Dec. 12, 1950 D. R. HULL ET AL 2,533,320

ROTARY GEAR TYPE METERING PUMP

Filed Jan. 4, 1949

Fig. 2.

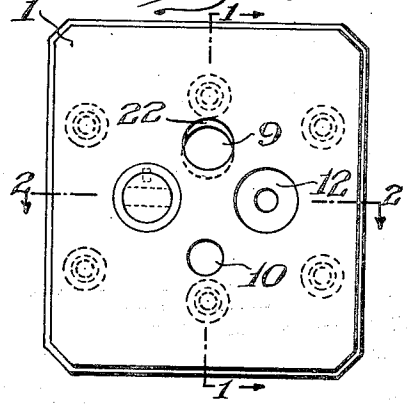


Fig. 1.

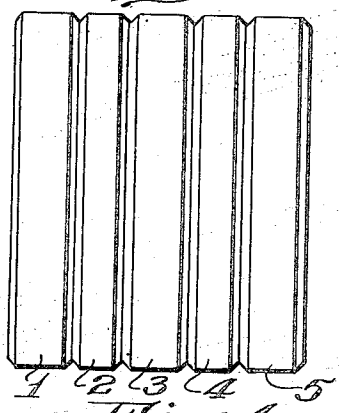


Fig. 3.

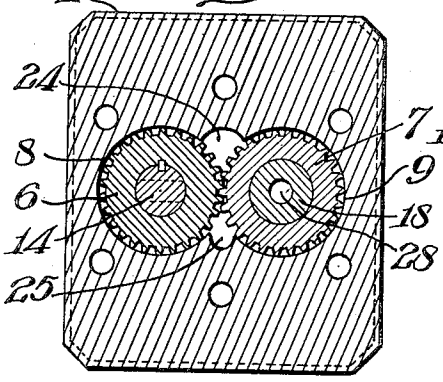


Fig. 4.

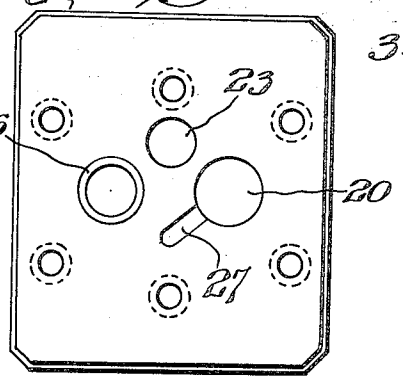


Fig. 5.

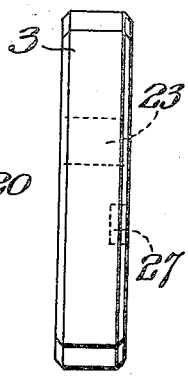


Fig. 6.

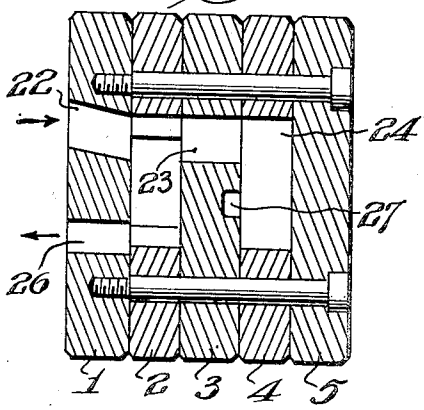


Fig. 7.

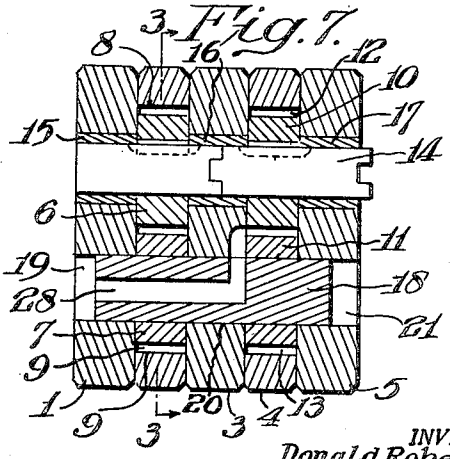
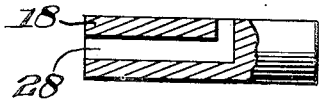


Fig. 8.



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ROTARY GEAR-TYPE METERING PUMP

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1 Claim. (Cl. 103—4)

1

This invention relates to improvements in precision liquid advancing pumps and more particularly to improvements in rotary metering pumps of the gear type adapted for use in advancing twin streams of a viscous liquid at a substantially constant rate.

Precision rotary pumps and particularly precision gear pumps have long been used for pumping and metering filament-forming compositions to spinnerets and the like in the rayon industry. Such pumps are suitable for forwarding the viscous compositions in a constant amount per unit time with great accuracy. These precision pumps with their attendant drives are very expensive and a considerable item of maintenance, and, where a separate pump is used for each spinning position, the space requirement factor is also of serious concern.

To conserve space a common concept in the past has been to divide the pump out-put or to utilize a single pump to deliver two streams of the liquid being metered. In general, this procedure has taken two courses. One method has been to use three or more intermeshing gears so arranged that a plurality of streams of material may be delivered therefrom. Another procedure has been the use of a pair of intermeshing gears with a conventional outlet, and, as a secondary outlet, discharge ports at the base of each tooth of the driven gear, whereby the meshing of the gears forces the entrapped portion of the liquid caught between the gears through said discharge ports in much the same manner as a piston operates to force liquid from its associated cylinder. The discharge ports in turn discharge into the hollow arbor of the driven gear and thence to a suitable supply line. Because of the normally viscous nature of spinning compositions, however, such modifications have not been successful in feeding equal amounts of material to each article-forming device. Furthermore, material supplied by the secondary outlet would pulsate in such a manner as to produce, in the case of spinning, a very non-uniform fiber. Consequently, it has been necessary to utilize individual pumps for each spinning position separately geared to a common drive.

An object of this invention therefore is to provide an improved rotary, gear-type metering pump.

Another object is to provide a rotary gear-type metering pump operative to deliver two streams of a viscous liquid at a substantially uniform rate.

Still another object is to provide a compact precision metering pump for supplying filament-

2

forming material to two spinning positions simultaneously.

A still further object is to provide an improved rotary, gear-type metering pump which will afford overall savings in space, and in investment and maintenance costs.

These and other objects will more clearly appear hereinafter.

These objects are realized by our invention which will now be described with reference to the accompanying drawings wherein the legends refer to like parts referred to in the description, and wherein;

Figure 1 is an elevational view of the side of a preferred embodiment of the invention showing the assembly of the plates forming the gear pump housing.

Figure 2 is an elevational view of the front face of the gear pump housing assembly shown in Figure 1.

Figure 3 is a vertical cross-section on the line 3—3 of Figure 7, of the plate forming the peripheral wall of the liquid-forwarding gears.

Figure 4 is an elevational view of one face of the middle plate of the gear pump housing assembly.

Figure 5 is an end view of the middle plate of the gear pump housing assembly.

Figure 6 is a vertical cross-section on the line 1—1 of Figure 2.

Figure 7 is a horizontal cross-section on the line 2—2 of Figure 2.

Figure 8 is a detail, partly in section of the fixed shaft of the gear pump.

Referring to Figure 1, the gear pump housing assembly comprises a front or face plate designated by the numeral 1, intermediate or gear plates 2 and 4, and a rear or back plate 5. The five plates are held together, preferably, by bolts or screws shown in Figure 6. A set of meshing liquid-forwarding gears comprising driving gear 6 and driven gear 7 are operatively positioned within the generally circular openings 8 and 9 (Figures 3 and 7) provided therefor in gear plate 2, and between face plate 1 and middle plate 3. A second set of meshing liquid-forwarding gears comprising driving gear 10 and driven gear 11 are positioned in like manner in openings 12 and 13 in gear plate 4, and between the middle plate 3 and the back plate 5, (each pair of meshing gears may be housed within a plate which serves the purpose of a gear plate and one side plate, whereby to form a housing assembly of three plates instead of five plates). The driving gears 6 and 10 are keyed or otherwise suitably fixed on

the split drive shaft 14 (rotated at constant speed by any suitable means not shown) journaled in bearings 15, 16 and 17 provided in plates 1, 3 and 5 respectively, and the driven gears 7 and 11 are mounted for free rotation about a fixed shaft or arbor 18 fitted in holes 19, 20 and 21 of plates 1, 3, and 5 respectively.

A liquid inlet channel to the inlet or low pressure side of each pair of meshed gears is provided by the registering openings 22 and 23 in plates 1 and 3, respectively, and by the arcuate recessed openings (opening 24, Fig. 3) in plates 2 and 4.

A liquid outlet from the delivery or high pressure side of meshed gears 6 and 7 is provided by the arcuate recessed opening 25 (which is smaller than opening 23) in plate 2 and by the opening 26 connecting therewith in plate 1. An outlet from the delivery side of meshed gears 10 and 11 is formed by an arcuate recessed opening in plate 4 (identical with opening 25 in plate 2), and a connecting groove 27 in plate 3 which groove in turn registers with a passageway 28 formed in shaft 18 (Figure 8).

In operation, the liquid to be forwarded by the pump enters at the inlet port or opening 22, either by gravity or from a booster pump, passes through plate 1 and thence to the low pressure or inlet side of gears 6 and 7 at 24, and through the opening 23 in plate 3 to the low pressure or inlet side of gears 10 and 11. A portion of this liquid is entrapped by meshing gears 6 and 7 and carried around the periphery of the openings 8 and 9 to the high pressure or outlet side of these gears from where it passes through opening 26 in the face plate and is delivered to a suitable spinning device. The remainder of the liquid at the inlet side of the pump is entrapped by gears 10 and 11 and is carried (in the pockets formed between the gear teeth) around the periphery of openings 12 and 13 to the high pressure side of these gears from which point it is forced in turn through groove 27 and passageway 28 to the outside of the pump and is delivered to a second suitable spinning device. The liquid fed into the pump is thus delivered in two substantially equal and independent streams.

The following specific example is further illustrative of the operation and preferred application of the device of this invention:

Molten polyhexamethylene adipamide having a relative viscosity of about 35 is delivered at 20 p. s. i. and 275° C. to the inlet port 22 of the pump construction hereinabove described. The pump operates to give two equal, accurately metered streams of 1.1 grams of melt per revolution per pump, as per the preceding description. The two streams of molten polymer delivered at the outlet ports are each forced through a suitable filtering device under a pressure of the order of 2,000 p. s. i. to two 20-hole spinnerets each at the rate of 22.07 gm./min. of polymer. From each spinneret there is obtained uniform 240 denier-20 filament yarn at the rate of 980 yds./min. Both yarns are identical in every respect.

A pump of the type described herein is especially adapted for the melt-spinning of synthetic linear polyamides, since it is capable of delivering very viscous liquids at high pressures. However, it is, of course, entirely suitable for delivering less viscous liquids at lower pressures. As examples of some filament-forming compositions which may be handled by such a pump, either in the molten state or as solutions, might be mentioned synthetic linear polyamides, polyesters, polyethers, polyacetals and mixed polyester-amides such as may be prepared by condensation reactions as described in U. S. Patent 2,071,250 or other synthetic polymers such as ethylene polymers, vinyl polymers, such as polystyrene and polyacrylonitrile, polyacrylic acid derivatives, solutions of cellulose esters or cellulosic solutions such as viscose or cuprammonium cellulose and others.

In general, the pump of this invention will operate efficiently with liquids, for example solutions or melts of filament-forming compositions of 25 poises viscosity or greater. 3,000 poise or still higher viscosity melts of nylon can be readily metered by means of this pump. The only limitations as to maximum viscosity is that the liquid be able to flow or be forced into the pump.

For extrusion of film or filament-forming compositions at high temperatures and especially where the composition is of a corrosive nature at these temperatures, e. g., in the melt extrusion of polymeric materials such as synthetic linear polyamides, the choice of a suitable material of construction for these pumps becomes of considerable importance. For these purposes it has been found that the essential characteristics are resistance to corrosion, resistance to abrasion and galling, together with a low thermal expansion characteristic after the parts that go to make up the pump have been heat-treated. It has been concluded that for certain purposes, such as the melt-spinning of nylon, this combination of properties can best be obtained by using steels containing in the range of 10%–16% chromium, 1%–1.6% carbon together with other elements which may be added, such as cobalt, vanadium and molybdenum. Other suitable steels are those such as air-hardened die steels and nitrided Nitralloys, in which a steel containing combinations of chromium, molybdenum and vanadium with the addition of small amounts of nickel, cobalt or aluminum is heated in a nitriding atmosphere to achieve case-hardening. Non-ferrous temperature-resistant alloys, such as Stellite (a commercial alloy of chromium, molybdenum, nickel and iron), are also useful.

It is recognized as being desirable to employ heat-treatment on the machined parts such that any tendency to distort or warp in service, thereby causing binding or leakage, may be minimized. This relative freedom from distortion in service may be accomplished by rapid cooling from the hardening temperature in air or by immersion in oil, which cooling is followed at once by a drawing operation in the upper temperature range of the 600° F.–1200° F. interval with approximately 800° F.–1000° F. preferred.

Although the pump of this invention has been described with reference to the extrusion of film or filament-forming compositions, it is also applicable to the metering of compositions in the spinning of bristles and the coating of wire, etc. The advantages of the apparatus of this invention are obvious, since by use of a single driven shaft and a single liquid supply duct, it is possible to obtain, at equal rates, delivery to two article-forming mechanisms. This is accomplished by an inexpensive and compact apparatus, the maintenance of which is much lower than two separate pumps as well as having a lower power consumption. Further, the pumps of the prior art normally used to deliver two equal stream of liquid, i. e., three-gear pumps do not meter as accurately as the pumps of this invention. As an additional advantage, the pump

of this invention uses fewer parts and which parts are all of a conventional design.

As many widely different embodiments may be made without departing from the scope and spirit of our invention it is to be understood that said invention is not to be restricted in any way except as set forth in the appended claim.

We claim:

A precision rotary gear-type metering pump adapted to forward molten polymers and like viscous liquids comprising two spaced and aligned sets of liquid-forwarding gears, each set comprising a drive liquid-forwarding gear and a driven liquid-forwarding gear meshed therewith, the drive gears being fixed to a common rotatable drive shaft for rotation therewith and the driven gears being mounted for free rotation on a common fixed shaft parallel to the drive shaft, a housing for said gears comprising a face plate disposed to serve as a front sidewall of the housing for the first of said sets of gears, a second plate cut out and disposed to serve as the peripheral wall of the housing for said first set of gears, a third plate disposed to serve as a rear side wall for the said first set of gears and as a front side wall of the housing for the other set of gears, a fourth plate cut out and disposed to serve as the peripheral wall of the housing for said other set of gears, and a back plate disposed to serve as the rear side wall of the housing for said other set of gears, the face plate, the third plate and the back plate having aligned openings into which are fitted the drive shaft and the fixed shaft, aligned openings in the face plate and in the third plate positioned to afford a passageway for liquid to the gears, an opening in the face plate positioned to afford a passageway for liquid forwarded by said first set of gears and liquid outlet means for said other set of gears comprising a groove in said third plate positioned to afford a passageway for liquid forwarded by said other set of gears from said gears to the fixed shaft and a connecting passgeway in said fixed shaft extending to and through the front end of said fixed shaft and through said face plate.

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DANIEL PARKER PHILLIPS.
NELSON HALL TATE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
796,724	Hewitt	Aug. 8, 1905
1,218,300	Nelson	Mar. 6, 1917
2,412,588	Lauck	Dec. 17, 1946

FOREIGN PATENTS

Number	Country	Date
9,359	Great Britain	1915