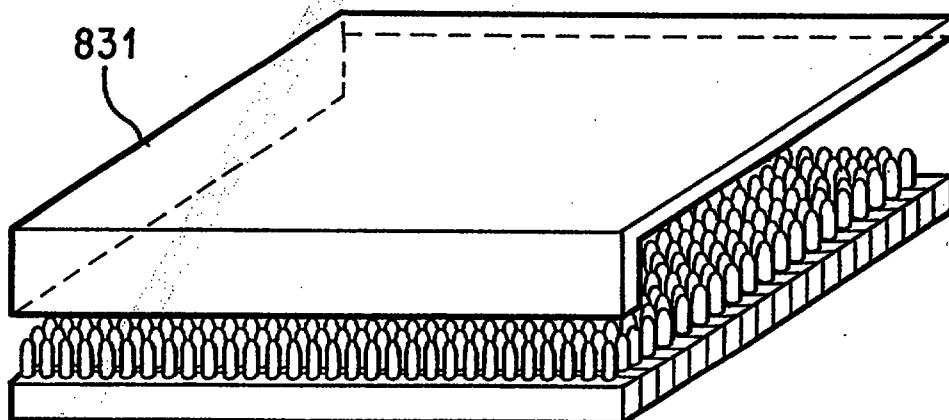


FIG. 8G

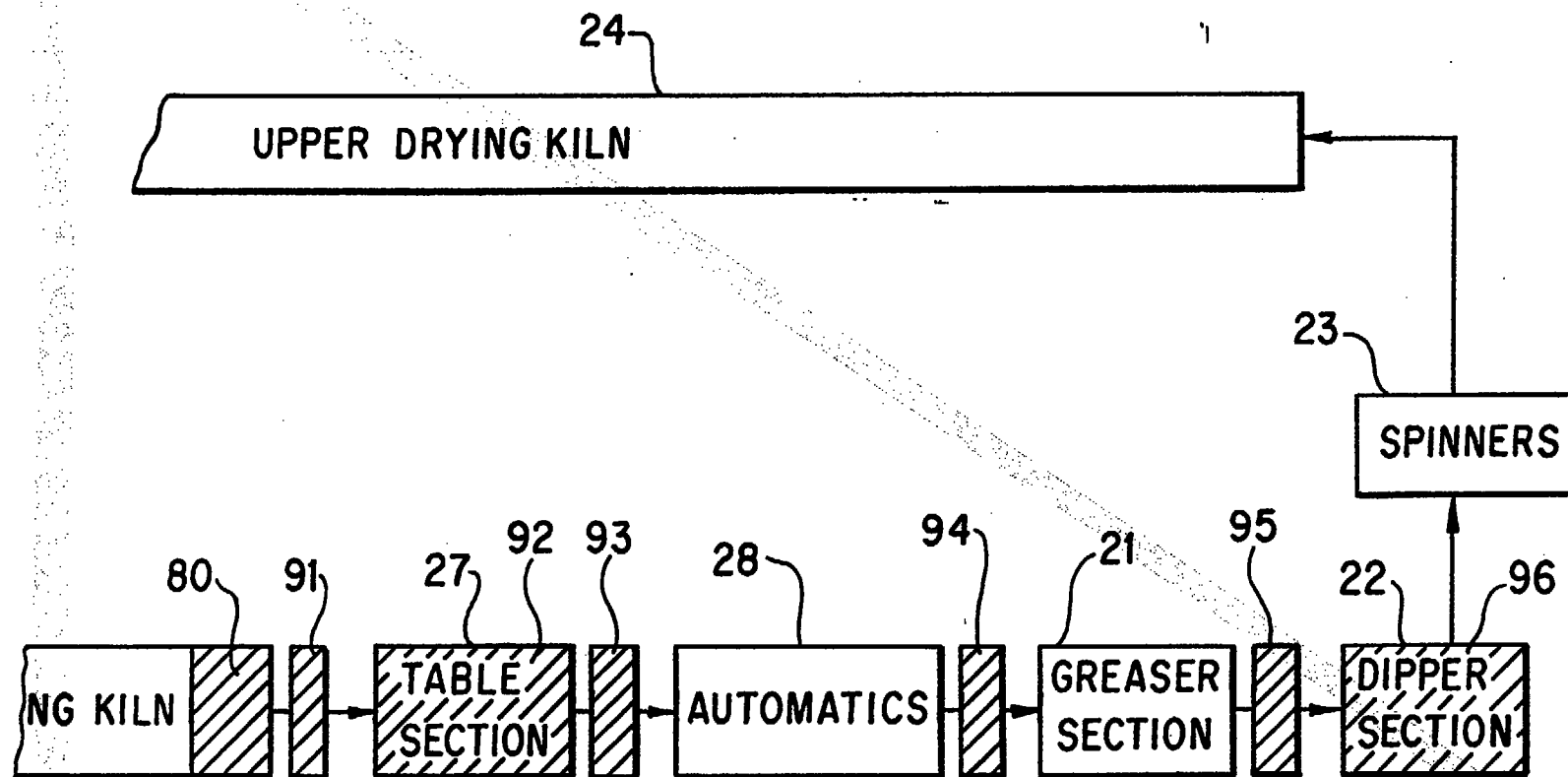


FIG. 9

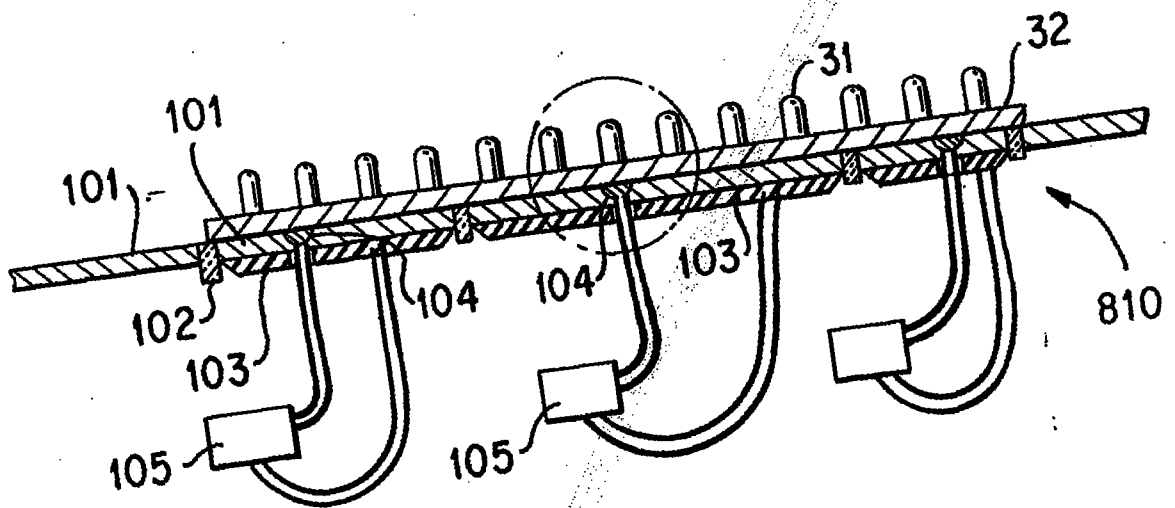
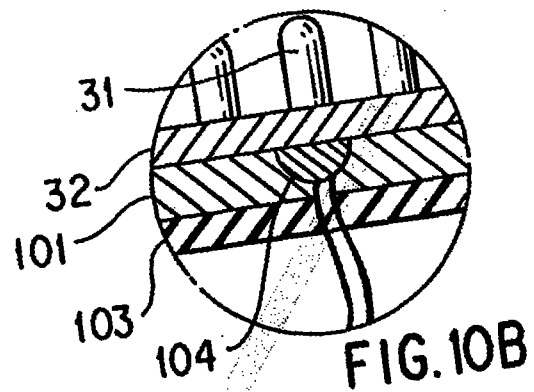


FIG. 10A

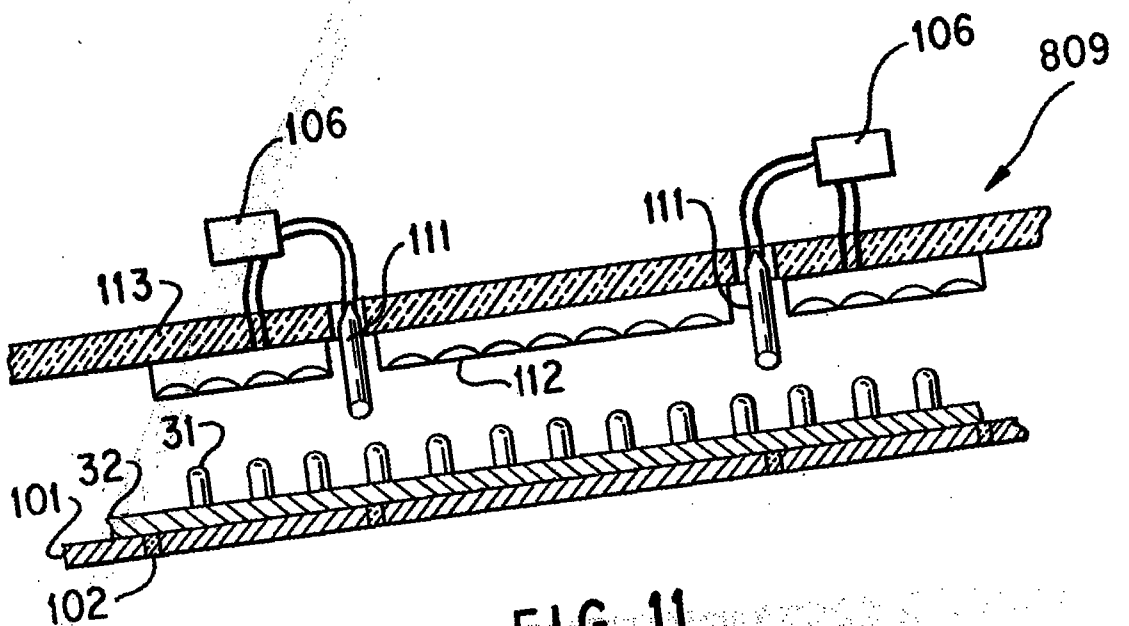


FIG. 11

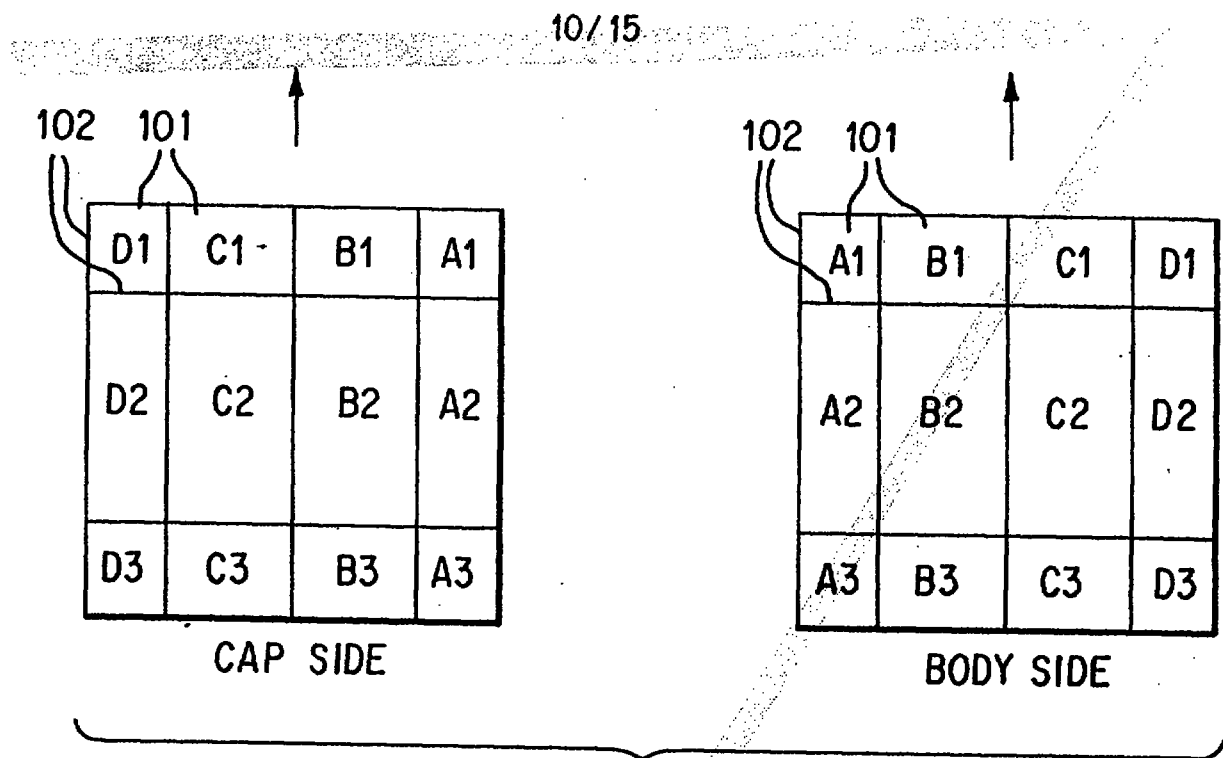


FIG. 10D

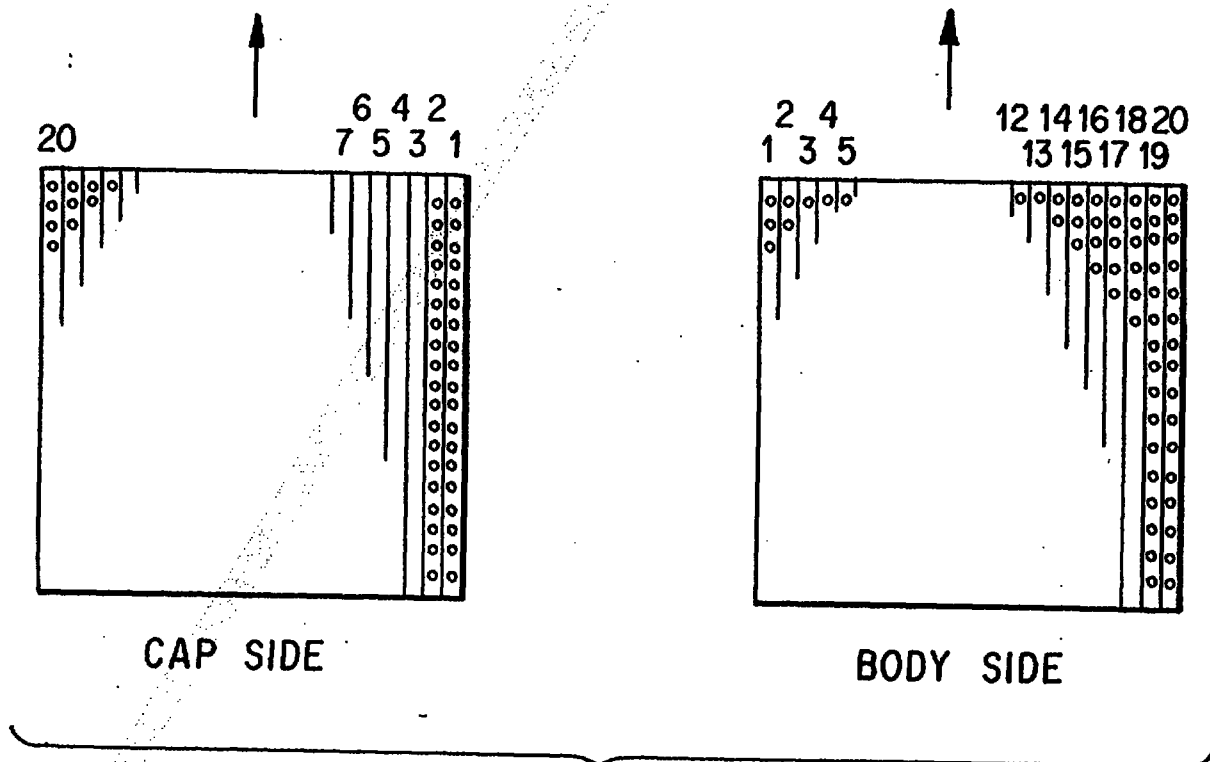


FIG. 10C

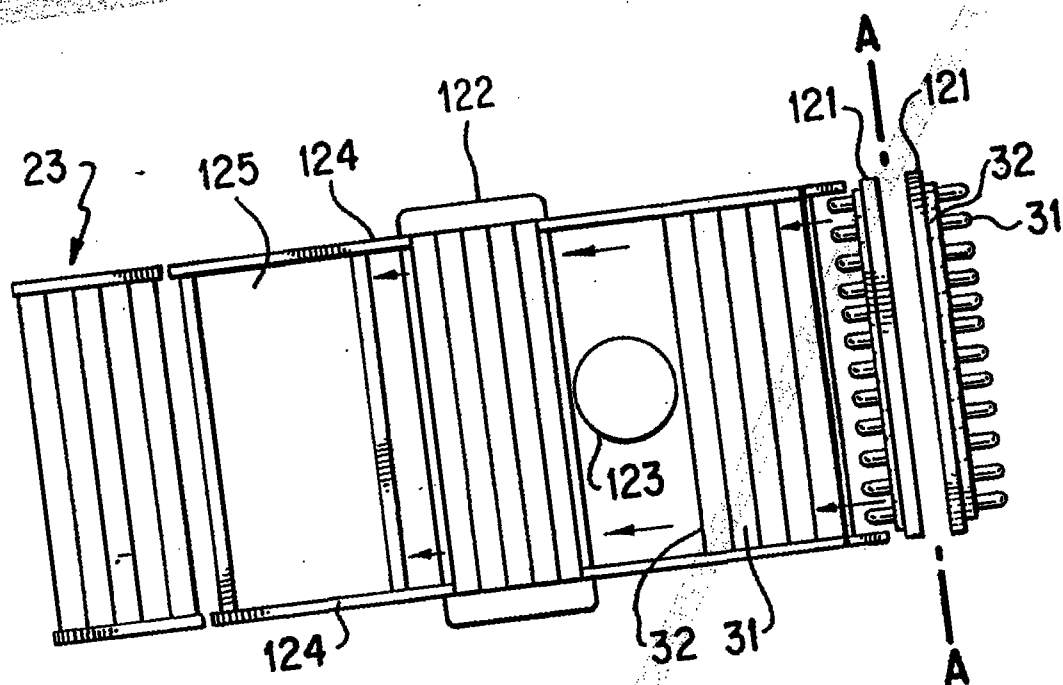


FIG. 12

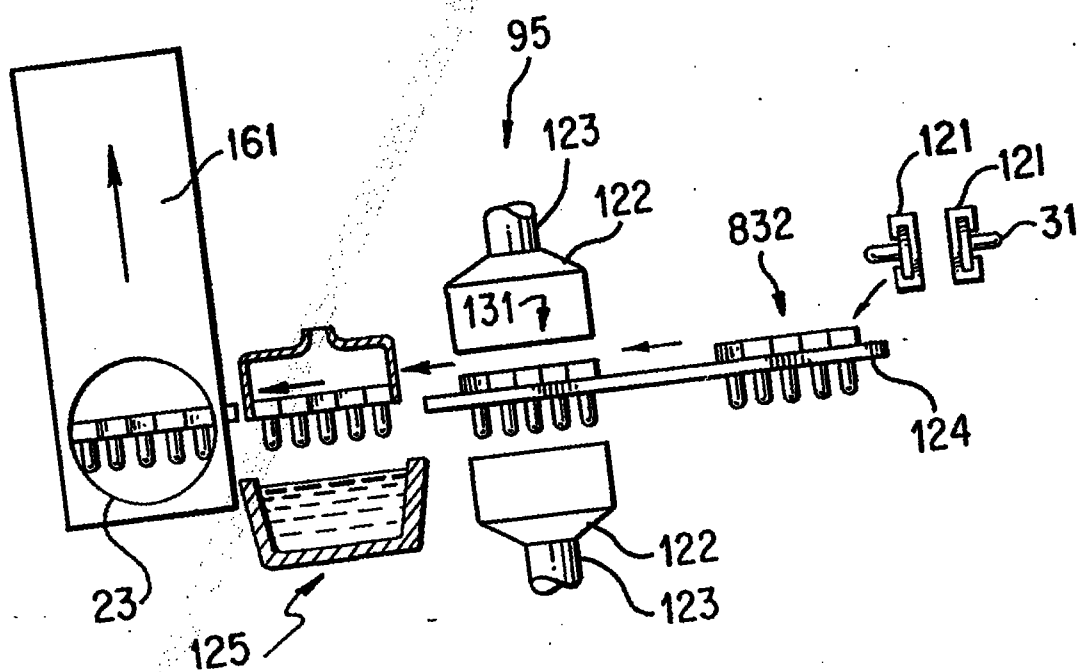


FIG. 13

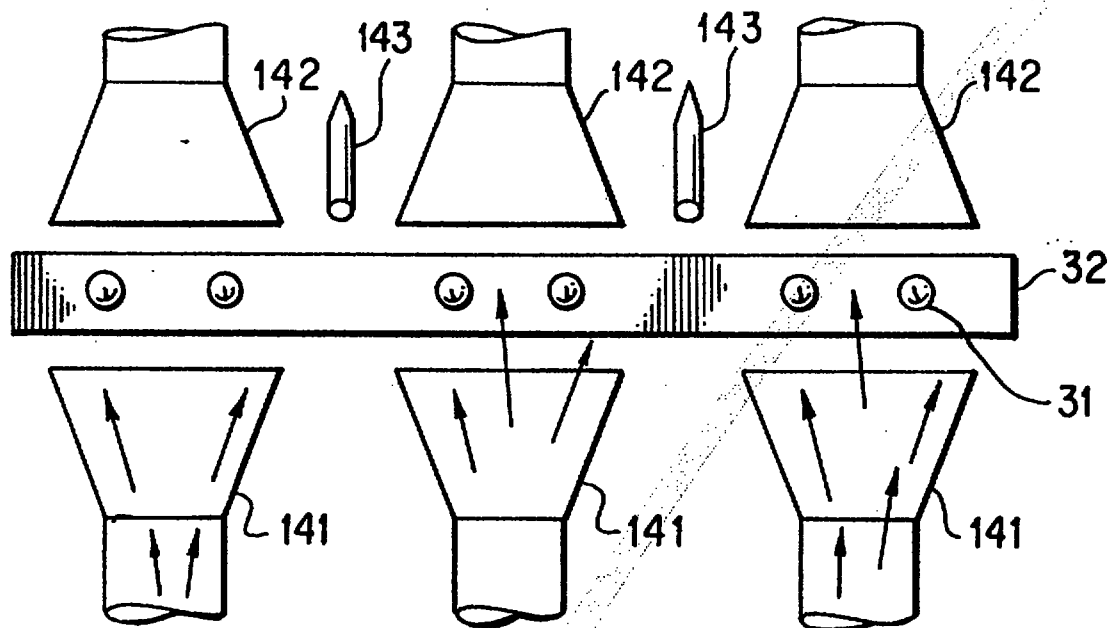


FIG. 14A

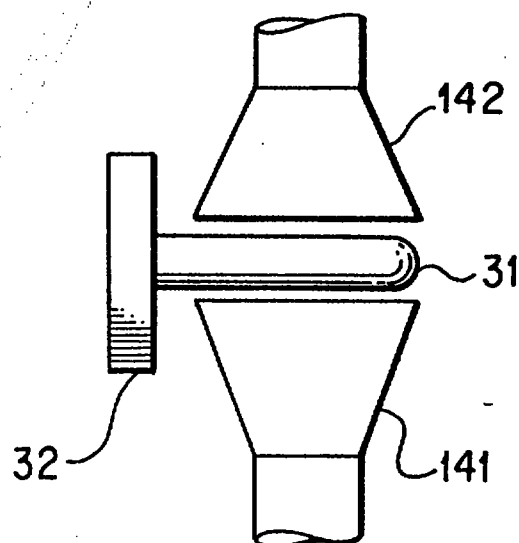


FIG. 14B

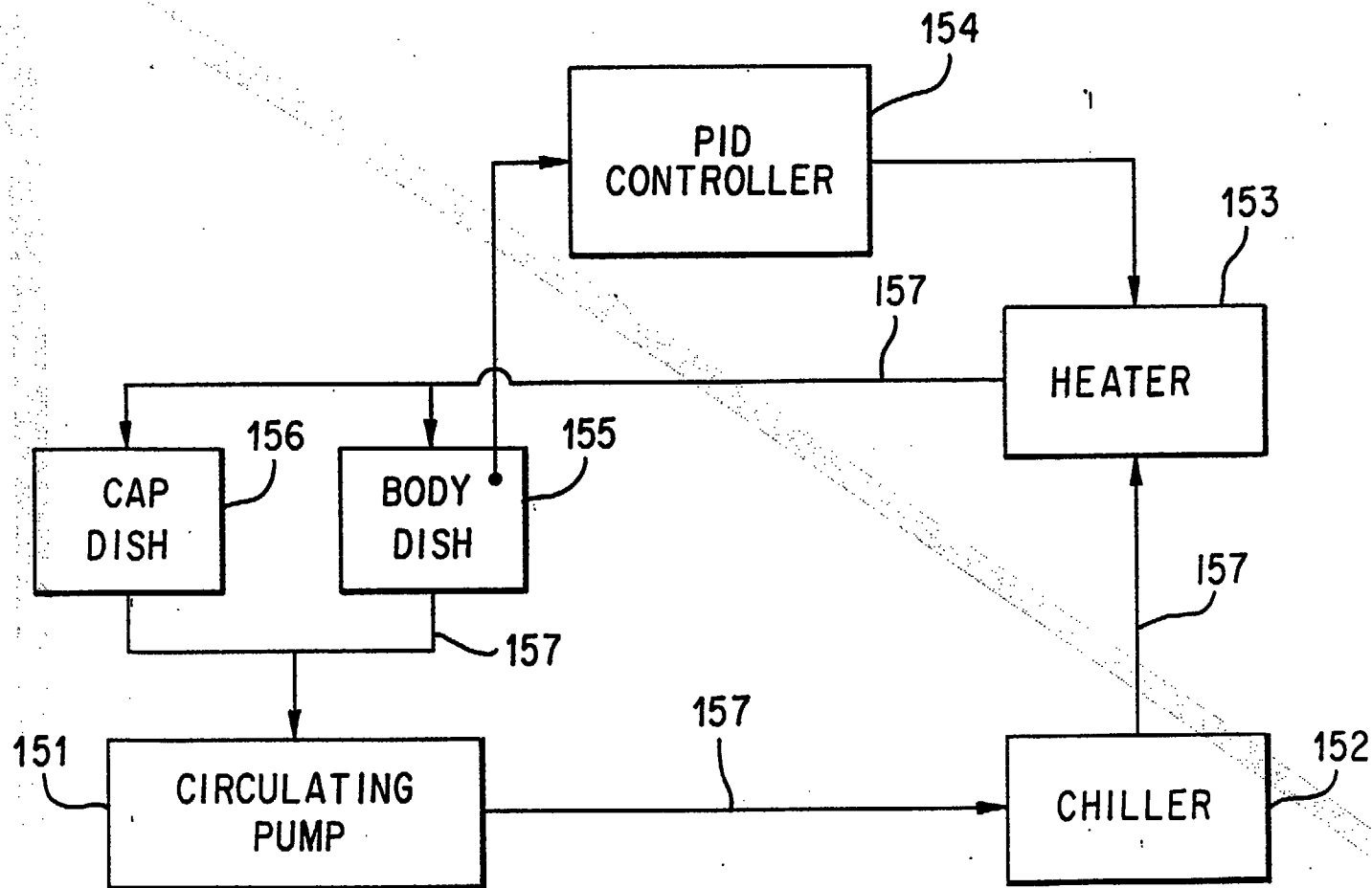


FIG. 15

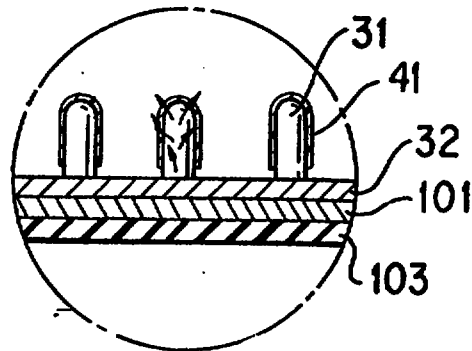


FIG. 16B

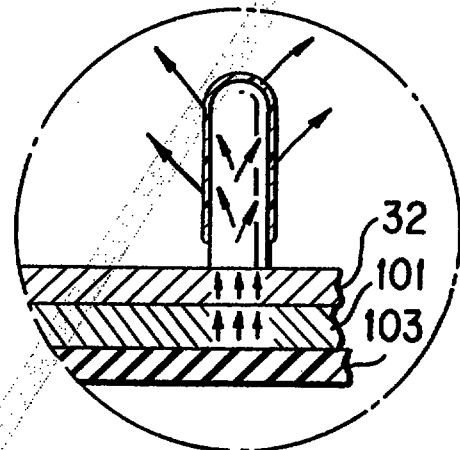


FIG. 16C

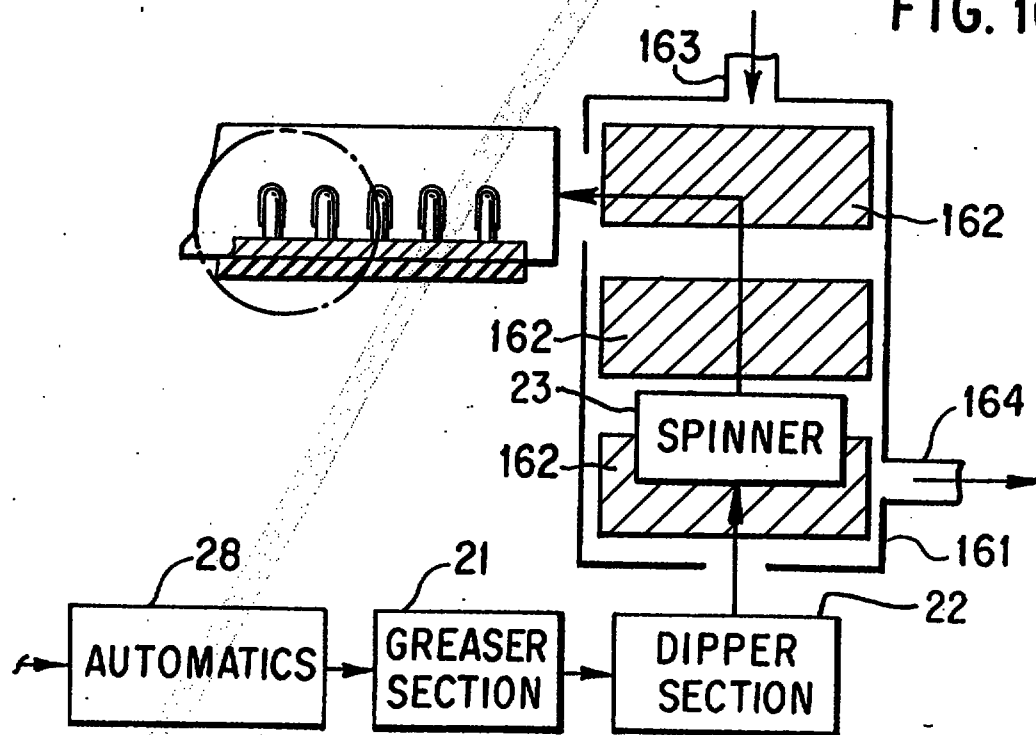


FIG. 16A

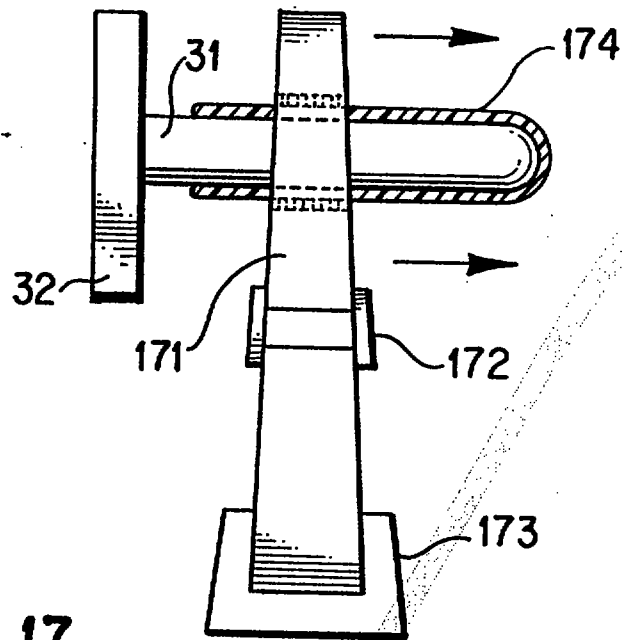


FIG. 17

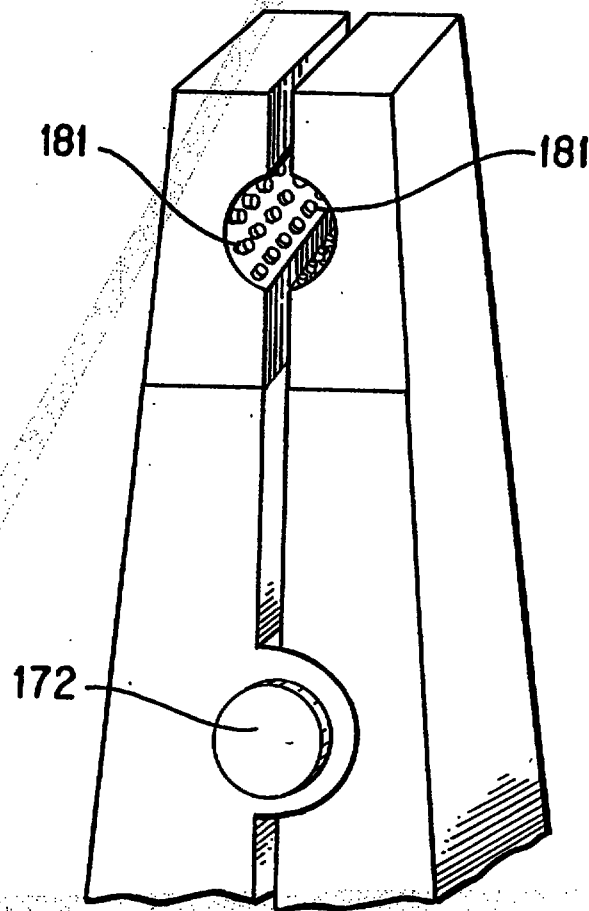


FIG. 18