

1 APPARATUS FOR TWO-STAGE FUSION OF FACE-TO-FACE
2 POLYMERIC SHEETS
3

4 **Cross-reference to Related Applications:**

5 This application is a continuation-in-part of co-
6 pending U.S. Application No. 08/419,457 commonly assigned
7 with the present application.
8

9 **Background and Summary of the Invention:**

10 The instant invention relates to the fusion of an
11 amorphous copolyester backing sheet and a polyvinyl
12 chloride sheet to form a two-piece card structure, such
13 as an identification card, and more particularly to belt-
14 type transport apparatus for transporting the facing
15 sheets through successive fusing and cooling stages.
16

17 Belt-type transport apparatus of the general type
18 contemplated herein have heretofore been known in the
19 lamination art. In general, the prior art apparatus
20 typically include only a single heating station for
21 applying heat to the surfaces of the thermoplastic sheets
22 while maintaining the sheets in face-to-face relation.
23 These apparatus are known as single-stage laminators and
24 they are effective for laminating many types of
25 thermoplastic sheet materials. However, there are
26 certain types of thermoplastic sheet materials, such as
27 the above-noted amorphous copolyester and polyvinyl
28 chloride materials, which have specific heating and
29 cooling characteristics which are not met by the prior
30 art devices. It has thus been found that there is a need
31 in the industry for an apparatus which is effective for
32 the fusion of these new card materials.

33 A first embodiment of the instant invention provides
34 a two-stage fusing apparatus comprising upper and lower

1 belt assemblies which are supported in closely spaced
2 adjacent relation. The lower belt assembly comprises a
3 stainless steel belt received around first and second
4 rollers, and the upper belt assembly comprises a
5 fiberglass belt received around third and fourth rollers.
6 The belt assemblies are supported in a frame structure
7 such that the first and third rollers form an input nip,
8 and the second and fourth rollers form an output nip,
9 with the endless belts in facing relation. The first and
10 second rollers are fixed in position, with the third and
11 fourth rollers being slidably suspended relative to the
12 first and second rollers. The third and fourth rollers
13 are biased downwardly from their suspended position
14 toward the first and second rollers to form spaced, but
15 pressurized input and output nips. The first, or lower,
16 input roller is heated by an internal cartridge heater to
17 a temperature of about 200°C. The heated input nip is
18 operative for pressing the copolyester sheet and the
19 polyvinyl chloride sheet together to initially fuse the
20 two facing sheets into a two piece structure. A heating
21 platen, positioned in abutting relation with an upper
22 portion of the metallic belt adjacent to the first roller
23 is heated to a temperature of about 160°C to define a full
24 fusing stage. Fan cooled heat sinks are positioned in
25 abutting relation adjacent to the output nip for cooling
26 the metallic and fiberglass belts passing therebetween
27 and removing heat from the card after fusion.

28 A second embodiment of the apparatus includes a
29 single belt assembly having an endless belt received
30 around first and second rollers. The apparatus further
31 includes a third roller mounted in cooperation with the
32 first roller to form an input nip with the first roller
33 such that the rollers press the sheets together to define
34 a two-piece structure having a polyvinyl chloride side

1 and an opposing amorphous copolyester side. The polyvinyl
2 chloride side is positioned adjacent to the first roller.
3 The apparatus still further includes a cartridge heater
4 for heating the first roller such that the polyvinyl
5 chloride side of the two piece structure is heated as the
6 facing sheets pass through the nip. The third roller is
7 actively cooled by a fan means so that the amorphous
8 copolyester side is cooled while the polyvinyl chloride
9 side is heated. The roller fan actively removes heat from
10 the amorphous copolyester sheet during the initial fusion
11 to prevent the copolyester from deforming under the nip
12 pressure. The apparatus further includes a heated platen
13 downstream of the input nip for applying additional heat
14 to the polyvinyl chloride side of the two piece structure
15 to effect a full fusion of the sheets. The heated platen
16 is in thermal communication with an underside of the belt
17 wherein further heat is applied to the polyvinyl chloride
18 side of said two-piece structure as the belt carries the
19 two piece structure over the platen. Finally, the
20 apparatus includes fan-cooled heat sinks positioned above
21 and below the transport belt for cooling both sides of
22 the two-piece card structure as the two-piece card
23 structure is transported away from the heated platen.

24 Accordingly, among the objects of the instant
25 invention are the provision of a two-stage fusing device
26 wherein two thermoplastic sheets are initially fused
27 under heat and pressure, fully fused under heat alone,
28 and then cooled; the provision of a fusing device
29 including an endless belt for transporting sheet
30 materials through an initial fusing station, a full
31 fusing station, and a cooling station; and the provision
32 of a fusing device including a heated input nip, a heated
33 platen and fan cooled heat sinks.

1 Other objects, features and advantages of the
2 invention shall become apparent as the description
3 thereof proceeds when considered in connection with the
4 accompanying illustrative drawings.

5
6 **Description of the Drawings:**

7 In the drawings which illustrate the best mode
8 presently contemplated for carrying out the present
9 invention:

10 Fig. 1 is a front view of the first embodiment of
11 the apparatus of the instant invention;

12 Fig. 2 is a rear view thereof;

13 Fig. 3 is a top view thereof;

14 Fig. 4 is a cross-sectional view thereof taken along
15 line 4-4 of Fig. 3;

16 Fig. 5 is a perspective view of a second embodiment
17 of the apparatus;

18 Fig. 6 is a front view thereof;

19 Fig. 7 is a rear view thereof;

20 Fig. 8 is a top view thereof;

21 Fig. 9 is a right side view thereof; and

22 Fig. 10 is a cross-sectional view thereof taken
23 along line 10-10 of Fig. 9

24
25 **Description of the Preferred Embodiment:**

26 Referring now to the drawings, a first embodiment of
27 the apparatus of the instant invention is illustrated and
28 generally indicated at 10 in Figs. 1-4. As will
29 hereinafter be more fully described, the instant
30 apparatus 10 is operative for fusing face-to-face
31 thermoplastic sheet materials, such as those types of
32 sheet materials used in constructing security cards.
33 More specifically, the instant invention 10 has been
34 found to be particularly useful in fusing a security card

1 system developed by Minnesota Mining and Manufacturing
2 Company of Saint Paul Minnesota, and described in PCT
3 Publication No. WO95/09084 which is incorporated herein
4 by reference.

5 The subject security card system generally indicated
6 at 12 in Fig. 4, comprises a backing sheet 14, a cover
7 sheet 16, and a security image (not shown), with the
8 security image preferably being reverse printed on the
9 inner surface 18 of the cover sheet 16 so that it is
10 located between the fused sheets 14, 16 when secured
11 together. When viewed through the upper side of the
12 cover sheet, the reverse printed security image appears
13 in its correct orientation. The backing and cover sheets
14 14, 16 are fused directly together without an
15 intermediate layer of adhesive, wherein the backing sheet
16 14 preferably comprises an amorphous copolyester film,
17 and the cover sheet 16 comprises a rigid polyvinyl
18 chloride film. The amorphous copolyester backing sheet
19 14 is preferably pigmented with titanium dioxide so that
20 it is opaque white, while the PVC cover sheet 16 is
21 preferably transparent, although other color schemes and
22 arrangements are also suitable. In most instances, the
23 backing sheet 14 is considerably thicker than the cover
24 sheet as it is intended to provide most of the rigidity
25 and strength of the assembled card 12. For example, the
26 backing sheet 14 preferably has a thickness of between
27 about 20 and 22 mils, and the cover sheet 16 preferably
28 has a thickness of between about 7 and 10 mils for a
29 total card thickness of between about 27 and 32 mils.
30 The particular advantage of the subject security card
31 system 12 is that good adhesion can be achieved between
32 PVC and amorphous copolyesters at relatively low
33 temperatures, e.g., at temperatures of about 150°C. The
34 fusion can be effectively achieved because both amorphous

1 copolyesters and PVC are softened during the fusion
2 process, and both contract on cooling at about the same
3 rate, thereby reducing warping problems encountered with
4 other existing card materials.

5 The first embodiment of the apparatus 10 comprises
6 upper and lower belt assemblies generally indicated at 20
7 and 22, which are supported in closely spaced adjacent
8 relation by a frame assembly comprising a bottom wall 24,
9 and parallel front and rear walls, 26 and 28
10 respectively.

11 The lower belt assembly 22 comprises a stainless
12 steel belt generally indicated at 30 received around
13 first and second metallic rollers 32, 34 respectively,
14 and the upper belt assembly 20 comprises a fiberglass
15 belt generally indicated at 36 received around third and
16 fourth metallic rollers, 38 and 40 respectively. Both
17 the stainless steel belt 30 and the fiberglass belt 36
18 preferably have thicknesses of about .003 inches. The
19 steel belt 30 is commercially available from Belt
20 Technologies of Agawam, MA, and the fiberglass belt 36 is
21 available from Greenbelt Industries, Inc. of Buffalo, NY.
22 The rollers 32, 34, 38, 40 preferably comprise aluminum
23 rollers having shafts 32S, 34S, 38S, 40S. It is pointed
24 out that shafts 32S and 38S are hollow, while shafts 34S
25 and 40S are solid.

26 The belt assemblies 20, 22 are supported in the
27 frame such that the first and third rollers 32, 38 form
28 an input nip, and the second and fourth rollers 34, 40
29 form an output nip, with the endless belts 30, 36 in
30 facing relation. The first and second rollers 32, 34 are
31 fixed in position, with the third and fourth rollers 38,
32 40 being slidably movable relative to the first and
33 second rollers 32, 34. More specifically, the shaft of
34 each roller is received through a pair of spaced bearing

1 mounts generally indicated at 42A, 42B, 42C, and 42D.
2 Each bearing mount 42 comprises a bearing 44A, 44B, 44C,
3 44D which is supported in a bearing holder 46. Bearings
4 44A and 44C each comprise a roller-type bearing, while
5 bearings 44B and 44D comprise sleeve-type bearings.
6 Furthermore, the sleeve bearings 44B and 44D are mounted
7 in a hardened outer sleeve 45. Each bearing holder 46
8 includes a recess 48 for receiving the bearing 44
9 therein, and further includes grooves 50 in the side
10 edges thereof. The grooves 50 of the bearing mounts 42
11 are slidably received in respective slots 52 in the front
12 and rear walls 26, 28 of the frame assembly so that the
13 bearing holder 46 engages both the inner and outer
14 surfaces of the walls 26, 28. The bearing mounts 42A and
15 42B rest against the bottom of their respective slots 52,
16 and thus maintain the first and second rollers 32, 34 in
17 a fixed vertical position. It is pointed out that the
18 recesses 48B in the bearing mounts 42B (second roller 34)
19 are elongated in a horizontal direction to allow sliding
20 horizontal movement of the axis of the second roller 34
21 with respect to the first roller 32. In this connection,
22 a set 54 is extended through a threaded opening in the
23 side wall of the bearing mount 46B and engaged with the
24 hardened outer sleeve 45 to adjust the distance between
25 the axis of the first roller 32 and the axis of the
26 second roller 34. This set screw arrangement is
27 operative for adjusting the parallelism of the first and
28 second roller axes as well as for taking up or tightening
29 slack in the steel belt 30. The bearing mounts 42D for
30 the fourth roller 40 have the same elongated recess 48D
31 and set screw 54 for adjustment of the fourth roller axis
32 with respect to the third roller axis.

33 The bearing mounts 42C, 42D for the third and fourth
34 rollers 38, 40 are suspended in the frame assembly by

1 screws 56 which extend downwardly through spaced
2 suspension bars 58 attached to the front and rear walls
3 26, 28. The head 60 of the screw 56 rests on top of the
4 bar while the shaft 62 passes through an opening (not
5 shown) in the bar 58 and extends into a threaded bore (no
6 shown) in the top of the respective bearing holder 46.
7 A compression spring 64 is received around each screw 56
8 and captured between the top of the respective bearing
9 holder 46 and the bottom of the respective suspension bar
10 58 to bias the third and fourth rollers 38, 40 downwardly
11 from their suspended position toward the first and second
12 rollers 32, 34. Rotation of the screw 56 permits
13 adjustment of the vertical spacing between the third and
14 first rollers 38, 32 (input nip rollers) and the fourth
15 and second rollers 40, 34 (output nip rollers). In this
16 regard, the belt assemblies 20, 22 are adjusted so that
17 there is at 25 mil spacing between the input rollers 32,
18 38 and between the output rollers 34, 40, the spacing
19 being slightly smaller than the combined thickness of the
20 security card sheets (27-33 mils). Since the third and
21 fourth rollers 38, 40 are biased downwardly toward the
22 first and second roller 32, 34, the roller pairs form
23 spaced, but pressurized input and output nips.

24 The first, or lower, input roller 32 is heated by a
25 conventional cartridge heater 66 to a temperature of
26 between about 190°C and about 215°C, but more preferably
27 to a temperature of about 200°C. The cartridge heater 66
28 is slidably received in the center of the hollow roller
29 shaft 32S and is energized by a conventional electric
30 source (not shown). The input nip (rollers 32, 38) thus
31 defines an initial fusing stage for fusing the cover and
32 backing sheets 14, 16 together under pressure and heat.

33 Referring now to Fig. 4, a full fusing stage is
34 defined by a 1/2 inch thick aluminum heating platen 68,

1 positioned in abutting relation with an upper portion of
2 the steel belt 30 adjacent to the first roller 32. The
3 platen 68 is preferably heated to a temperature between
4 about 150°C and about 170°C, and more preferably to a
5 temperature of about 160°C. Heating of the platen 68 is
6 accomplished by means of a rubber plate heater 70 glued
7 to the bottom surface of the platen 68. A rubber plate
8 heater 70 of the type contemplated is available from
9 Hotset, Inc. of Battle Creek, MI. Alternatively, other
10 heating devices, such as cartridge-type heaters, could be
11 used to heat the platen 68.

12 In order to cool the belts 30, 36 and the fused
13 sheets 14, 16 held therebetween, first and second fan
14 cooled heat sinks generally indicated at 72, 74
15 respectfully, are positioned in abutting relation
16 adjacent to the output nip (rollers 34, 40). More
17 specifically, a first aluminum heat sink 72 is positioned
18 between the front and rear walls 26, 28 of the frame,
19 with the body portion 72B in abutting relation with the
20 upper portion of the steel belt 30. Fasteners 76 extend
21 through the front and rear walls 26, 28 of the frame and
22 into openings (not shown) in the heat sink 72 to fixedly
23 secure the heat sink 72 in position. A second heat sink
24 74 is positioned between the front and rear walls 26, 28
25 of the frame assembly with the body portion thereof 74B
26 in abutting relation with the lower portion of the
27 fiberglass belt 36. A second set of fasteners 78 extend
28 through vertical slots 80 in the frame walls 26, 28 and
29 into the second heat sink 74. Springs 82 are secured
30 between the fastener pairs to draw the second movable
31 heat sink 74 downwardly into compressing relationship
32 with the first fixed heat sink 72. The fins 72F, 74F of
33 the heat sinks 72, 74 extend perpendicular to the
34 direction of travel of the belts 30, 36 wherein first and

1 second fans 83, 84 mounted to the rear wall of the frame
2 respectively blow air over the fin surfaces 72F, 74F in
3 a direction perpendicular to the direction of belt
4 travel. To facilitate rapid air movement and optimize
5 cooling, the air is moved through openings 86, 88 in the
6 front and rear walls 26, 28 of the frame assembly.

7 In use, the belts 30, 36 are rotated simultaneously
8 in opposite directions for transporting the overlapping
9 cover and backing sheets 14, 16 between the endless belts
10 from the input nip to the output nip. Rotation of the
11 belts 30, 36 is accomplished via an electric motor
12 generally indicated at 90 and gear system. The body 92
13 of the electric motor 90 is mounted to a bracket 94
14 attached to the rear wall 28 of the frame assembly. The
15 drive shaft 96 of the motor 90 includes a worm gear
16 portion 98 for rotating a drive gear 100 mounted on the
17 rear end of the shaft 34S of the second roller 34 (Fig.
18 2, 3). Rotation of the lower belt assembly 22 is
19 transferred to the upper belt assembly 20 by a pair of
20 intermeshing transfer gears 102, 104 mounted on the front
21 ends of the shaft 34S, 40S of the second and fourth
22 rollers 34, 40 (Fig. 1). The motor 90 and gear assembly
23 are preferably timed for transporting cards through the
24 apparatus at a rate of about 0.25 inches per second. The
25 instant device is thus operative for transporting a
26 conventional size ID card through the apparatus at a rate
27 of about 1 card per minute.

28 The apparatus 10 further includes upper and lower
29 steering assemblies generally indicated at 106 and 108
30 for maintaining proper alignment and rotation of the
31 belts 30, 36 on their respective rollers. Each steering
32 assembly 106, 108 comprises a shaft 110 mounted between
33 the front and rear walls 26, 28 of the frame. The shaft
34 110U of the upper steering assembly 108 extends

1 immediately beneath the upper portion of the fiberglass
2 belt 36 adjacent the input nip, and the shaft 110L of the
3 lower steering assembly extends immediately above the
4 lower portion of the steel belt 30 adjacent to the input
5 nip (Fig. 4). Mounted on each of the shafts 110 is a
6 mating pair of truncated cone rollers 112 with the larger
7 diameter ends of the roller 112 facing toward the outer
8 ends of the shafts 110. In this regard, as the belts 30,
9 36 rotate, if either belt should skew toward one side or
10 the other, the belt will ride upwardly on the
11 corresponding truncated roller 112, wherein it will be
12 urged back downwardly into its normal rotating position.

13 The apparatus 10 is intended to be used with the
14 cover sheet 16 of the card system facing downwardly and
15 the backing sheet facing 14 upwardly. As the overlying
16 sheets 14, 16 are fed into the input nip, the backing and
17 cover sheets 14, 16 are pressed together under the
18 pressure of the nip while the cover and backing sheets
19 14, 16 are heated by the heated lower roller 32 of the
20 input nip. The pressure of the input nip squeezes out
21 air bubbles from between the sheets 14, 16 prior to
22 fusion, and further maintains the cover and backing
23 sheets 14, 16 in proper registration during initial
24 heating by the roller 32. Maintaining the sheets 14, 16
25 in proper registration during the initial heating is
26 extremely important, since the plastic materials become
27 somewhat soft, and movement of the sheets at their
28 interface while in a molten state will cause smudging or
29 smearing of the security image printed on the inner side
30 18 of the cover sheet 16. After the initial fusion, the
31 sheets 14, 16 are transported over the heated platen 68
32 which further heats the sheets for a longer duration
33 while in a fixed position wherein they are able to fully
34 fuse together. It is noted that the longer exposure to

1 heat over the platen 68 significantly softens the upper
2 backing sheet 14 to a point wherein the surface grain or
3 texture of the fiberglass belt 36 can be unwantedly
4 imprinted on the back surface 114 of the backing sheet
5 14. In this connection, a lower portion of the
6 fiberglass belt 36 directly above the heating platen 68
7 is cooled by a fan 116. The air directed across the
8 fiberglass belt 36 keeps the back surface 114 of the
9 backing card 14 sufficiently cool and rigid so as not to
10 be imprinted with the surface texture of the fiberglass
11 belt 36.

12 The fused sheets 14, 16 are thereafter cooled to
13 almost room temperature by passage between the fan-cooled
14 heat sinks 72, 74. The sinks 72, 74 effectively remove
15 almost all of the heat from the sheets 14, 16 prior to
16 exiting from the apparatus between the output nip.

17 Referring now to Figs. 5-10, a second embodiment of
18 the apparatus is illustrated and generally indicated at
19 117. The second embodiment 117 is generally similar to
20 the apparatus 10 with the exceptions that there is only
21 a single transport belt, and the upper input roller is
22 cooled. More specifically, the second embodiment 117
23 comprises a belt assembly generally indicated at 118
24 which is supported in a frame assembly comprising front
25 and rear spaced walls, 119, 120 respectively. The belt
26 assembly comprises a Teflon coated .005 inch thick
27 stainless steel belt 122 received around first and second
28 rollers 124, 126 respectively. The rollers 124, 126 are
29 preferably fabricated from aluminum for good heat
30 conduction. The rollers 124, 126 are rotatably mounted on
31 shafts 128, 130 respectively wherein shaft 128 is hollow
32 while shaft 130 is solid (See Fig. 10). The opposing
33 ends of the shafts 128, 130 are rotatably mounted in
34 respective fixed bearing mounts 132 received in the

1 spaced front and rear walls 119, 120 of the frame such
2 that the rollers 124, 126 are maintained in fixed
3 parallel relation at all times.

4 The belt assembly 118 is rotated by an electric
5 drive motor 134 having a drive shaft 136 with a worm gear
6 surface 138 which intermeshes with a corresponding drive
7 gear 140 on the shaft 130 of the second roller 126. The
8 motor 134 and gears 138, 140 cooperate to rotate roller
9 126 at an appropriate speed to transport a card received
10 on top of the belt 122 through the various heating and
11 cooling stages of the apparatus 117.

12 During rotation, the belt 122 is tensioned around
13 the first and second rollers 124, 126 by a spring-biased
14 tension roller assembly generally indicated at 142 (See
15 Fig. 10). The assembly 142 comprises a roller 144
16 rotatably mounted on a shaft 146. The shaft 146 is
17 slidably mounted in a pair of opposing guide slots 148 in
18 the front and rear frame walls 119, 120. The shaft 146
19 is normally biased upwardly by a pair of springs 150 each
20 having one end received around an end of the roller shaft
21 146, and the opposite end received around a fixed post
22 152 mounted on the respective front and rear frame walls
23 119, 120.

24 The first roller 124 is heated by a conventional
25 cartridge heater 154 which is slidably received into the
26 hollow shaft 128 of the first roller 124. The cartridge
27 heater 154 is energized by a conventional electric source
28 (not shown) and is effective for heating the roller 124
29 to a temperature between about 190°C and about 215°C.

30 The apparatus 117 further includes a third roller
31 assembly generally indicated at 156 mounted in
32 cooperation with the first roller 124 to form an input
33 nip with the first roller 124 such that the sheets 14, 16
34 (See Fig. 4) together to define a two-piece structure

1 having a polyvinyl chloride side 16 and an opposing
2 amorphous copolyester side 14. The roller assembly 156
3 generally comprises a roller 158, front and rear
4 retaining walls 160, 162, and a fan 164. More
5 specifically, the roller 158 is preferably fabricated
6 from aluminum for good heat conduction, and is further
7 formed with a plurality of lateral bores 166 (Fig. 10)
8 extending parallel to the turning axis and spaced around
9 the circumference of the roller 158. The bores 166 are
10 intended to allow an air stream from the fan 164 to
11 travel through the roller 158 to remove heat from the
12 roller 158. The roller 158 is rotatably mounted on a
13 shaft 168 which is received in fixed bearing mounts 170
14 which are secured in the front and rear retaining walls
15 160, 162. The retaining walls 160, 162 are attached by
16 flanges 172, 174 respectively to the respective front and
17 rear frame walls 119, 120. The roller 158 is positioned
18 in the assembly 156 to provide approximately a 25 mil
19 spacing between the rollers 124, 158 so that the nip has
20 adequate clearance to accept the combined thicknesses of
21 the facing sheets 14, 16. The front and rear retaining
22 walls 160, 162 each include a plurality of apertures 176
23 to permit air flow from the fan 164 to pass through the
24 retaining walls 160, 162 and the bores 166 in the roller
25 58. The fan 162 is a conventional electrically powered
26 fan, which is mounted on four spaced stanchions 178
27 affixed to the outside surface of the front retaining
28 wall 160.

29 The input nip (rollers 124, 158) is intended to
30 function as an initial fusing stage wherein the two
31 facing sheets 14, 16 are initially fused together under
32 temperature and pressure. In operation, the sheets 14, 16
33 are fed into the input nip with the polyvinyl chloride
34 side 16 facing the first roller 124 and the amorphous

1 copolyester side 14 facing the third roller 158. In this
2 manner, only the polyvinyl chloride side 16 is heated.
3 The heat provided by the heated roller 124 is sufficient
4 to soften the entire polyvinyl chloride sheet 16 and at
5 least the lowermost facing surface of the amorphous
6 copolyester sheet 14. However, it has been found by
7 experimentation, that the heat from the roller 124 often
8 is conducted completely through the copolyester backing
9 14 thereby softening the backing 14 and causing
10 deformation the entire card structure. This was sometimes
11 a problem in the first embodiment 10 because the
12 softening of the backing sheet 14 allowed the texture of
13 the fiberglass belt 36 to be imprinted into the back
14 surface of the card during passage through the nip.
15 Obviously, if a user wanted to print on the rear surface
16 of the card, the imprinting of the texture would be
17 unacceptable. The key aspect in the initial fusion of the
18 instant card structure is to retain the stability of the
19 backing 14, i.e. to heat the polyvinyl chloride cover
20 sheet 16 and only the facing surface of the copolyester
21 sheet 14 while maintaining the back surface of the
22 copolyester sheet 14 at room temperature. Accordingly,
23 this second embodiment 117 has been provided with a means
24 for actively cooling the upper, i.e. third roller 158 to
25 actively remove heat from the back surface of the
26 copolyester sheet 14 during fusion. In operation, the
27 fan 164 creates an air flow which passes through the
28 bores 166 in the roller 158 to remove heat from the
29 roller 158, and the copolyester sheet 14. By removing
30 the heat provided by the roller 124, the back surface of
31 the copolyester backing sheet 14 remains rigid and the
32 fused card is not deformed.

33 The apparatus 117 further includes a heated platen
34 180 (Fig. 10) for applying additional concentrated heat

1 to the polyvinyl chloride side 16 of the two piece
2 structure to achieve a complete fusion of the two sheets
3 14, 160. The platen 180 comprises an aluminum body which
4 is positioned in thermal communication with an underside
5 of the belt 122 adjacent to the first roller 124. More
6 specifically, the platen 180 is mounted between the front
7 and rear frame walls 119, 120. The platen 180 is heated
8 to a temperature of between 150°C to 170°C by a cartridge
9 heater 182 inserted into a bore in the body platen 180.
10 As the fused two-piece structure exits the input nip it
11 is transported over the surface of the heated platen 180
12 by the belt 122. In order to maintain the card in
13 intimate thermal contact with the belt 122 and platen
14 180, the apparatus includes a plurality of pivotally
15 linked rollers 184 which rest on the top surface of the
16 belt 122. As the two-piece card structure passes under
17 the rollers 184, the rollers 184 hold the card in contact
18 with the belt 122. It is noted that the rollers are free
19 floating and are not affixed to the frame so that they
20 can move up and down as the card structure passes beneath
21 each roller 184. However, the rollers 184 are disposed
22 within an upper housing 186 which maintains the rollers
23 184 in position on top of the belt 122. In this regard,
24 the rollers 184 are pivotably linked together by link
25 elements 188, and the link elements 188 are slidably
26 pinned to the upper housing 186 by a pin 190. Pin 190
27 rides in a slot 192 in the housing 186 to permit upward
28 movement of the roller assembly while restricting
29 longitudinal movement of the rollers 184 with respect to
30 the belt 122. While the rollers 184 do exert some
31 downward pressure due to gravitational forces, they are
32 not intended exert any positive pressure onto the card.
33 Accordingly, as the two-piece card structure card passes
34 over the platen 180, the card structure is heated to a

1 sufficient temperature to fully fuse the polyvinyl
2 chloride and copolyester materials together. It is to be
3 understood that the second heating of the card by the
4 platen 180 will not deform the card because there is no
5 positive pressure exerted on the card to cause
6 deformation.

7 In order to cool the two-piece card structure back
8 to room temperature, the apparatus 117 includes a lower
9 fan-cooled heat sink 194 (See Figs. 7 and 10) positioned
10 in abutting relationship with the underside of the belt
11 122. The heat sink 194 is mounted between the front and
12 rear frame walls 119, 120 and is cooled by a fan 196
13 mounted to the front frame wall 119. The front and rear
14 frame walls 119 are provided with appropriate apertures
15 198, 200 respectively, to permit an air flow from the fan
16 196 to pass through the front frame wall 119, through the
17 fins of the heat sink 194 and outwardly through the rear
18 frame wall 120. The apparatus 117 further includes a
19 second upper heat sink 202 which is pivotably linked at
20 its upstream end to the rollers 184. The heat sink 202
21 also includes a chamfered corner 204 at its upstream end
22 to permit the fused card structure to easily slide
23 underneath the heat sink 202 during transport. It is
24 noted that the heat sink 202 is captured within the upper
25 housing 186 and is permitted to float upwardly so that
26 the upper surface of the backing sheet 14 is maintained
27 in intimate contact with the lower surface of the heat
28 sink 202. The heat sink 202 is cooled by another fan 206
29 which is mounted on the upper wall of the upper housing
30 186. In operation, air passes downwardly through the
31 upper housing 186, over the heat sink 202 and outwardly
32 through openings at the sides and ends of the housing
33 186.

1 Before the cooled card is output to the operator,
2 the card passes through an output nip formed by the lower
3 belt roller 126, and a fourth roller 208 mounted in
4 cooperation with the lower belt roller 126. The roller
5 208 is rotatably mounted on a shaft 210 having ends which
6 are received in shaft blocks 212. The shaft blocks 212
7 are slidably received in openings 214 in the sidewalls of
8 the upper housing 186. The blocks 212 are biased in a
9 downward direction by springs 216 captured between the
10 upper housing 186 and the shaft blocks 212. The springs
11 216 bias the roller 208 downwardly to form a pressurized
12 output nip for output of the card.

13 It can therefore be seen that the instant invention
14 provides apparatus 10 and 117 which are effective for
15 initially fusing a pair of sheet materials under pressure
16 and heat, further heating the fused sheets without
17 pressure to achieve a full bond, and then cooling the
18 fused sheets prior to exiting the apparatus. The
19 apparatus achieve these objectives by providing a
20 pressurized input nip having a heated roller. Sheet
21 materials passed through the input nip are fused under
22 the pressure and heat of the nip. The fused materials
23 are then passed over a heated platen for further heating
24 of the sheets materials to achieve a full bonding of the
25 materials. The fully fused sheets are then cooled by fan
26 cooled heat sinks prior to passage out of the apparatus.
27 For these reasons, the instant invention is believed to
28 represent a significant advancement in the art which has
29 substantial commercial merit.

30 While there is shown and described herein certain
31 specific structure embodying the invention, it will be
32 manifest to those skilled in the art that various
33 modifications and rearrangements of the parts may be made
34 without departing from the spirit and scope of the

1 underlying inventive concept and that the same is not
2 limited to the particular forms herein shown and
3 described except insofar as indicated by the scope of the
4 appended claims.

**Claims:**

- 1 1. Apparatus for fusing a first polymeric sheet in
2 face-to-face relation with a second polymeric sheet, the
3 apparatus comprising:
4 means for pressing said sheets together in face-to-
5 face relation to define a two-piece structure;
6 first means for applying heat only to the first
7 polymeric sheet while said sheets are being pressed
8 together, said pressure and heat achieving an initial
9 fusing of said first and second polymeric sheets;
10 means for cooling said second polymeric sheet while
11 said sheets are being pressed together; and
12 second means for applying heat only to said first
13 polymeric sheet under ambient pressure to achieve a full
14 fusion of the first and second polymeric sheets to each
15 other.
- 1 2. In the apparatus of claim 7, said means for pressing
2 said sheets together comprising an input nip having first
3 and second rollers.
- 1 3. In the apparatus of claim 8 said first polymeric
2 sheet being received adjacent to said first roller and
3 said second polymeric sheet being received adjacent to
4 said second roller while said sheets are being pressed
5 together, said first means for applying heat to said
6 first polymeric sheet comprising means for heating said
7 first roller.
- 1 4. In the apparatus of claim 9, said means for cooling
2 said second polymeric sheet while said sheets are being
3 pressed together comprising means for cooling said second
4 roller.

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☒	Claim(s) : paged to paged	20 23
☐	Drawing(s) : paged to paged	
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1 5. The apparatus of claim 7 further comprising a second
2 cooling means downstream of said second heating means for
3 cooling said sheets.

1 6. The apparatus of claim 8 further comprising a second
2 cooling means downstream of said second heating means for
3 cooling said sheets.

1 7. The apparatus of claim 9 further comprising a second
2 cooling means downstream of said second heating means for
3 cooling said sheets.

1 8. Apparatus for fusing a first polymeric sheet in
2 face-to-face relation with a second polymeric sheet
3 comprising;

4 a first belt assembly including a first endless belt
5 received around first and second rollers;

6 a third roller mounted in cooperation with said
7 first roller to form an input nip with said first roller,
8 said first and third rollers pressing said sheets
9 together in face-to-face relation to define a two-piece
10 structure, said first polymeric sheet being received
11 adjacent said first roller and said second polymeric
12 sheet being received adjacent said second roller while
13 said sheets are being pressed together;

14 means for heating said first roller such that only
15 said first polymeric sheet is heated, said pressure and
16 said heat achieving an initial fusing of said first and
17 second polymeric sheets;

18 means for cooling said third roller such that said
19 second polymeric sheet is cooled while said first
20 polymeric sheet is heated; and

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21 heated platen means for applying heat to said first
22 polymeric sheet, said heated platen means being in
23 thermal communication with an underside of said belt,
24 said two piece structure being supported on an upper side
25 of said belt and being transported from said input nip
26 over the surface of said heated platen means wherein
27 further heat is applied under ambient pressure to said
28 first polymeric sheet.

1 9. The apparatus of claim 14 further comprising a
2 second cooling means downstream of said heated platen
3 means for cooling said sheets.

1 10. A method of making an identification card in an
2 apparatus as claimed in claim 7 comprising the steps of:
3 providing first and second polymeric sheets;
4 arranging said first and second polymeric sheets in
5 face-to-face relation to define a two-piece card
6 structure;
7 applying pressure to said face-to-face sheets to
8 press said sheets together;
9 preheating only the second polymeric sheet while
10 said sheets are being pressed together, said pressure and
11 heat achieving an initial fusing of the sheets;
12 removing the applied pressure from the initially
13 fused sheets; and then
14 applying heat to only said second polymeric sheet of
15 the initially fused two-piece card structure to achieve
16 full fusion of the first and second polymeric sheets to
17 each other.

1 11. The method of claim 16 further comprising the step
2 of cooling said fused sheets of said two-piece structure.





- 1 12. A method for fusing a first polymeric sheet in face-
2 to-face relation with a second polymeric sheet,
3 comprising the steps of;
4 arranging said first and second polymeric sheets in
5 face-to-face relation to define a two-piece card
6 structure;
7 applying pressure to said face-to-face sheets to
8 press said sheets together;
9 preheating only the second polymeric sheet while
10 said sheets are being pressed together, said pressure and
11 heat achieving an initial fusing of the sheets;
12 removing the applied pressure from the initially
13 fused sheets; and then
14 applying heat to only said second polymeric sheet of
15 the initially fused two-piece card structure to achieve
16 full fusion of the first and second polymeric sheets to
17 each other.
- 1 13. The method of claim 18 further comprising the step
2 of cooling said fused sheets of said two-piece structure.

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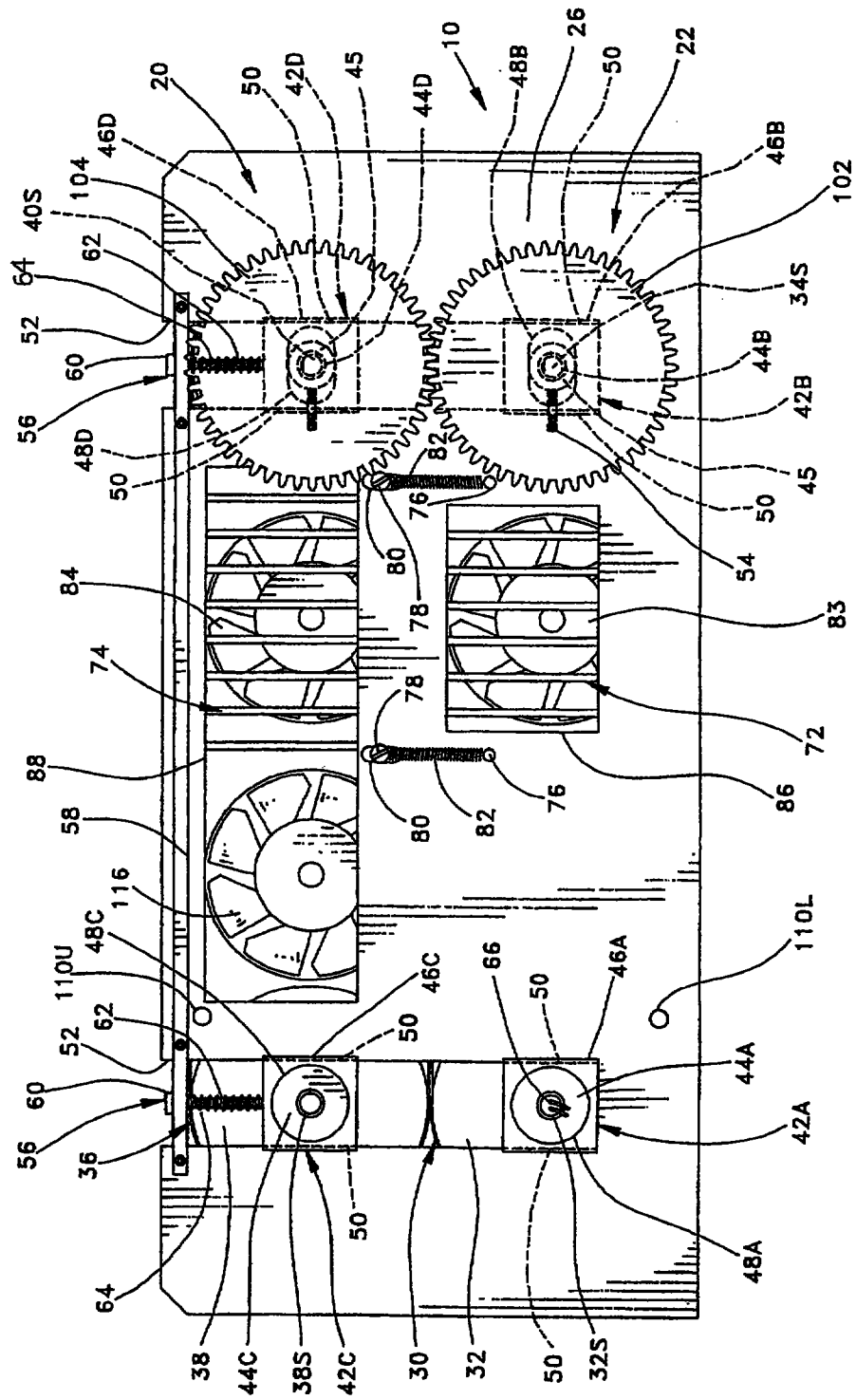
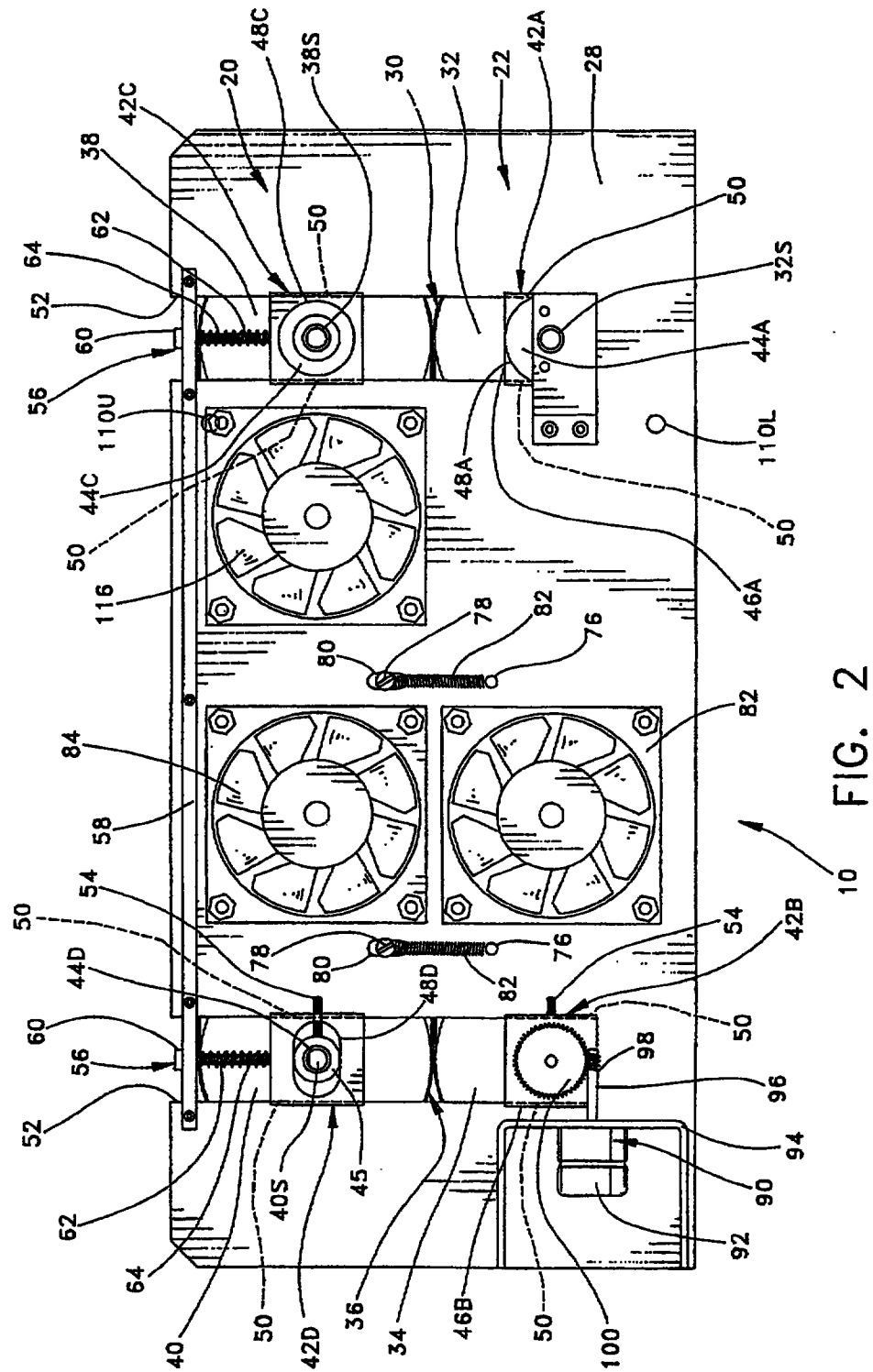


FIG. 1



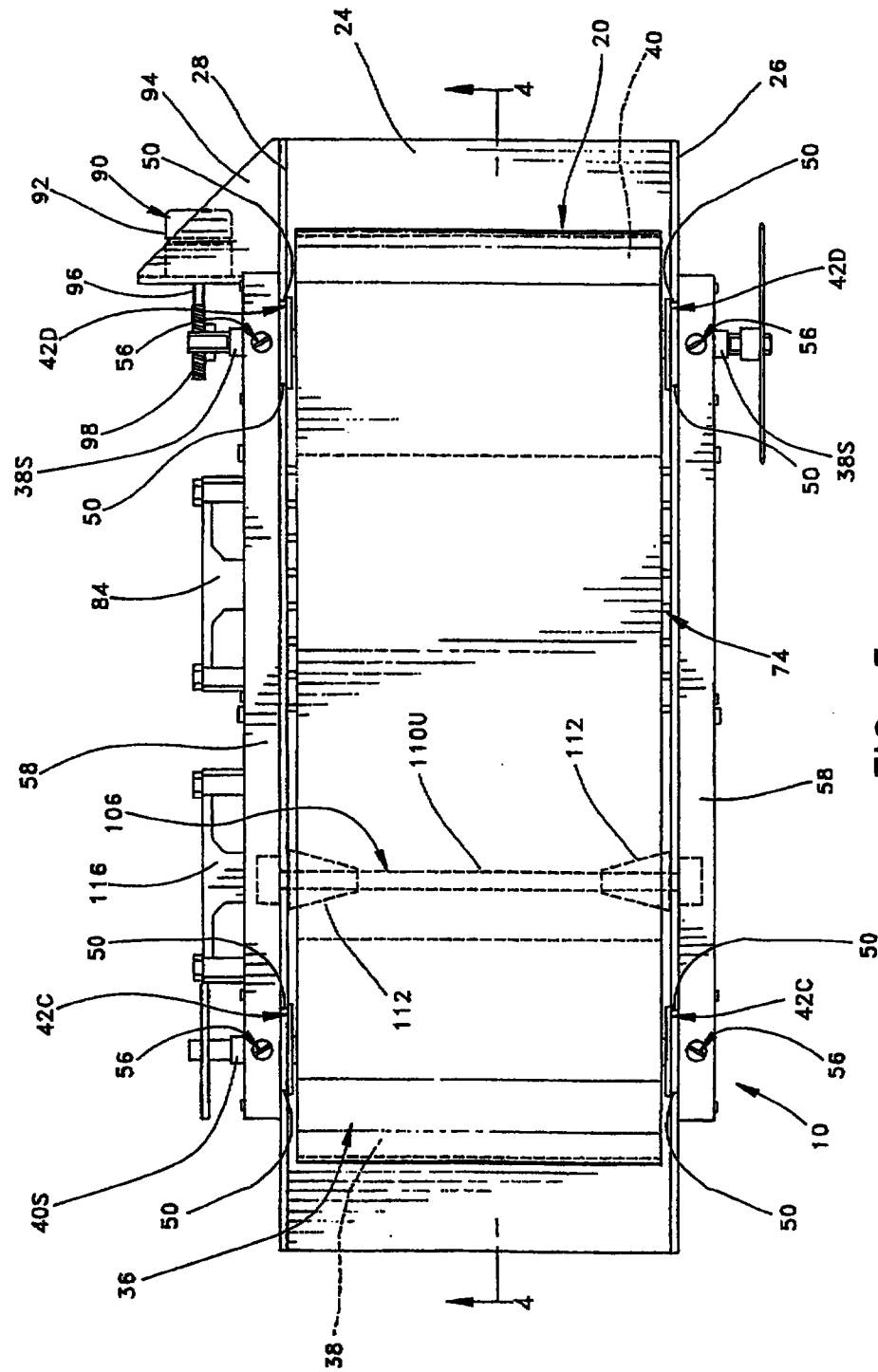
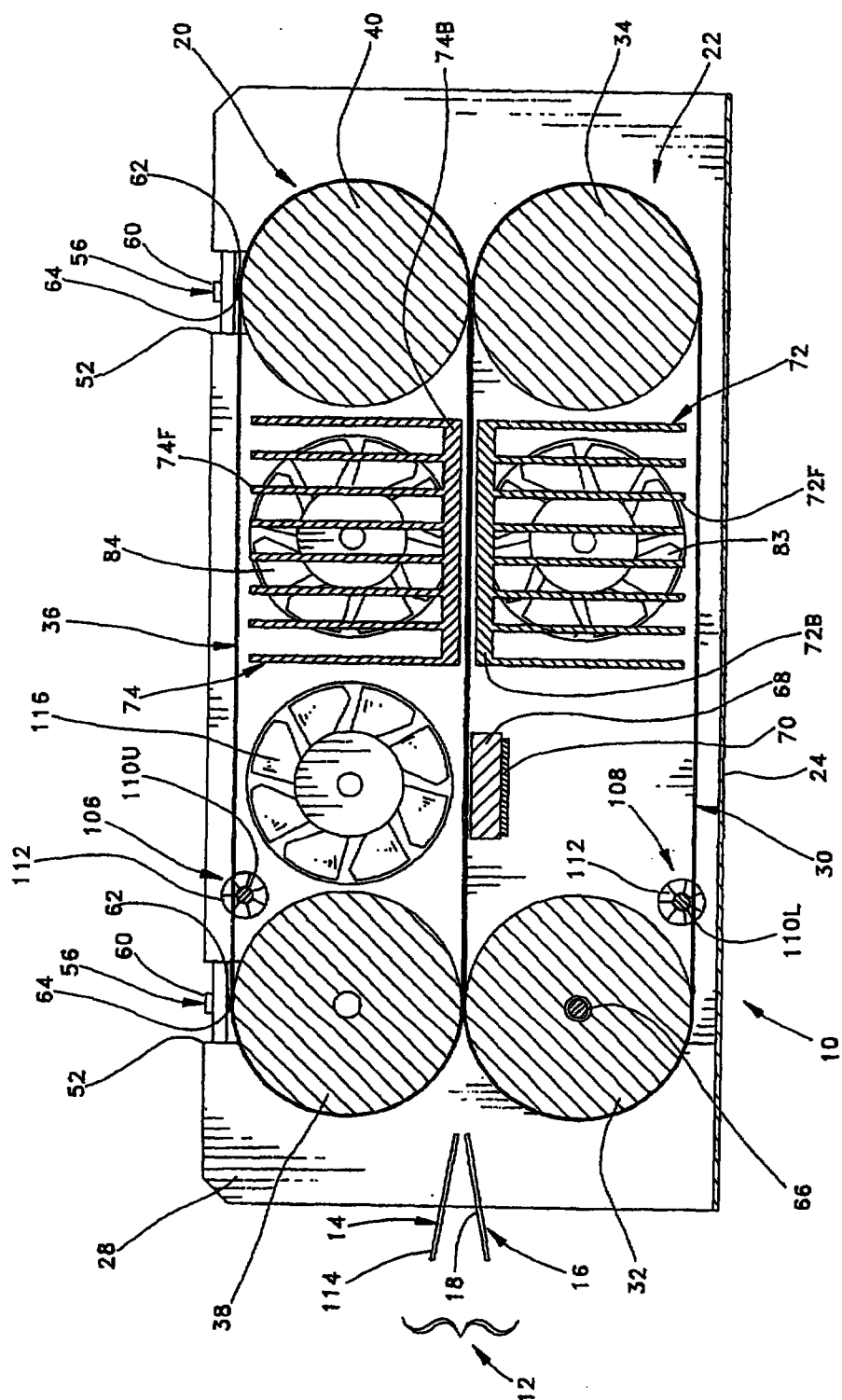


FIG. 3



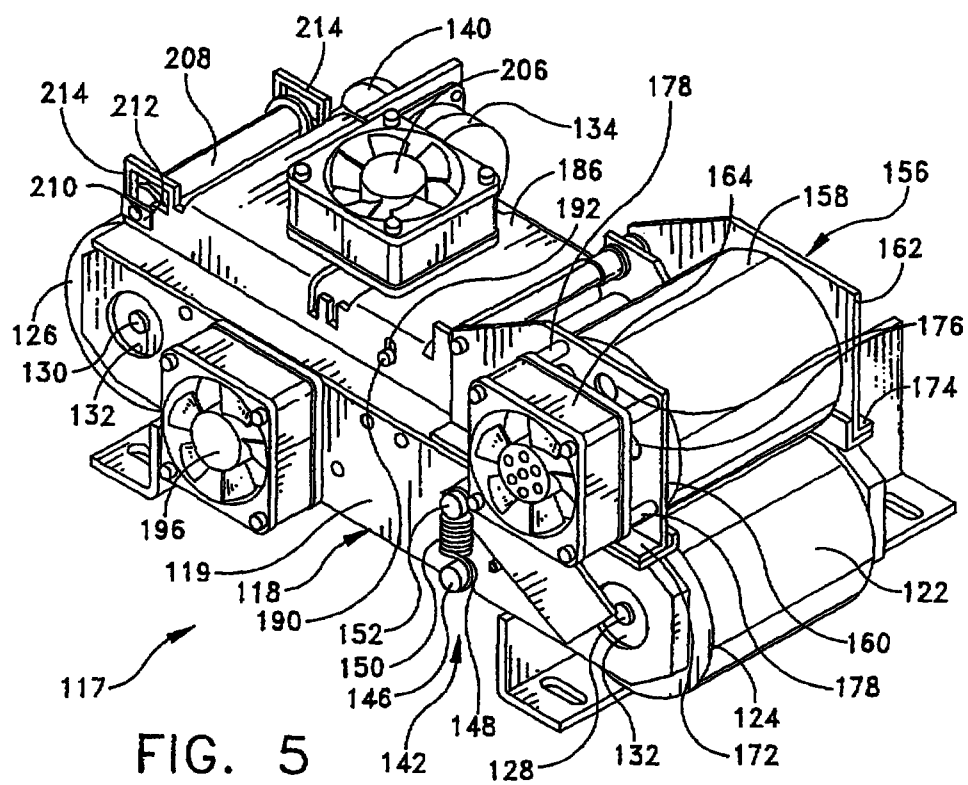


FIG. 5

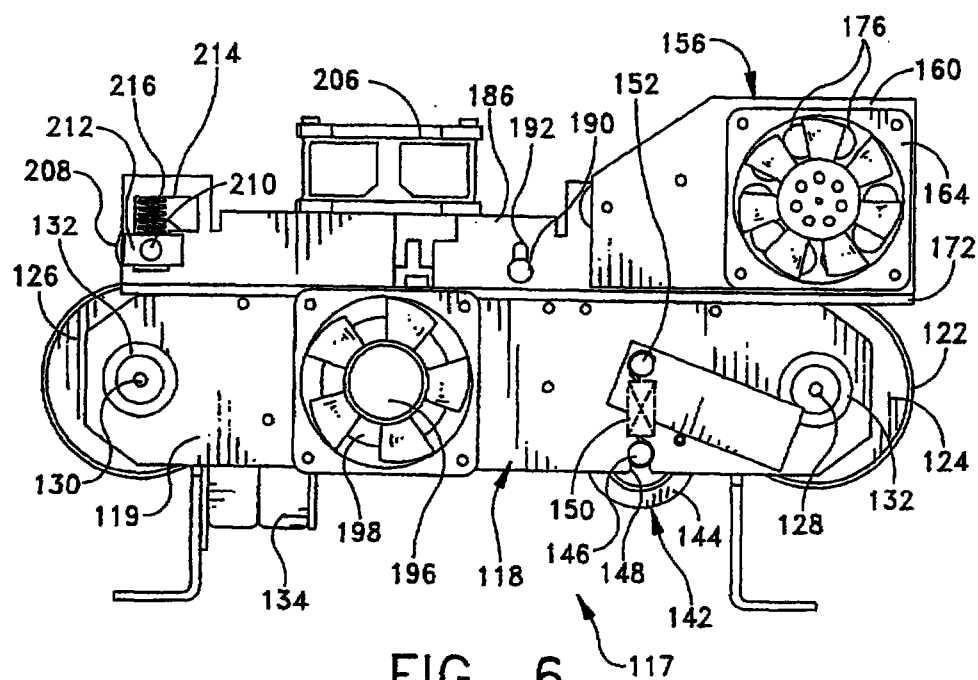


FIG. 6

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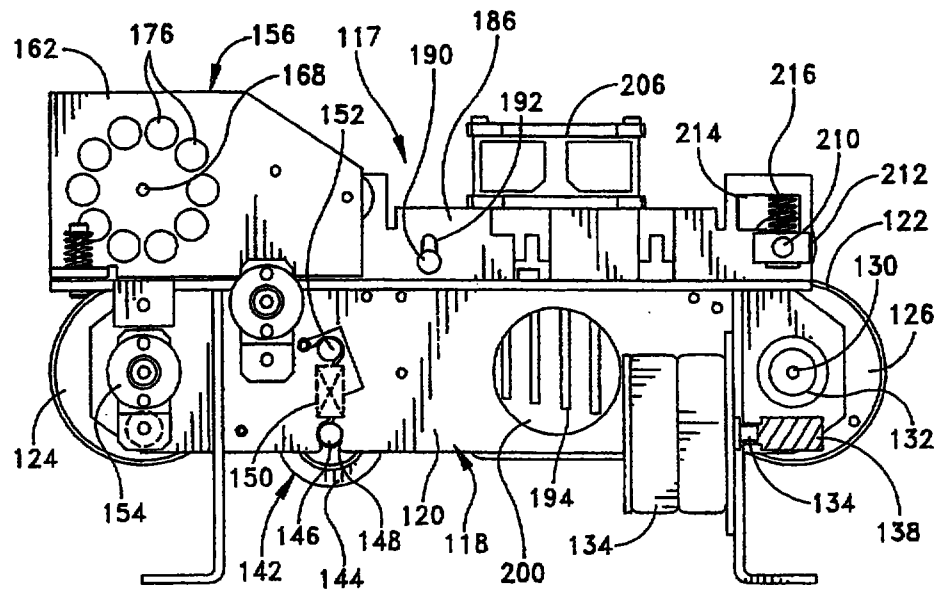


FIG. 7

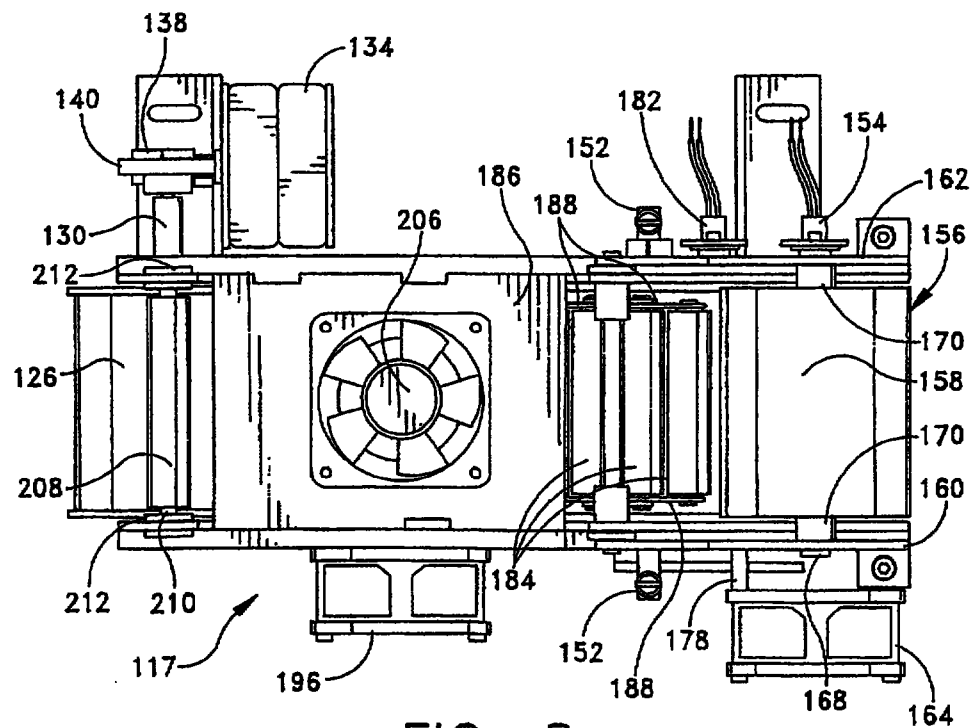


FIG. 8

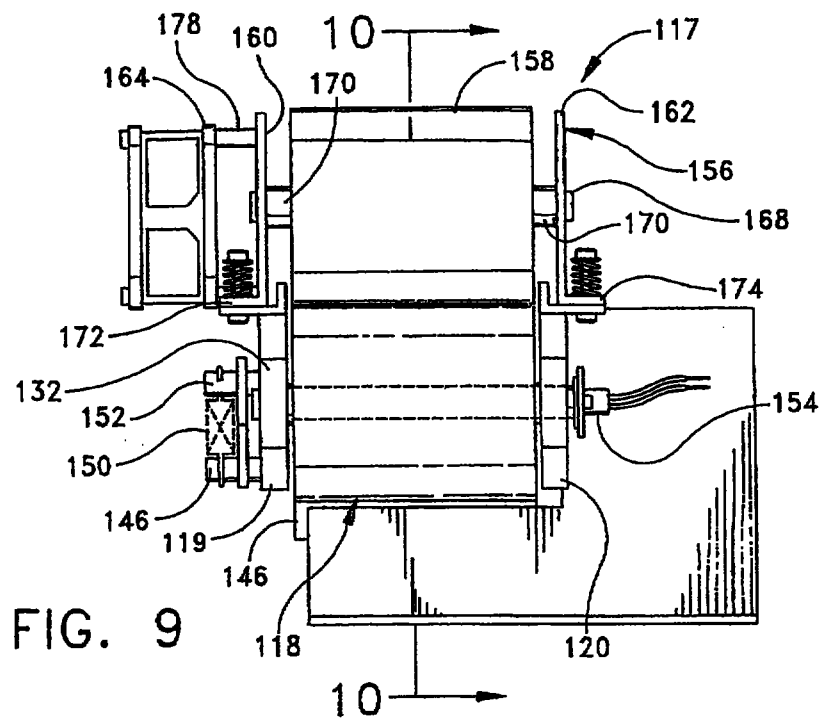


FIG. 9

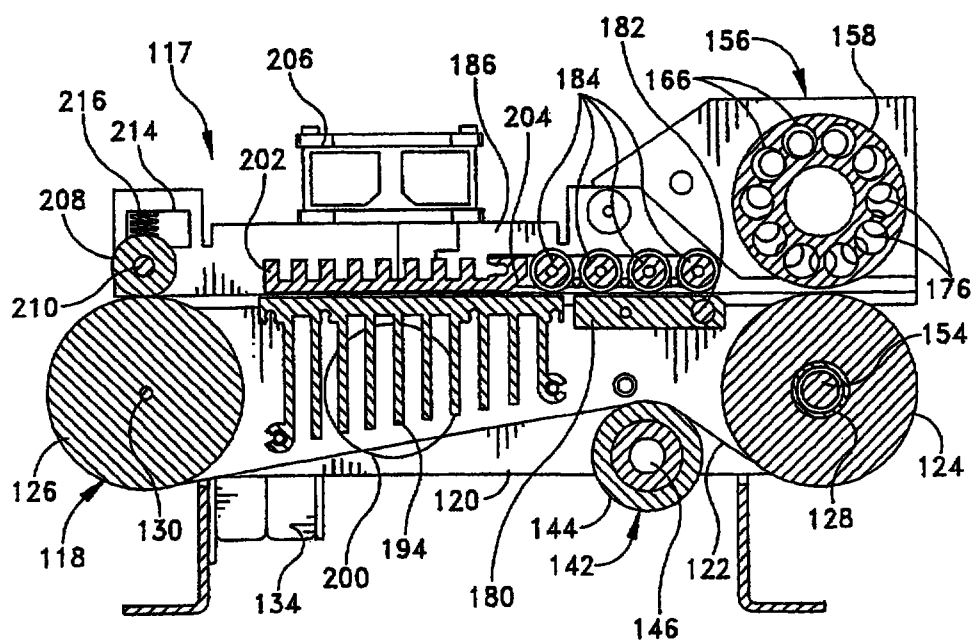


FIG. 10



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CLAIMS

1. Apparatus for fusing a first polymeric sheet in face-to-face relation with a second polymeric sheet, the apparatus comprising:

a presser which presses said sheets together in face-to-face relation to define a two-piece structure;

a first heat application device which applies heat only to the first polymeric sheet while said sheets are being pressed together, said pressure and heat achieving an initial fusing of said first and second polymeric sheets;

a cooling device operable to cool said second polymeric sheet while said sheets are being pressed together; and

a second heat application device which applies heat only to said first polymeric sheet under ambient pressure to achieve a full fusion of the first and second polymeric sheets to each other.

2. In the apparatus of claim 1, said pressing device comprising an input nip having first and second rollers.

3. In the apparatus of claim 2, said first polymeric sheet being received adjacent to said first roller and said second polymeric sheet being received adjacent to said second roller while said sheets are being pressed together, said first heat application device is operable to heat said first roller.

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4. In the apparatus of claim 3, said cooling device is operable to cool said second roller.

5. The apparatus of claim 1 further comprising a second cooling device downstream of said second heat application device, which cooling device is operable to cool said sheets.

6. The apparatus of claim 2 further comprising a second cooling device downstream of said second heat application device, which cooling device is operable to cool said sheets.

7. The apparatus of claim 3 further comprising a second cooling device down downstream of said second heat application device, which cooling device is operable to cool said sheets.

8. Apparatus for fusing a first polymeric sheet in face-to-face relation with a second polymeric sheet comprising;
a first belt assembly including a first endless belt received around first and second rollers;

a third roller mounted in cooperation with said first roller to form an input nip with said first roller, said first and third rollers pressing said sheets together in face-to-face relation to define a two-piece structure, said first polymeric sheet being received adjacent said first

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roller and said second polymeric sheet being received adjacent said second roller while said sheets are being pressed together;

a heat application device which heats said first roller such that only said first polymeric sheet is heated, said pressure and said heat achieving an initial fusing of said first and second polymeric sheets;

a cooling device which cools said third roller such that said second polymeric sheet is cooled while said first polymeric sheet is heated; and

heated platen means for applying heat to said first polymeric sheet, said heated platen means being in thermal communication with an underside of said belt, said two piece structure being supported on an upper side of said belt and being transported from said input nip over the surface of said heated platen means wherein further heat is applied under ambient pressure to said first polymeric sheet.

9. The apparatus of claim 8 further comprising a second cooling device downstream of said heated platen means which cools said sheets.

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(21) International Application Number: PCT/US97/07727 (22) International Filing Date: 7 May 1997 (07.05.97) (30) Priority Data: 08/645,230 13 May 1996 (13.05.96) US (71) Applicants: MINNESOTA MINING AND MANUFACTURING COMPANY [US/US]; 3M Center, P.O. Box 33427, Saint Paul, MN 55133-3427 (US). ATLANTTEK, INC. [US/US]; 10 High Street, Wakefield, RI 02879 (US). (72) Inventors: CORPUS, Paul, V.; P.O. Box 5123, Wakefield, RI 02879 (US). FIELD, Gary; 274 Dexter Street, Portsmouth, RI 02871 (US). FOSSUM, Douglas, K.; P.O. Box 33427, Saint Paul, MN 55133-3427 (US). (74) Agents: HOLMES, Stephen, J.; Salter & Michaelson, 321 South Main Street, Providence, RI 02903-7128 (US) et al.	(81) Designated States: AU, BR, CA, JP, KR, SG, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>	

(54) Title: APPARATUS FOR TWO-STAGE FUSION OF FACE-TO-FACE POLYMERIC SHEETS**(57) Abstract**

Apparatus (117) operative for fusing an amorphous copolyester sheet (14) with a polyvinyl chloride sheet (16) includes a belt assembly (118) having an endless belt (122) received around first and second rollers (124, 126). The apparatus (117) further includes a third roller (158) mounted in cooperation with the first roller (124) to form an input nip with the first roller (124) such that the rollers (124, 158) press the sheets (14, 16) together to define a two-piece structure (12) having a polyvinyl chloride side and an opposing amorphous copolyester side. The polyvinyl chloride side is positioned adjacent to the first roller (124). The

apparatus (117) still further includes a cartridge heater (154) for heating the first roller (124) such that the polyvinyl chloride side of the two-piece structure (12) is heated as the sheets (14, 16) pass through the nip. The third roller (158) is cooled by a fan means (164) so that the amorphous copolyester side is cooled while the polyvinyl chloride side is heated. The apparatus (117) even further includes a heated platen (180) for applying additional heat to the polyvinyl chloride side of the two-piece structure (12). The heated platen (180) is in thermal communication with an underside of the belt (122) wherein further heat is applied to the polyvinyl chloride side of the two-piece structure as the belt (122) carries the two-piece structure over the platen (180). Finally, the apparatus includes fan cooled heat sinks (194, 202) positioned above and below the belt (122) for cooling both sides of the two-piece structure (12) as the two-piece structure is transported away from the heated platen (180).

