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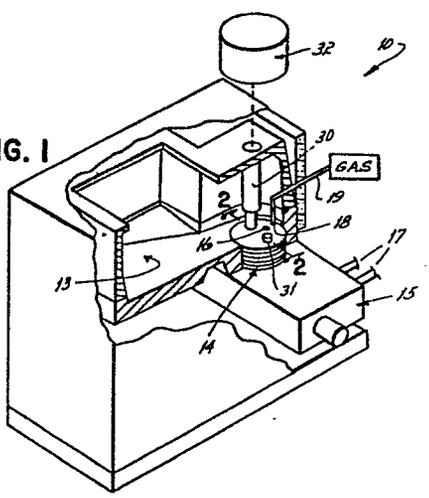
(54) Hot melt adhesive pump with ported gears.

(57) A hot melt adhesive pump having a first stage gear pump for metering molten hot melt adhesive into a second stage gear pump where gas is mixed and driven into solution with the adhesive is provided with ports extending between opposed gear faces permitting the leakage of adhesive under pressure between gear faces. Pressure imbalances which might otherwise exist due to the accumulation of hot melt adhesive in an interface between the gear faces and adjacent surfaces, e.g., a pair of plates, between which the gears are sandwiched, are alleviated because adhesive under pressure in this interface can pass through the ports, thereby balancing the thrust forces on the opposed gear faces. The result is reduced gear and end plate wear and increased pump life.

FIG. I



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HOT MELT ADHESIVE PUMP WITH PORTED GEARS

Field of the Invention

This invention relates generally to hot melt adhesive systems, such as hot melt adhesive foam systems, and more particularly to a hot melt adhesive gear pump for use in such a system having ports for pressure equalization along the gear faces.

Background of the Invention

Thermoplastic adhesives or so-called "hot melt" adhesives are widely used throughout industry for adhering substrates one with another. Conventionally, hot melt adhesives are converted from a solid to a molten state in a tank. The melted material is then maintained in a reservoir in sufficient volume to be pumped to one or more applicators or dispensers.

One of the most common uses of hot melt adhesives is in the packaging and cartoning industry, where the quick setting time of hot melt adhesives is particularly advantageous. A dramatic improvement in the use of hot melt adhesives in this industry came from the discovery that the adhesive strength of a bond achieved with a given quantity of a selected hot melt adhesive can be appreciably improved if the

adhesive is applied as a cellular foam rather than in the conventional way as a non-foamed adhesive. For example, in U.S. Pat. No. 4,200,207, a pump system is disclosed which is particularly adapted for dispensing hot melt adhesive foam. This pump system employs a two stage gear pump, each stage comprising oppositely rotating and meshed gear pairs carried on a drive and idler shaft. The motor driven gear pumps mix the liquid adhesive with a foaming agent, and supply the mixture under pressure, as, for example, 300 pounds per square inch, to a conventional adhesive dispensing gun. In such gear pumps, the liquid flow is "segmented," as discrete volumes, in the intertooth spaces of the gears. The action of the meshing gear teeth on the segmented portion of the fluids mixes and pressurizes the fluids.

The gear pairs of each pump stage are located in "pump plates", and sandwiched within a stack of plates which make up the pump housing. (For the sake of clarity in description hereinafter, "outward" refers to radially outward with respect to the center (or center plate) of the pump, while "inward" refers to radially inward to the same center.) It has been found that adhesive, under pressure from the gears, migrates inwardly from the gear teeth along both sides of the gears and toward a respective gear shaft. That is, the adhesive gets between the gear faces and the adjacent plates which sandwich the gears in the stack housing. Hot melt between the outward

facing gear surfaces and the end plates of the stack can seep out along the gear shafts, through the clearance gap between the shafts and the plates of the stack. This relieves pressure buildup at this interface. Hot melt between the inward facing surfaces of the gears cannot seep out in this manner, however, due to the fact that the gears are fit to the shaft much tighter than the shafts are fit within the plates in the stack. A buildup of pressurized adhesive thus occurs at these two inward interfaces. For example, one gear face may have a buildup pressure exerted thereon of 120 p.s.i., while the opposite gear face only 10 - 30 p.s.i. (both pressures indicated in the region adjacent the shaft). This results in a pressure imbalance on opposite faces of the gears and produces an axially outward thrust on the gears. The gears are consequently forced toward and typically into contact with the end plates, producing greater wear on the gears and the end plates in this area.

Summary of the Invention

It is a primary object of this invention to provide an improved gear pump for an apparatus for melting and dispensing thermoplastic materials, which has balanced adhesive pressure thrust forces on the opposed gear faces to reduce wear on the pump parts. It is a particular object of this invention to provide such pressure balanced gears in a two stage gear pump for a hot melt adhesive foam system, by permitting the

leakage of adhesive under pressure between opposed gear faces.

These as well as other objects have been accomplished through the provision of pressure relief ports extending between opposed gear faces, such that pressurized adhesive migrating between a gear face and an adjacent surface of a gear pump housing can readily pass through the ports and out along the gear shaft, thereby eliminating any pressure imbalance which might otherwise exist along the inward and outward surfaces of the gears.

In a presently preferred embodiment of the invention, an improved hot melt adhesive system includes a two stage gear pump formed of a first stage metering gear pump and a second stage mixing gear pump. Each stage includes a pair of meshing gears, with both pairs of gears rotatably carried by a pair of shafts. Each pair of gears is located in cavities in a pump plate, with the pump plate sandwiched in a stack of plates forming the gear housing. Hot melt adhesive flows from a reservoir into the two stage pump where it is pressurized in the meshing gears.

A plurality of slots are formed in the inner circumference of the gears leaving open ports between the gears and the shafts. These ports allow pressurized adhesive in the inward interfaces between the gears and center stack plate to pass through the ports and out along a respective gear shaft. Thrust forces on opposed faces of the gears are thereby balanced,

reducing wear of the gears and end plates of the pump housing.

Brief Description of the Drawings

Fig. 1 is a perspective view, partially broken away, of a thermoplastic material melting and dispensing apparatus;

Fig. 2 is a cross-sectional view taken along line 2-2 of Fig. 1 of the gear pump of Fig. 1, detailing the gear arrangement in a stacked plate pump housing;

Fig. 3 is a cross-sectional view along line 3-3 of Fig. 2 showing one arrangement for the pressure relief ports of this invention.

Detailed Description of the Invention

This invention is particularly adapted for use in a hot melt adhesive dispenser, such as that shown in U. S. Pat. No. 4,009,974, "Method and Apparatus for Pumping Viscous Material". The invention has specific application as an improvement in a type of two stage gear pump for a hot melt adhesive foam dispensing pump such as that shown in U. S. Pat. No. 4,200,207, "Hot Melt Adhesive Foam Pump System". The disclosures of both of the aforementioned patents are hereby incorporated into this specification, and reference should be made to these two patents for detail generally relating to the dispenser and gear pump. The following detailed description concentrates specifically on an improved two stage gear pump in this environment.

Referring now to Fig. 1, a hot melt dispenser generally indicated at 10 has a melter (not shown), an adhesive material reservoir 13, a gear pump 14, and a manifold block 15. Solid thermoplastic material in the form of chunks, pellets or blocks is placed in the top of a hopper (not shown) from which it flows through the hopper's open bottom into contact with the melter, where surface contact of the solid thermoplastic material with the melter causes the solid thermoplastic material to be converted to a molten state. The molten thermoplastic material then flows via gravity from the reservoir 13 into an inlet 16 of the pump 14. The pump 14 then moves the melted material into the manifold block 15 from which it is directed to one or more conventional applicators or dispensers via hoses or conduits 17.

The gear pump 14 is a two stage gear pump having intermeshing gear teeth which operate as multiple "pistons" to pull incoming liquid into the pump, pressurize it, and dispense it from the pump outlet. Such pumps generally create a suction on the inlet opening 16 so as to draw the liquid into the pump. In the illustrated embodiment, gas as for example, air, nitrogen or carbon dioxide is also supplied to the pump 14 through pump inlet 18 via the inlet tube 19. As will be more specifically set forth below, the gas 13 mixed with the molten adhesive under pressure to ultimately generate a foam adhesive.

The two pairs of intermeshing gears of the pump 14 are mounted on a pair of parallel shafts 30 and 31. One of these shafts 30 is driven by a motor as, for example, a pneumatic motor 32, while the other shaft 31 is an idler shaft.

With reference also to Fig. 2, the pump 14 includes a series of specially configured plates stacked on top of, and connected to, the manifold block 15. These are an inlet end plate 20, a first stage pump plate 21, a center port plate 22, a second stage pump plate 23, and an outlet end plate 24, all of which are generally the same peripheral configuration and size, and all stacked one on top of the other. Each stage of this two-stage gear pump comprises oppositely rotating meshed gear pairs 28a and 28b, and 29a and 29b, respectively. The driven gears 28a and 29a of each stage are carried by the common drive shaft 30, and the idler gears 28b and 29b of each stage are carried by common idler shaft 31.

As previously stated, this particular pump and dispenser is adapted for the delivery of hot melt adhesive foam. Molten adhesive is delivered at the inlet 16 of the pump 14, and there passes to the meshing area of first stage gears 28a, 28b. The molten adhesive infeed is metered by the first stage pump and transferred through porting (not shown) in center port plate 22 to the meshing area of second gear pair 29a, 29b. A gas, e.g., air, nitrogen, or carbon dioxide, is also introduced into the second

stage pump, (29a, 29b), where the gas and molten adhesive are intimately mixed at a pressure which forces the gas to go into solution with the molten adhesive. The pressurized molten adhesive/gas is then exhausted from the second stage pump through an outlet (not shown) in outlet end plate 24 and into the manifold block 15 for dispensing through hoses 17.

Referring now to Figs. 2 and 3, first stage metering gears 28a, 28b are located in a pair of partially overlapping circular gear cavities 36a, 36b which are defined in the first stage pump plate 21. The second stage mixing pump gears are likewise located in a second pair of partially overlapping gear cavities 37a, 37b which are defined in the second stage pump plate 23. The first and second stage gears are connected to their respective shafts by ball keys 40 received in slot key-ways 41. All of the gears are tightly fit on the shafts 30, 31 with a tolerance fit on the order of 5/10,000 of an inch. The tolerance fit of the rotating shafts 30, 31 with the plates 20 through 24 of the pump housing is on the order of 3-4/1000 of an inch, an order of magnitude less than the fit of the gears to the shaft.

With specific reference to the first stage pump, it has been found that hot melt adhesive pressurized by the gears migrates along the interfaces between the gears and the adjacent plates in the stack from the gear teeth toward a respective shaft. That is, pressurized hot melt adhesive gets in the

interface 42 between the outward facing surface of the gears 28a, 28b and the inward facing surface of the inlet end plate 20. Pressurized hot melt adhesive likewise gets in the interface 43 between the inward facing surface of gears 28a, 28b and the outward facing surface of the center plate 22. The clearance gap between a gear face and a plate is about .5 - 1.5/1000 of an inch.

The clearance gap in the fit between the inlet end plate 20 and the shafts 30 and 31 allows pressurized adhesive in the interface 42 to seep out along the side of the shafts and out beyond the top of the end plate 20, thereby relieving pressure at this interface 42. Hot melt adhesive caught in the interface 43 cannot leak out in a like manner, due to the tight fit of the gears 28a and 28b on the shafts. As a consequence, hot melt adhesive builds up in this interface 43, and causes a pressure imbalance on opposed gear faces producing a thrust on the first stage gears 28a, 28b. This thrust drives the gears axially outwardly and against the bottom surface of the inlet end plate 20, causing excessive adhesive wear of the gears and the end plate. If the pressure is great enough and for an extended time, galling of the gears and plates can occur from adhesive ~~welding.~~ wear.

To alleviate this pressure imbalance, ports 45 are formed between the opposed sides of the gears 28a, 28b. These ports 45 take the form, in this embodiment, of three axially extending slots which are

equiangularly spaced around the inner circumference of each gear, which slots extend along the entire thickness of each gear. Slots having a semi-spherical wall contour with a depth of 1/16 inch have been used to advantage with gears having a 5/8 inch internal diameter and 11/8 inch external diameter. Adhesive building up in interface 43 thus finds a ready path through the gear-to-shaft connection, and can then migrate out beyond the end plate 20 along the shaft in the manner previously described. A like set of ports 48 are formed in the second stage gears 29a, 29b, which would otherwise be subject to the same pressure imbalance as described in relation to the first stage gears. Pressurized adhesive in the interface 50 between gears 29a, 29b and the adjacent side of center port plate 22 can then pass through the gears and out along the shafts, as into gap 52 between the pump 14 and manifold 15.

The elimination of pressure imbalances between opposed faces of the gears by the use of ports between the gear faces through which pressurized adhesive can leak thus results in reduced gear and end plate wear and increased pump life.

Thus, while this invention has been described in connection with a specific embodiment, those skilled in the art will recognize modifications of structure arrangement, portions, elements, and components can be used in the practice of this invention without departure from the spirit or scope of the

general inventive concept. For example, although ports 45 and 48 have been illustrated as slots formed along the inner circumference of the gears, the ports could just as well be axially extending slots formed in the drive shafts in the region of the gears. Alternatively, the ports 45 and 48 could extend elsewhere through the gears themselves rather than being located along the inner circumference; this is presently considered less advantageous however, due to the tendency of the adhesive to migrate to the shaft.

What is claimed is:

1. An improved gear pump for a fluid dispensing apparatus comprising:

a pair of meshed gears rotatably carried by a pair of shafts for pressurizing a fluid, and

a gear housing enclosing said meshed gears, said housing having a pair of surfaces between which said meshed gears are sandwiched, said surfaces and said gear faces forming interfaces through which pressurized fluid can migrate,

each said gear having a port extending between opposed faces of the gear permitting pressurized fluid to pass between said interfaces to balance fluid pressure in said interfaces.

2. The improved gear pump of claim 1 wherein said ports are located between said shafts and said gears.

3. An improved gear pump for a fluid dispensing apparatus comprising:

a pair of meshed gears rotatably carried by a pair of shafts for pressurizing a fluid, and

a gear pump housing enclosing said meshed gears, said housing having a pair of generally planar surfaces between which said meshed gears are located, said generally planar surfaces being adjacent opposite faces of said gears and forming interfaces along said opposite faces in which fluid can collect,

said shafts and said gears defining a port therebetween permitting fluid to pass between said opposite faces to thereby substantially balance fluid pressure in both said interfaces.

4. The improved gear pump of claim 3 wherein said gear pump has two stages, each stage including a pair of meshed gears, both pairs of gears rotatably carried by a pair of rotatable shafts mounted in said gear pump housing, said gear pump housing being formed of a plurality of plates arranged in a stack with said gear pairs being sandwiched between plates in said stack, and wherein said ports comprise slots spaced around the inner circumference of said gears and extending between the opposite faces of said gears.

5. An improved hot melt adhesive dispenser comprising:

a first stage metering pump and a second stage mixing pump for pressurizing fluid adhesive, each pump having an inlet and an outlet,

each said pump having a pair of meshing gears rotatably mounted on a pair of shafts, each said gear having opposed faces,

means for supplying fluid adhesive to the inlet of said first stage pump,

means for delivering hot melt adhesive from said second stage pump to an applicator, and

a gear pump housing formed of a plurality of stacked plated enclosing said meshing gears, said gear pairs each being sandwiched between plates in said stack with said plates and gears forming a pair of interfaces along said opposed faces of each gear pair along which interfaces pressurized adhesive can migrate,

said gears each having at least one port formed between its opposed faces through which pressurized adhesive can pass to thereby balance the fluid pressure on both said faces of each gear.

6. The improved dispenser of claim 5 further comprising a plurality of ports between said shafts and said gears.

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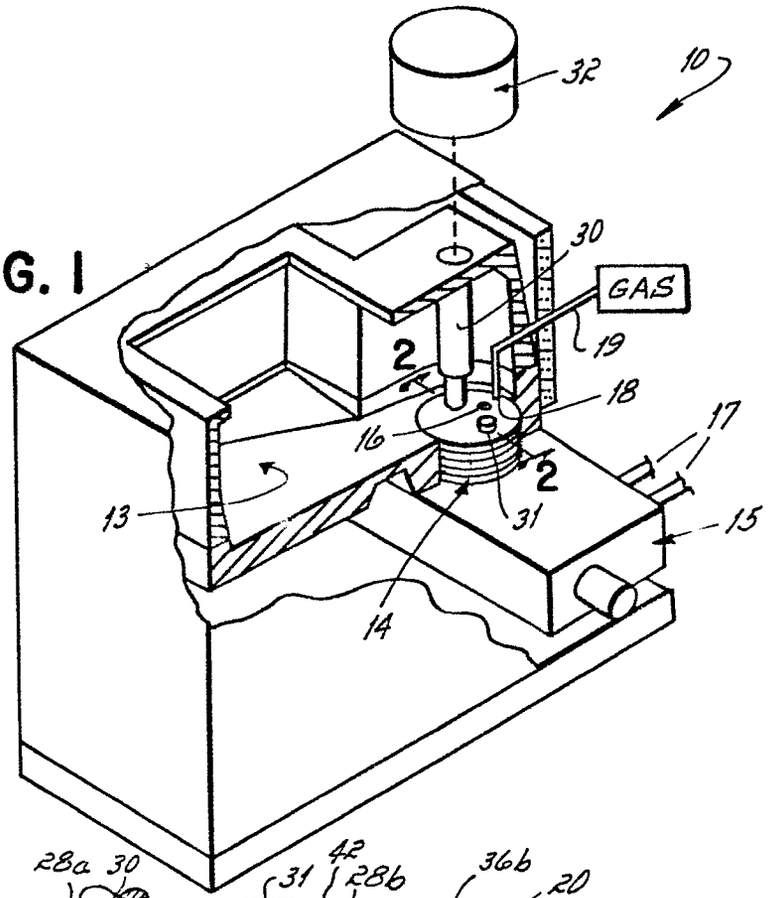
FIG. 1



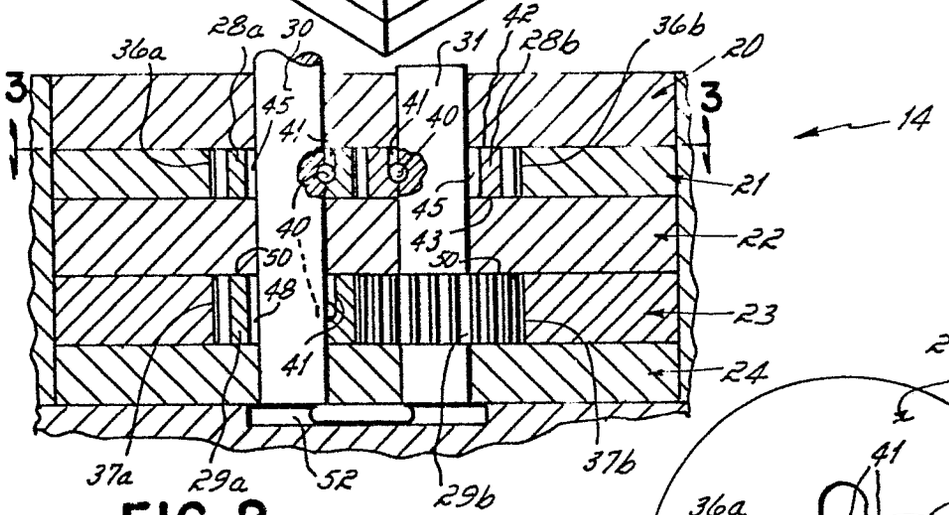


FIG. 2

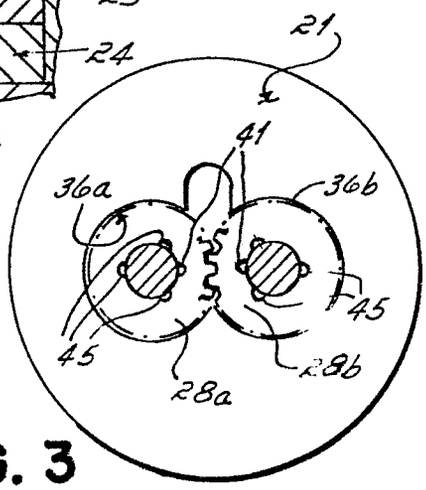


FIG. 3