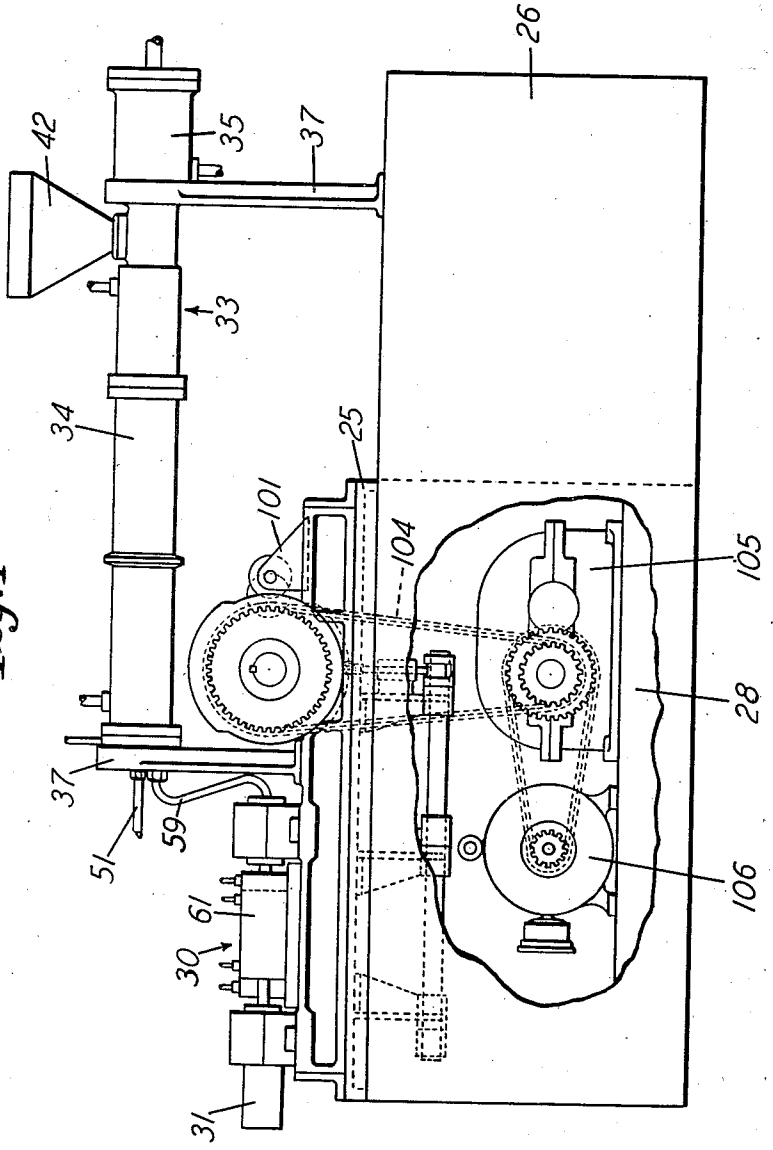
Jan. 23, 1945. F. M. RODDY 2,367,691

PUMP FOR PLASTIC, DOUGHY, PASTY OR VISCOUS MATERIALS

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Fig. 1



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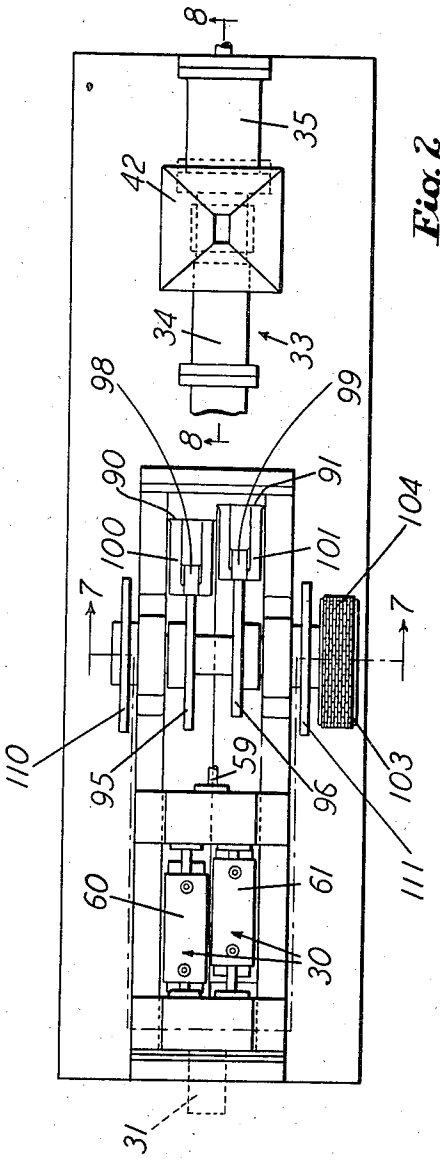


Fig. 2

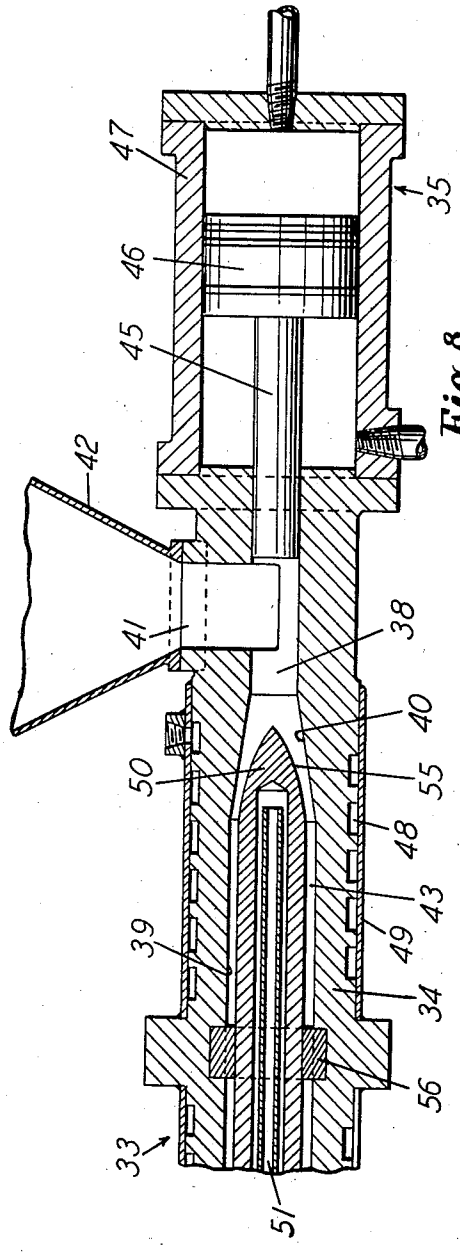


Fig. 8

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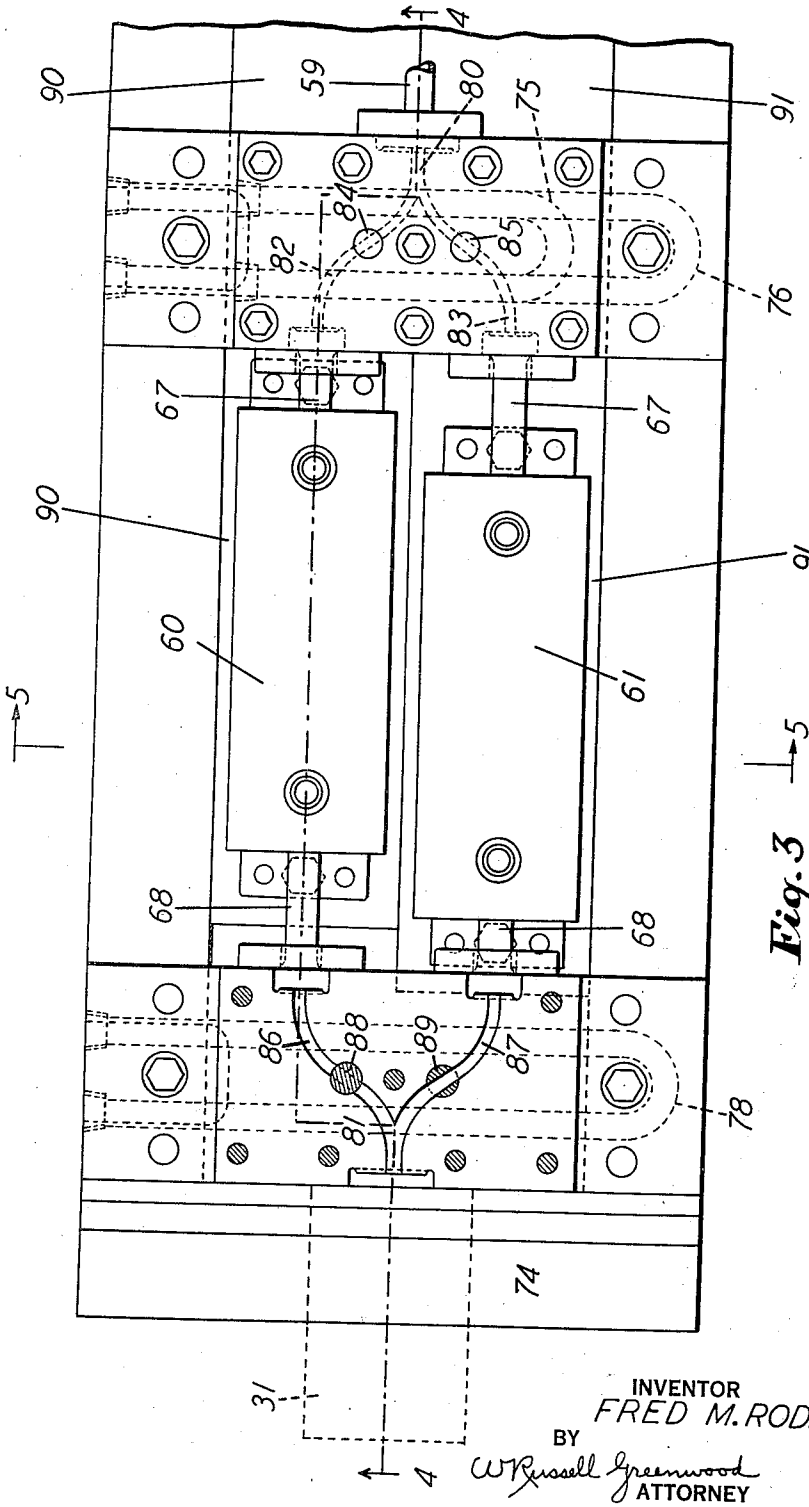


Fig. 3

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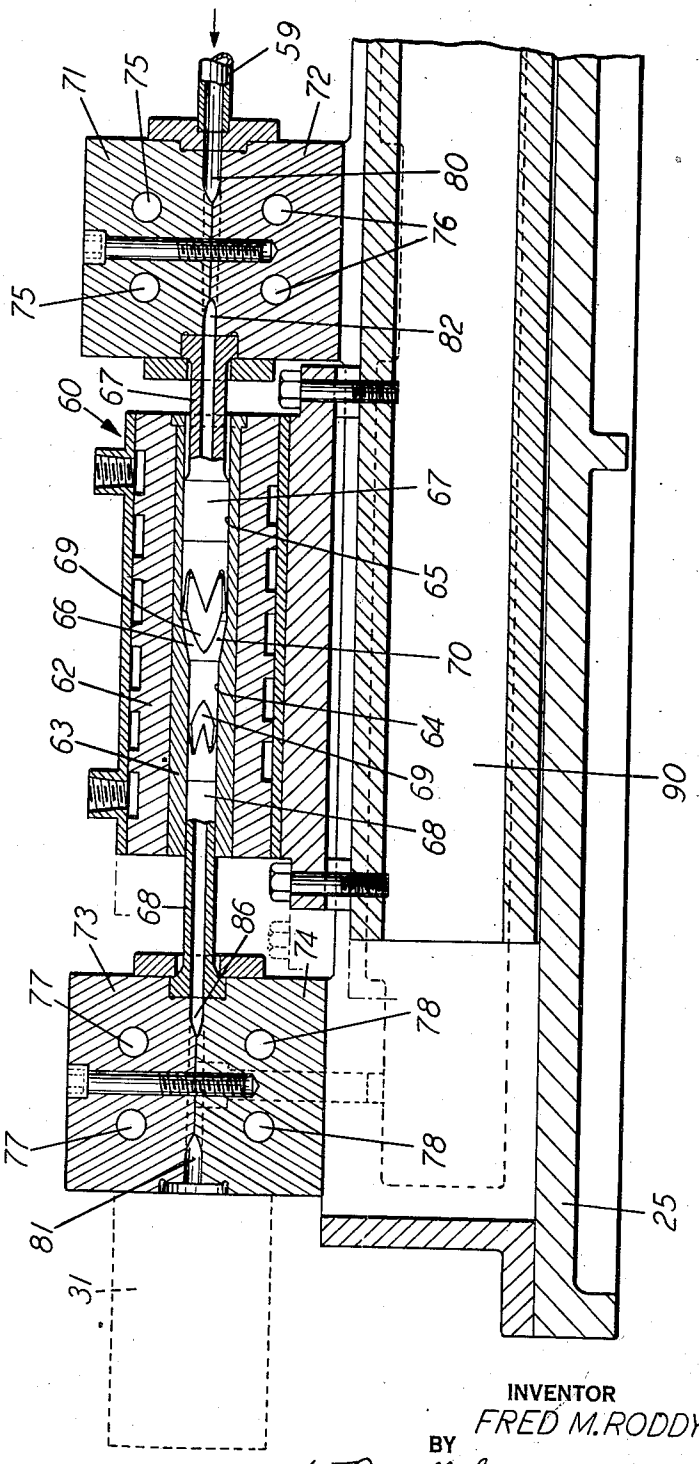


Fig. 4

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Fig. 5

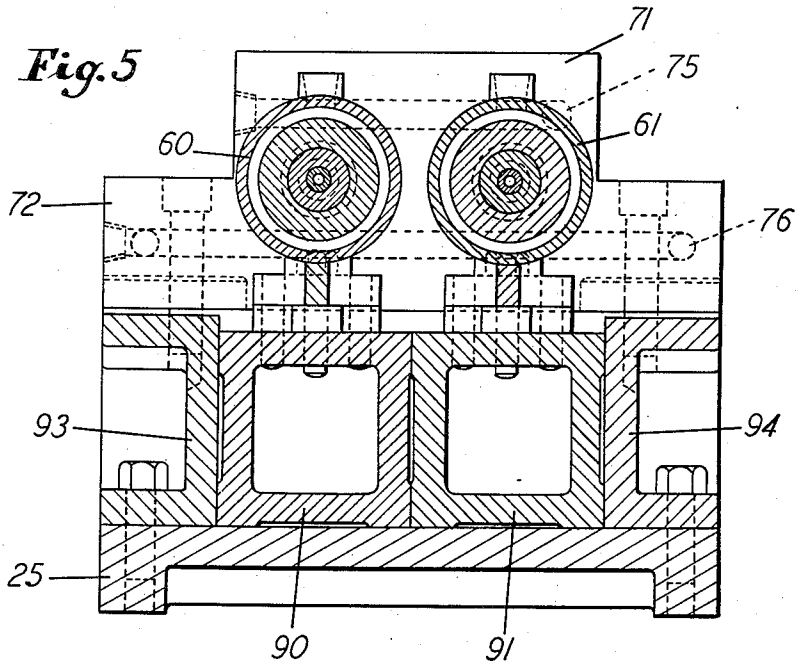
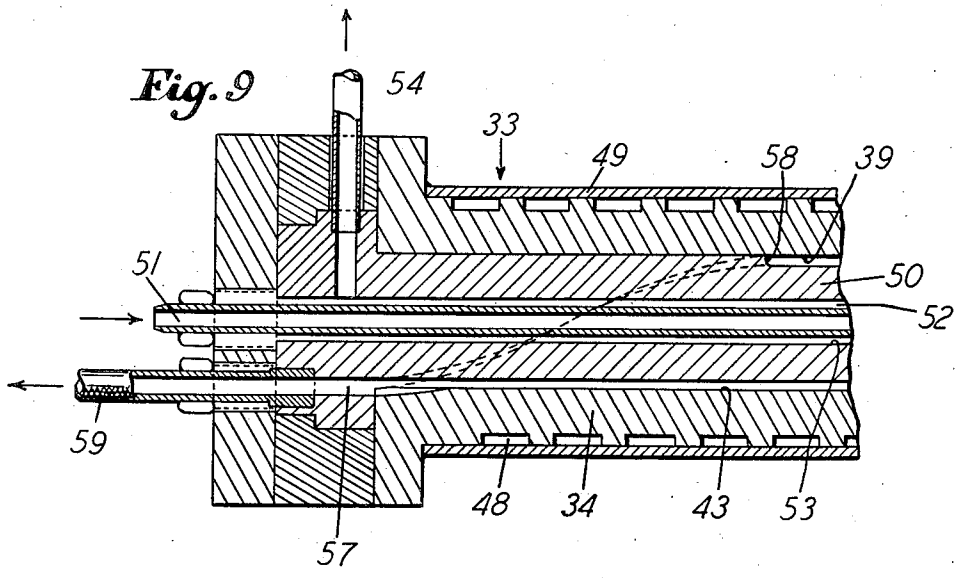


Fig. 9



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PUMP FOR PLASTIC, DOUGHY, PASTY OR VISCOUS MATERIALS

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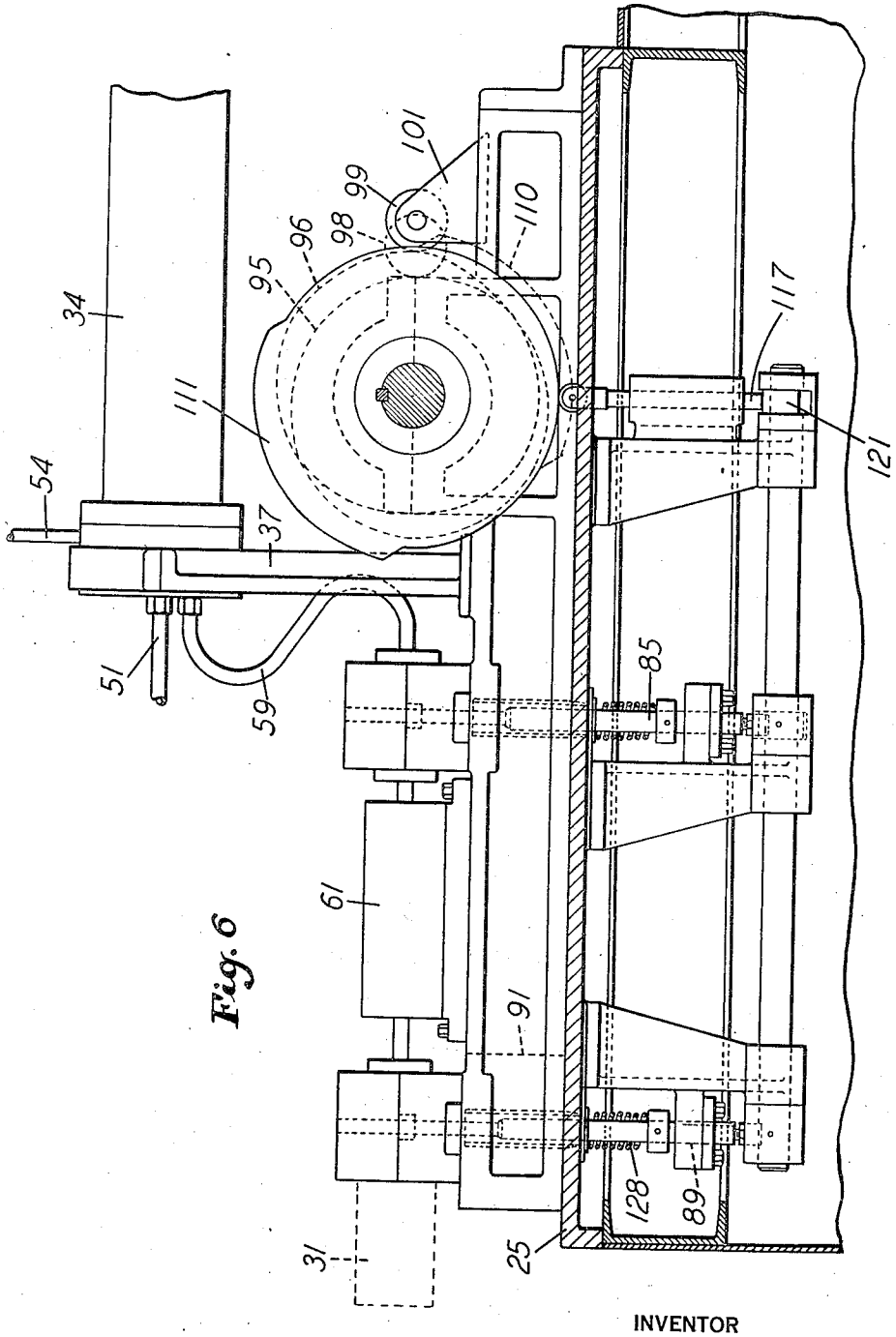


Fig. 6

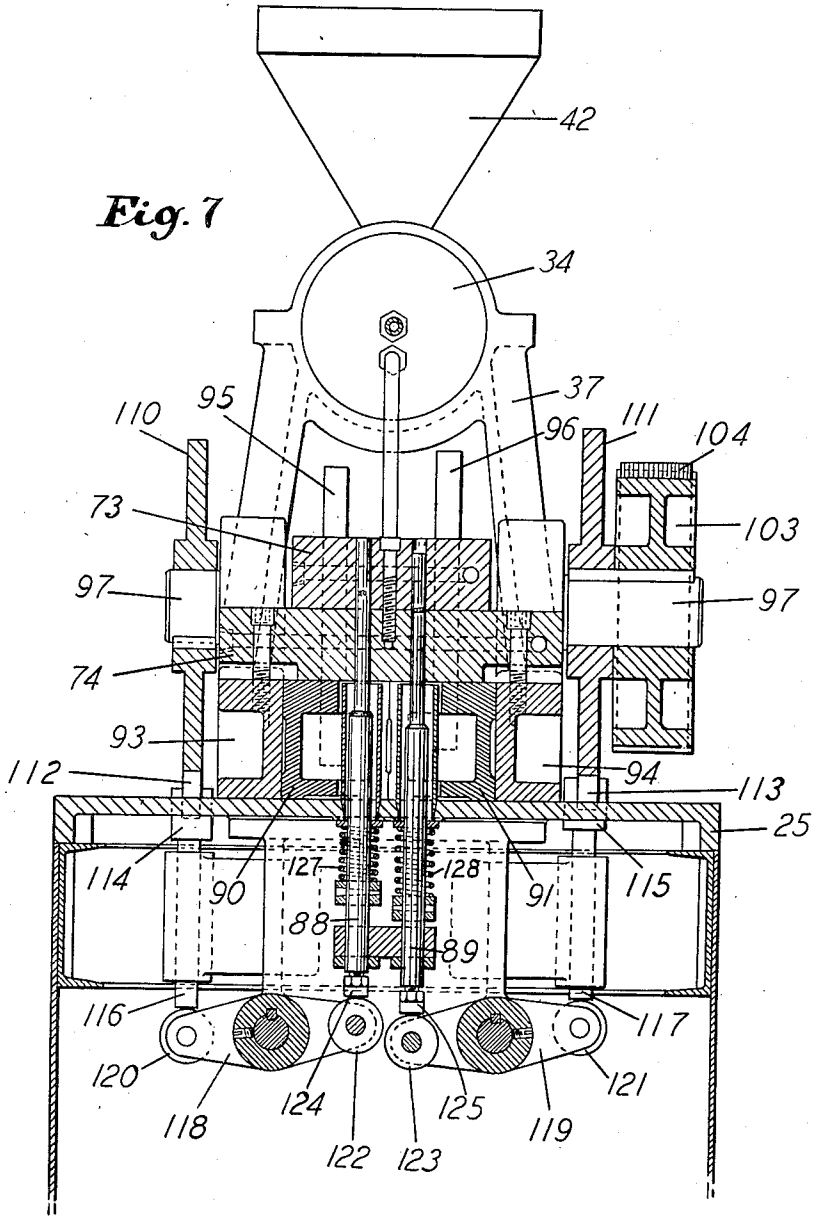
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PUMP FOR PLASTIC, DOUGHY, PASTY OR VISCOUS MATERIALS

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Fig. 7



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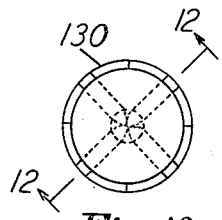


Fig. 10

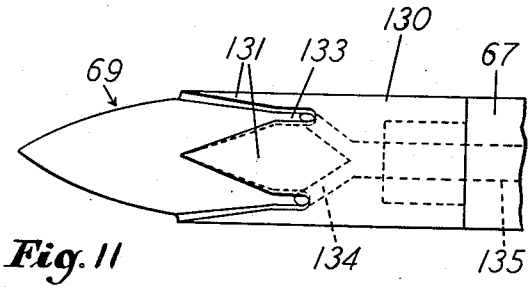


Fig. 11

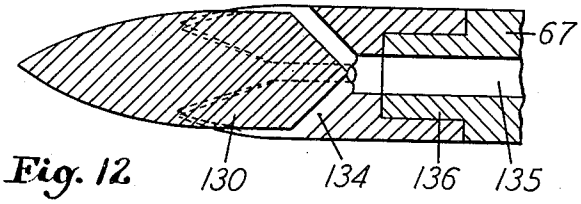


Fig. 12

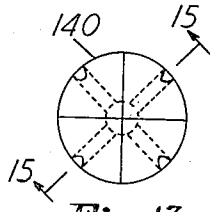


Fig. 13

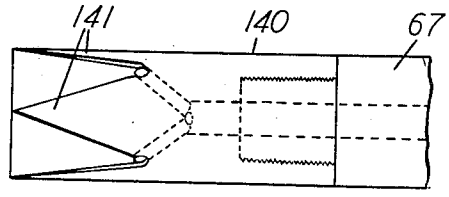


Fig. 14

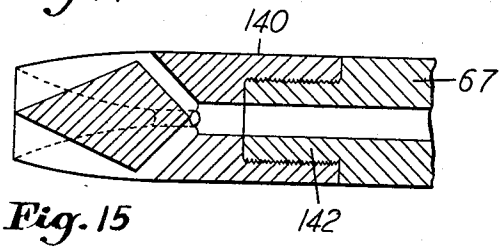


Fig. 15

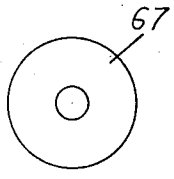


Fig. 16

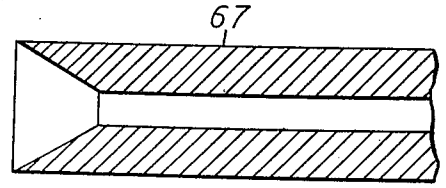


Fig. 17

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PUMP FOR PLASTIC, DOUGHY, PASTY OR VISCOUS MATERIALS

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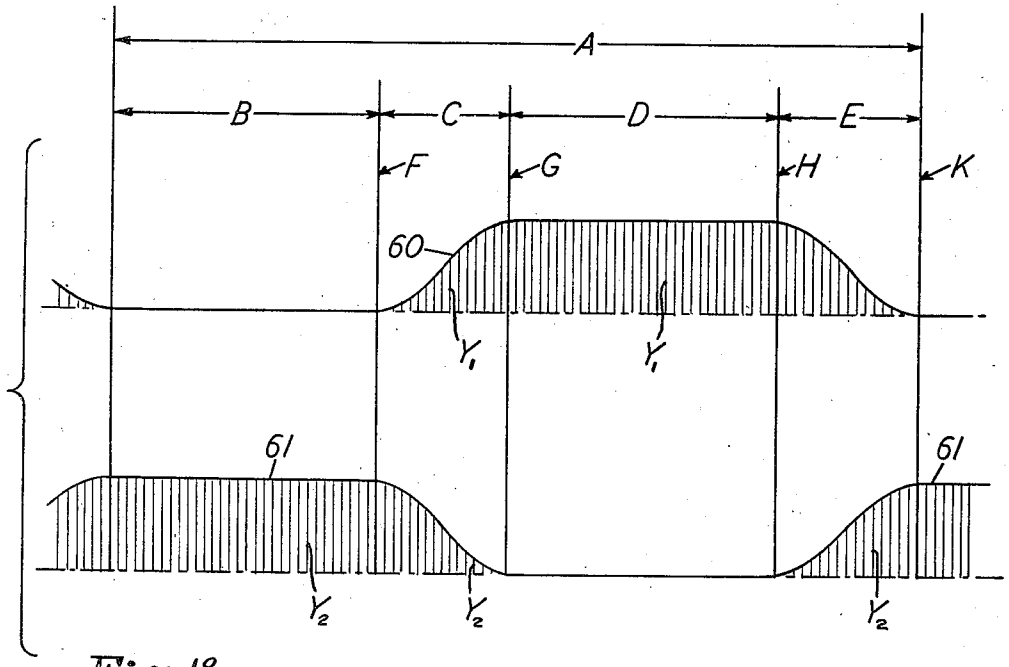


Fig. 18

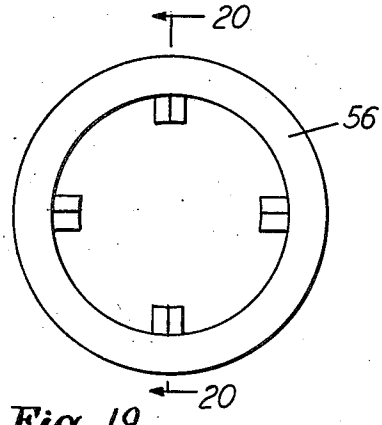


Fig. 19

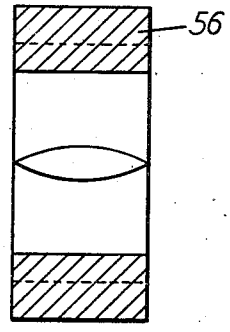


Fig. 20

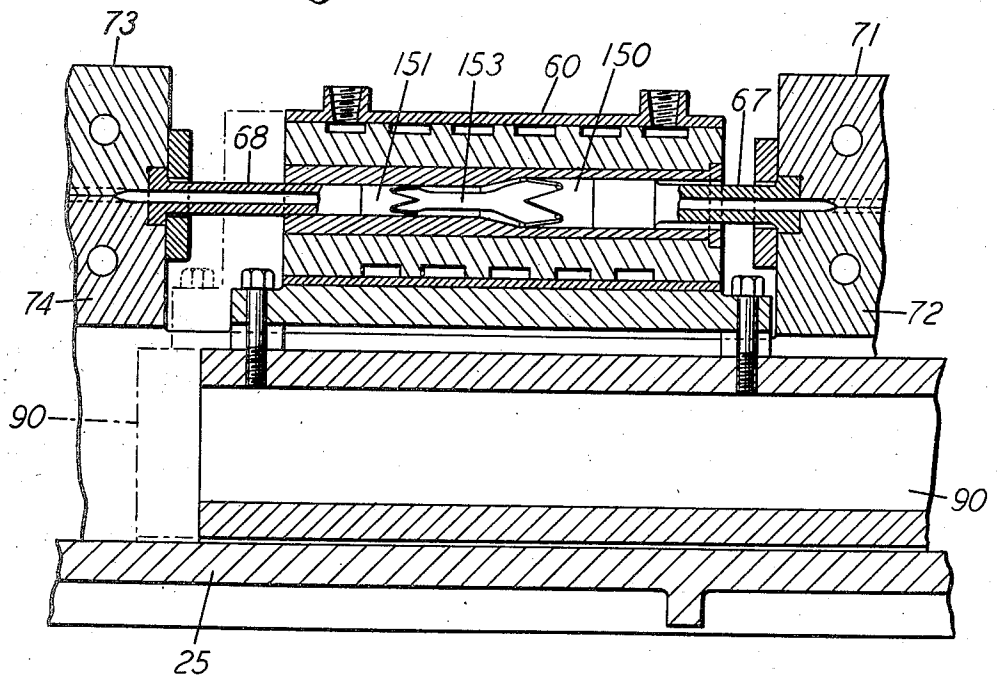
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PUMP FOR PLASTIC, DOUGHY, PASTY OR VISCOUS MATERIALS

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Fig. 21



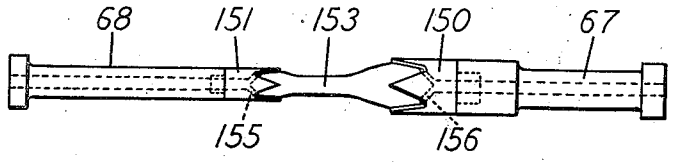


Fig. 22

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Patented Jan. 23, 1945 2,367,691

UNITED STATES PATENT OFFICE

2,367,691

PUMP FOR PLASTIC, DOUGHY, PASTY, OR VISCOUS MATERIALS

Fred M. Roddy, Providence, R. I.

Application April 20, 1942, Serial No. 439,634

20 Claims. (Cl. 103—158)

The present invention relates to the pumping of materials in a flowable state, and has particular reference to a positive displacement type, streamline-flow pump especially adapted for pumping plastic or semi-fluid or viscous materials such, for example, as thermoplastic plastics, among which may be named cellulose acetate, cellulose acetate-butyrate, ethylcellulose, vinyl acetate, vinyl chloride, vinylidene chloride, etc., the foregoing materials being mixed with suitable liquid plasticizers. The pump of my invention also is applicable to the pumping of flowable masses of natural rubber and of synthetic rubber-like substances, as well as to the pumping of doughy materials or of viscous fluids of the type used in the various processing operations employed in manufacturing plastics and synthetic rubbers.

One general application of my improved pump is for the extruding of any of the above mentioned materials into shaped lengths to form rods, tubes or other shaped extruded articles, or for the purpose of forming an extruded insulating covering of these materials over wire.

I have illustrated my invention as applied to an extruding machine, but wish it to be understood that this positive-type streamline-flow pump is not limited to use with extruding machines as it is obvious that it may be used in conjunction with other types of machines or apparatus employed in various manufacturing processes where it is required that plastic, pasty, or doughy materials, or viscous fluids be pumped or forced to flow under high pressure.

In the manufacture of extruded strands or shapes from plastic masses of thermoplastic materials satisfactory results depend upon forcing a completely homogeneous mass of the said plastic material through a die or orifice at uniform volume rate of flow. Present machines for extruding plastic materials in the form of strands, rods, tubing, etc., are usually of the worm or screw conveyor type and are therefore non-positive in their pumping action. The volume delivery of such extrusion mechanisms varies considerably with slight changes in viscosity of the plastic material being pumped, and in use such prior types of machines are found to be sensitive, hard to control, and generally unsatisfactory. Another difficulty experienced with such extruding machines is that they are often not capable of developing as high a pressure as may be desirable.

It is an object of the present invention to provide a positive-displacement type of pump which is so constructed as to overcome the above mentioned difficulties and will be capable of pumping plastic, doughy, or viscous materials at high pressures.

Another object of the invention is to provide a positive displacement pump that is so constructed that streamline flow of the material through the pump during its pumping action will be obtained; and that it will be self-cleaning in its action.

Another object of the invention is to provide a pump of the above character so constructed that it is self-cleaning in its action and devoid of pockets or cavities in which material can lodge and become stagnant thereby contaminating subsequent material being pumped, and in which there will be no abrupt changes in direction of flow of the material being pumped.

Another object of the invention is to provide a pump of the above character that will insure a uniform or practically constant volume rate of flow of extruded product through a die or extrusion orifice under high pressure conditions.

A further object of the invention is to provide plasticating means in conjunction with a positive displacement type, streamline-flow pump for plasticizing the material to be extruded and forcing the plastic mass into the inlet of the pump.

These and other objects of the invention will become apparent as the description of the invention proceeds, it being understood that the showing made here is but one embodiment of the invention, other forms being possible without a departure from the essential elements of the improvement.

In the drawings, in which like reference numerals indicate like parts:

Fig. 1 is a front elevational view of an extrusion machine embodying the preferred form of the invention, a portion of the figure being broken away to show certain elements of its internal mechanism in elevation;

Fig. 2 is a top plan view of the extrusion machine illustrated in Fig. 1, the forward portion of the plasticating cylinder being broken off to expose the cam mechanism for operating the pumping cylinders;

Fig. 3 is an enlarged top plan view of the pumping cylinders showing the arrangement thereof, one of the upper blocks being removed to show the branched conduit passages at the discharge ends of the cylinders;

Fig. 4 is a vertical longitudinal sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is an enlarged transverse vertical section taken on the line 5—5 of Fig. 3;

Fig. 6 is an enlarged fragmentary side elevational view partly in section of the portion of the machine containing the pumping cylinders, the cam mechanism for operating these cylinders, and the operating mechanism for actuating the valves controlling the flow of material into and from the pumping cylinders;

Fig. 7 is an enlarged transverse vertical section taken on the line 7—7 of Fig. 2;

Fig. 8 is a central vertical longitudinal section taken on the line 8—8 of Fig. 2, showing the entrance portion of the plasticating cylinder showing the central core member and the material-feeding plunger;

Fig. 9 is a central vertical longitudinal section of the forward or delivery end portion of the plasticating cylinder shown in Fig. 6 and Fig. 1;

Figs. 10 and 11 are end and side elevational views, respectively, representing one type of construction that may be employed for the end portions of the stationary rods which are located within the movable pumping cylinders;

Fig. 12 is a longitudinal section taken on the line 12—12 of Fig. 10 showing the arrangement of passages for providing streamline flow of material through the stationary rods;

Figs. 13 and 14 are end and side elevational views, respectively, representing an alternative type of construction that may be employed for the end portions of the stationary rods which are located within the movable pumping cylinders;

Fig. 15 is a central longitudinal section taken on line 15—15 of Fig. 13 showing the arrangement of passages for providing streamline flow of material through the stationary rods;

Figs. 16 and 17 are end and central longitudinal sectional views respectively, representing a second alternative type of construction that may be employed for the end portions of the stationary rods which are located within the movable pumping cylinders;

Fig. 18 is a typical displacement diagram for the two pumping cylinders employed in my extrusion machine;

Fig. 19 is an end view showing a detail of the support ring for the central core member of the plasticating cylinder;

Fig. 20 is a vertical central longitudinal section taken on the line 20—20 of Fig. 19;

Fig. 21 shows in longitudinal section an alternative form of pumping cylinder in which the larger and smaller diameter stationary rods are made of an integral construction; and

Fig. 22 is a longitudinal sectional view, on enlarged scale, of the central portion of the integral rod construction shown in Fig. 21.

In its broad aspects the invention consists of a positive displacement pump, the essential elements of which consist of one or more movable pumping cylinders, each cylinder being arranged to be reciprocated to and fro upon two stationary rods of different diameters extending into the interior of the cylinder from its opposite ends. The inner ends of the rods are spaced from one another to provide a material receiving space within the cylinder, and passages are provided through the rods for the flow of material, the said passages and the inner ends of said rods being so designed as to provide streamline flow of material through the pump. Means are provided for individually reciprocating each of these pumping cylinders longitudinally on the associated fixed rods whereby material confined within the space between the opposed ends of said rods will be forced out of this space and expelled through the passages in the smaller rod as the cylinder moves in a direction so as to engage the larger diameter rod more deeply, thereby effecting a decrease in the volume of the space within the pumping cylinder between the ends of said stationary rods. As the pumping cylinder is withdrawn in the opposite direction thereby engaging the smaller stationary rod more deeply, the space within the cylinder increases in volume and simultaneously is filled with material which is forced under pressure, provided by suitable means, into the expanding space within the pumping cylinder. Suitable valves are provided at the inlet and outlet of each cylinder, said valves being so operated that the inlet valve is always closed and outlet valve open during the pumping stroke, and the inlet valve open and outlet valve closed during the filling stroke. All passages within said pumping cylinders, stationary rods and valves are so designed as to provide for streamline flow of material through the pumping mechanism.

Referring to the drawings, and in particular to Fig. 1, the present invention is shown applied to an extruding machine which will be described in detail only insofar as such description is necessary to a complete understanding of the present invention. As here shown, the machine includes a bed or frame 25 mounted upon and bolted or otherwise fixedly secured to the main base or housing frame 26 of the machine. Within the interior of the base 26 and disposed laterally thereof is a mounting block 28 designed for supporting a motor unit and also a speed reducer unit, the function of which units serves the purpose of driving the pump, as will be hereinafter more fully described. The bed or frame 25 supports the pump unit of the present invention and generally designated 30 by which plastic material is delivered through a die 31 in an uninterrupted stream having a uniform or practically constant volume rate of flow.

Means are provided for plasticizing the thermoplastic material to a desired consistency before it is received by the pump unit 30. As here shown, this means consists of a plasticating apparatus generally designated 33 which includes a plasticating or heating cylinder 34 in combination with a plunger unit 35 for feeding the material forwardly through the heating cylinder. The combined cylinder and plunger units 34 and 35 are shown in the present arrangement disposed horizontally in an elevated position above the mechanism of the pump unit 30 and supported by upright supports 37 which are suitably secured to the base 26 of the machine. It is to be understood that the plasticating apparatus 33 shown is merely illustrative of one form of plasticizing arrangement that may be employed in conjunction with my novel pump and it will be apparent that it may be replaced by other known forms of plasticizing apparatus suitable for preparing plastics in a consistency flowable under pressure and for feeding the material to the pump unit 30.

In Figs. 8 and 9 wherein the plasticating apparatus 33 is shown in detail, the plasticating or heating cylinder 34 includes two cylindrical bores 38 and 39 which extend axially inwardly from opposite ends of the cylinder 34 and are connected by a tapered bore 40. The bore 38 is relatively short and forms the entrance chamber or inlet of the plasticating cylinder 34. The material to be processed, such as any of the ther-

moplastic plastics above-mentioned, in either granular, flake or powdered form and mixed with a liquid plasticizer, is introduced into the cylindrical bore 38 of the plasticating cylinder 34 through the opening 41 from the hopper 42 after which it is fed forwardly through the heating chamber 43 of the cylinder 34 by the ram or plunger 45. The ram 45 is reciprocable in the inlet bore 38 and is hydraulically actuated by appropriate means, as, for example, a piston 46 movable in the hydraulic cylinder 47. The plasticating cylinder 34 has its outer wall surface helically grooved to provide heating channels 48 which are appropriately jacketed by the outer jacketing 49 and a suitable fluid heating medium, such as hot oil, is circulated through the channels 48, or, if desired, suitable electrical heating coils (not shown) may be embedded in the channels 48 and in contact with the cylinder may serve as the heating agency. The heating or plasticating chamber 43 is of suitable length for properly preheating the thermoplastic material and has an annular cross-section formed by the cylindrical walls of the larger axial bore 39 and the exterior surface of central core member 50. The core member 50 is heated by circulating a suitable heating medium which enters through the conduit 51 disposed axially within the core member 50 and passes through the space 52 between the outer surface of the conduit 51 and the inner bore 53 of the core 50 and leaves by way of the conduit 54. The core member 50 is disposed axially of the heating chamber 43 and extends inwardly from the exit end of the heating cylinder for substantially its entire length and terminates in a conical shaped end portion 55 as shown in Fig. 8. The forward end portion of the core member 50 is supported in spaced relationship to the outer wall surface 39 of the heating chamber 43 by the support ring 56 (see Figs. 8, 19 and 20) thereby providing the tubular heating chamber 43 through which the plastic mass is forced forwardly by the ram 45. In doing so, the material spreads over the conical surface of the core member 50 and is shaped into tubular form, the side walls of which are relatively thin and thereby more readily susceptible to heat penetration as the material advances forwardly of the heating chamber toward the outlet passage 57 thereof (see Fig. 9).

The compression ram 45 is retracted, a second charge of thermoplastic material drops through the opening 41 from the hopper 42 into the inlet bore 38 of the plasticating cylinder 34, and the ram 45 is again forced inwardly of the bore 38 pushing the newly introduced mixture forwardly of the heating chamber 43 whereby the second mixture follows the same course through the heating chamber as the previously introduced thermoplastic material, which now is already moderately plastic. The plastic material just before being expelled from the outlet passage 57 is deflected by the wedge member 58 (see Fig. 9) formed by two opposite hand helix and caused to travel in the converging space between the helical surfaces whereby the tubular formation of the stream surrounding the core member 50 is divided into two streams which converge in the outlet passage 57 from which it is delivered as a solid stream from the plasticating cylinder 34 and thence led via conduit 59 to my novel pump 30.

Referring now to Figs. 3, 4 and 5, the pump 30 as here disclosed comprises two pumping cylinders 60 and 61 which are arranged side by side and are reciprocable independently of each other and with respect to the bed 25 and the base 26 of the machine by mechanism hereinafter described. The constructions of the pumping cylinders 60 and 61 are similar so that the description of one will suffice for that of the other. Thus in Fig. 4 is shown details of the construction of the movable pumping cylinder 60 and associated parts, and includes an outer casing 62 containing an inner sleeve 63 which has a pressed fit in the casing 62 and is formed with two axial cylindrical bores 64 and 65 of different diameters. These bores extend inwardly from opposite ends of the casing 62 and communicate with each other at their inner ends by means of the tapered bore 66 located substantially near the mid-portion of the casing. Disposed within and snugly fitting the bores 64 and 65 respectively are the stationary rods 68 and 67. These rods have their end portions 69 formed in a special shape, preferably any of the constructions which are shown in Figs. 10 to 17 inclusive, and will be hereinafter described in detail. Suitable passages are provided in the stationary rods through which the material can enter and leave the material receiving chamber or space 70 formed between the opposed ends of the rods 67 and 68. The special shapes given the end portions 69 of the rods and the passages have been so designed that streamline flow of the material through the pumping cylinders 60 and 61 results and that no material can become lodged and remain stagnant in the pumping cylinders. Suitable mounting blocks 71 and 72 adjacent the inlet end of the pumping cylinder fixedly secure the larger rod 67 in place while similar blocks 73 and 74 at the other end of the pumping cylinder hold the rod 68 fixed in place. The upper blocks 71 and 73 are shown as being superimposed upon the lower blocks 72 and 74 respectively and are bolted or suitably secured thereto by appropriate fastening bolts.

It will be noted that as the pumping cylinder 60 moves toward the right of the position shown in Fig. 4 so as to bring about deeper engagement of the larger rod 67 within the larger bore 65 of the cylinder, the volume of the material receiving chamber 70 presented between the opposed ends of the rods 67 and 68 within the cylinder becomes smaller, and if the space or chamber 70 has been previously filled with material being pumped and received from the plasticating apparatus 33, the said material will be ejected from the cylinder as the volume of the space 70 is reduced simultaneously with the reciprocation of the cylinder 60 toward the blocks 71 and 72. It will be noted also that the direction of flow of preplasticated material into the pump from the plasticating apparatus 33 is such that the material enters through the larger stationary rods 67 of each of the cylinders 60 and 61 and is ejected from these cylinders through the smaller stationary rod 68.

The supporting blocks 71, 72, 73 and 74 to which are affixed the stationary rods 67 and 68 are provided with suitable passages 75, 76, 77 and 78 respectively, through which are circulated oil or other fluid heating media. Also, the mating faces of the pairs of blocks 71 and 72 and blocks 73 and 74 respectively, are provided with the branched passages 80 and 81 respectively through which the plastic material enters and leaves the cylinders 60 and 61 of the pump 30. In the arms 82 and 83 of the branched passage 80 are vertically reciprocable valves 84 and 85 respectively, while in the arms 86 and 87 of the branched passage 81

are vertically reciprocable valves 88 and 89 respectively. The valve rods 84, 85, 88 and 89 have holes equal in diameter to that of the passages 82, 83, 86 and 87 respectively and these holes extend transversely of the valve rods for alignment with these passages when the valve associated with a particular passage is open. Plastic material will be contained in the transverse holes of the valve rods when they are moved endwise into closed position to completely block off the passages 82, 83, 86 and 87. The valves are operated by a cam mechanism to be presently described, and function in a manner so as to permit the pumping cylinders 60 and 61 alternately to become filled, and eject the plastic material as the cylinders reciprocate during their pumping strokes.

Means are provided for individually supporting the pumping cylinders 60 and 61 for independent pumping movement. Also, other means are provided for actuating these pumping cylinders whereby at certain portions of the cycle one cylinder alone will accomplish the pumping action while the other cylinder makes its return stroke, and at the other portions of the cycle the pumping action will be accomplished by both cylinders pumping simultaneously with each other in such a manner that their combined action will deliver a continuous and uniform volume rate of flow of material.

Referring now to Figs. 2 to 7 inclusive, slides 90 and 91 are provided upon which are separately mounted the pumping cylinders 60 and 61 respectively. As illustrated, the slides are confined between and independently movable longitudinally of the parallel side frame members 93 and 94 which are bolted or suitably attached to the bed 25. Cams 95 and 96 fast upon the cross shaft 97 journaled in the frame members 93 and 94 engage cam follower rollers 98 and 99 respectively mounted on blocks 100 and 101 at the end portions of the slides 90 and 91. Thus reciprocatory movement is imparted to the slides 90 and 91 as the cams 95 and 96 are rotated with the shaft 97. On the retracting stroke which is effected in a shorter interval of time than that required for the pumping stroke, the cam follower rollers 98 and 99 are held against the cams 95 and 96 respectively by virtue of the reaction from the pressure within the cylinder which is exerted upon the material with which the cylinder is being filled. Suitable driving means are provided for rotating the shaft 97 but as here shown this comprises a sprocket 103 operatively connected by means of a chain 104 to a speed reduction unit 105, which in turn is driven by an electric motor 106 or other suitable source of power.

Means are provided to actuate the plunger valves 84, 85, 88 and 89 in a manner so as to properly control the entry and discharge of plastic material into and out of the material chambers 78 of the pumping cylinders 60 and 61 respectively. To this end cams 110 and 111 fast on the shaft 97 engage cam followers 112 and 113 respectively, which are rotatable in blocks 114 and 115 carried at the upper end of the vertical push rods 116 and 117, thereby imparting alternate rocking movement to the rocker arms 118 and 119 through rollers 120 and 121 as the shaft 97 and cams 110 and 111 rotate. This rocking movement of the rocker arms 118 and 119 is transmitted by the rollers 122, 123 and shoes 124 and 125 to the plunger valves 88 and 89 respectively to produce reciprocatory movement of the valves. The shoes 124 and 125 respectively are adjustably mounted upon the bottom end of the valve rods 88, 89 thereby permitting adjustment of the lift of these valves in order to bring the transverse holes through the valve rods in proper alignment with the passages 82, 83, 86 and 87 when the valves are in wide open position. Springs 127 and 128, which surround the valve rods 88 and 89 and are operatively connected thereto, act to maintain the shoes 124 and 125 in contact with the rollers 122 and 123 and also to maintain the rollers 120 and 121 in contact with the lower end of the push rods 116 and 117.

The operation of the pump is now described with reference to the displacement diagram of the pumping cylinders 60 and 61 depicted in Fig. 18 of the drawings. Referring now to this figure, the distance A represents one revolution of the cams hereinafter described, for actuating the pumping cylinders 60 and 61, and A also represents the time interval of one complete pumping cycle of these pumping cylinders. B and D represent the time interval during which the pumping cylinders 60 and 61 respectively, each pump alone at full volume rate while the other cylinder is filling with material. C and E represent the time interval during which the pumping cylinders 60 and 61 pump simultaneously. The ordinate Y_1 represents the volume rate of pumping by the pumping cylinder 60 at any instant. The ordinate Y_2 represents the volume rate of pumping by the pumping cylinder 61 at any instant. The total volume rate of pumping at any instant is the sum of Y_1 and Y_2.

Thus during the time interval B the pumping cylinder 60 fills with material and the valves 84 and 88 operate while the pumping cylinder 61 pumps at full volume rate. During the time interval C the cylinder 60 starts pumping at F and reaches its full volume rate at G, while the pumping cylinder 61 starts to slow down at F and ceases pumping at the point G. During the time interval D, as above stated, the cylinder 60 pumps at full volume rate. During the time interval E the cylinder 60 starts to slow down at the point H and ceases pumping upon reaching the point K, while the pumping cylinder 61 begins to pump at the point H and moves faster in this interval until it reaches its full volume rate at K. It will be observed that the total volume rate of pumping at any instant in the time interval E is the sum of Y_1 and Y_2 which is the full volume rate of flow of material, and is equal to the volume rate of pumping during the intervals B and D in which intervals the cylinder 61 and 60 respectively are pumping alone.

As previously explained, the inlet valves 84 and 85 are held closed during the pumping strokes of the cylinders 60 and 61 and the outlet valves 88 and 89 of these cylinders are held open. During the filling stroke of the cylinders 60 and 61 the inlet valves 84 and 85 are held open and the outlet valves 88 and 89 closed. The inlet and outlet valves of a given cylinder are actuated simultaneously but it is to be pointed out that at no time are these two valves in a partially open position. The construction employed is such that either the inlet or the outlet valve is always entirely closed before the other valve of the same pumping cylinder opens. It is to be pointed out also that during the interval of time in which the valves are being actuated from open to closed position, and vice versa, there is no movement whatever of the pumping cylinder. In other words, one of the pumping cylinders has reached the end terminal of its stroke, such as for example, the points F and K indicated on the diagram

of Fig. 18 for the cylinder 60, and there is at this point on the cam actuating the pumping cylinder a circular arc which acts to hold the cylinder stationary during the time necessary to actuate the inlet and outlet valve mechanism of either pumping cylinder by means of the camming portions of the cam 110 or cam 111 shown in Fig. 7.

Returning now to the shape of the tip portions of the rods of different diameters disposed within the pumping cylinder, the simplest construction that I propose to employ is that shown in Figs. 16 and 17. It will be seen that while this shape provides for streamline flow of material it is not a desirable form for use at high pressures since the flowing material when under high pressure will expand the conical portion of the rod and create great friction between the said rod and its mating cylinder wall. In order to provide for streamline flow of the material through the rods and at the same time accommodate very high pressure, two alternative constructions for the tip members of the stationary rods 67 and 68 have been illustrated. In the first alternative construction shown in Figs. 10, 11 and 12, it will be observed that the tip member, which I generally designate 130, is a separate body from the rod 67 and has a rounded and substantially bullet-shaped formation, the base of which merges into the floor of a cluster of upstanding wedge-like members 131 extending longitudinally of the rod and disposed in spaced relation to each other circumferentially of the tip member. The spaces between adjacent wedge members 131 form rows of converging channels 133, the terminal ends of said channels being connected by oblique passages 134 with the central passage or axial bore 135 of the particular rod. In this embodiment, the tip member 130 is shown as being press fitted to the short reduced extension 136 formed at the end of the rod 67 to which the tip member is attached.

In Figs. 13, 14 and 15 there is shown a second alternative shape of tip member for use under high pressure. In this form of construction the tip member 140 has a somewhat similar general appearance to that shown in Figs. 11 and 12 with the exception that the outer terminal ends of the upstanding wedge-like members 141 terminate squarely at the outer end of the tip member instead of on the meeting line with the base of a bullet-shaped extension in the form shown in Fig. 11. The tip member 140 has a screw-threaded connection with the reduced extension 142 of the associated rod member instead of press fitted attachment as is shown in the preceding construction.

In these two alternative constructions, the tip members 130 and 140 respectively are shown as being attached to the rods proper to produce a two-piece construction. These tip members, however, could be made integral with the associated rods but the manufacture of them as separate parts facilitates the fabrication of these parts.

In Figs. 21 and 22 there is shown another modified form of construction for the stationary rods 67 and 68, wherein the tip members 150 and 151 attached to the two rods are made integral as a single unit and are joined together by a central neck portion 153. It will be noted that this construction will reduce the cross-sectional area of the material receiving passage between the two tip members and thereby increase the speed of flow of the material through the cylinders. This construction will be advantageous for certain types of material being pumped.

In Fig. 21 the pumping cylinder 60 is shown as previously illustrated in Fig. 4. The rods 67 and 68 are represented similarly positioned within the cylinder 60 as those shown in Fig. 4. In Fig. 21, the inner ends of the rods 67 and 68 instead of having the spaced arrangement shown in Fig. 4 are here shown connected by the one-piece tip member unit above described with the neck portion 153 joining the larger and smaller diameter tip members 150 and 151.

Fig. 22 is a longitudinal sectional view on enlarged scale showing the tip members 150 and 151 and the integral connection neck portion 153. In this form the oblique material passages 155 and 156 have the same general arrangement as the corresponding passages 134 shown in the tip member constructions illustrated in Figs. 11, 12, 14 and 15.

I claim:

1. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials comprising a movable pumping cylinder having two aligned bores of different diameter extending inwardly from opposite ends of the cylinder and communicating with each other through a tapered bore joining said aligned bores, stationary rods fixedly supported exteriorly of the cylinder, the free end portions of said rods being disposed within and slidably fitting said aligned bores, the opposed ends of said rods being spaced within the cylinder to provide a material receiving chamber therein, said rods having passages therethrough for the flow of material, one of said rods serving as an inlet for material to said chamber and the other rod providing an outlet for material as it is pumped from said chamber, valve means for controlling the flow of material through said inlet and outlet rods, said valve means being operable to insure flow of material through said outlet rod and prevent flow of material through said inlet rod during only the pumping stroke, and being operable to prevent flow of material through said outlet rod during the filling stroke, and means for reciprocating said pumping cylinder on said rods whereby the material confined within said material receiving chamber will be forced out and expelled through the outlet rod as the pumping cylinder moves in a direction so as to effect a decrease in the volume of the material receiving space within the pumping cylinder between the opposed inner ends of said stationary rods.

2. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials comprising a plurality of movable pumping cylinders each having two aligned bores of different diameter extending inwardly from opposite ends of the cylinder and communicating with each other, stationary rods fixedly supported exteriorly of the cylinder, the free end portions of said rods being disposed within and slidably fitting said bores, the opposed ends of said rods being spaced within the cylinder to provide a material receiving chamber therein, said rods having passages therethrough for the flow of material, one of said rods serving as an inlet for material to said chamber and the other rod providing an outlet for material as it is pumped from said chamber, valve means for controlling the flow of material through said inlet and outlet rods, said valve means being operable to insure flow of material through said outlet rod and prevent flow of material through said inlet rod during the pumping stroke, and vice versa during the filling stroke, and means for reciprocating said pumping cylinder on said rods whereby the

material confined within said material receiving chamber will be forced out and expelled through the outlet rod as the pumping cylinder moves in a direction so as to effect a decrease in the volume of the material receiving space within the pumping cylinder between the opposed inner ends of said stationary rods; the last said means starting the pumping stroke of one cylinder before the pumping stroke of the other cylinder is completed thereby effecting continuous discharge from the cylinders jointly.

3. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials comprising a movable pumping cylinder having two axial bores of different diameter extending inwardly from opposite ends of the cylinder and communicating with each other through a streamlined connecting passage, stationary rods fixedly supported exteriorly of the cylinder, the free end portions of said rods being disposed within and slidably fitting said bores, the opposed ends of said rods being spaced within the cylinder to provide a material receiving chamber therein including said streamlined passage, said rods having passages therethrough for the flow of material, the larger of said rods serving as an inlet for material to said chamber and the smaller rod providing an outlet for material as it is pumped from said chamber, valve means for controlling the flow of material through said inlet and outlet rods, said valve means being operable to insure flow of material through said outlet rod and prevent flow of material through said inlet rod during the pumping stroke, and being operable to prevent flow through the outlet rod during the filling stroke, and means for reciprocating said pumping cylinder on said rods whereby the material confined within said material receiving chamber will be forced out and expelled through the outlet rod as the pumping cylinder moves in a direction so as to engage the inlet rod more deeply thereby effecting a decrease in the volume of the material receiving space within the pumping cylinder between the opposed inner ends of said stationary rods.

4. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials comprising a movable pumping cylinder having two aligned bores of different diameters extending inwardly from opposite ends of the cylinder and connected with each other by a tapered bore, stationary rods fixedly supported exteriorly of the cylinder, the free end portions of said rods being disposed within and slidably fitting said bores, the opposed ends of said rods being spaced within the cylinder to provide a material receiving chamber therein, said rods having passages therethrough for the flow of material, the larger of said rods serving as an inlet for material to said chamber and the smaller rod providing an outlet for material as it is pumped from said chamber, valve means for controlling the flow of material through said inlet and outlet rods, said valve means being operable to insure flow of material through said outlet rod and prevent flow of material through said inlet rod during the pumping stroke, and being operable to prevent flow through the outlet rod during the filling stroke, and means for reciprocating said pumping cylinder on said rods whereby the material confined within said material receiving chamber will be forced out and expelled through the outlet rod as the pumping cylinder moves in a direction so as to engage the inlet rod more deeply thereby effecting a decrease in the volume of the material receiving space within the pumping cylinder between the opposed inner ends of said stationary rods, the end portions of said rods being of streamlined shape to cooperate with the said tapered bore to insure streamline flow of material through the pumping cylinder from the passage of the inlet rod to the passage of the outlet rod.

5. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials comprising a support, a slide movable on said support, means for reciprocating said slide, a cylinder carried by said slide and movable with said slide, said cylinder having two aligned bores of different diameter extending inwardly from opposite ends of the cylinder and communicating with each other through a streamlined passage, stationary rods fixedly supported exteriorly of the cylinder, the free end portions of said rods being disposed within and slidably fitting said bores, the opposed ends of said rods being spaced within the cylinder to provide a material receiving chamber therein including said streamlined passage, said rods having passages therethrough for the flow of material, the larger of said rods serving as an inlet for material to said chamber and the smaller rod providing an outlet for material as it is pumped from said chamber, valve means for controlling the flow of material through said inlet and outlet rods, said valve means being operable to insure flow of material through said outlet rod and prevent flow of material through said inlet rod during the pumping stroke, and being operable to prevent flow through said outlet rod during the filling stroke, and means for reciprocating said pumping cylinder on said rods whereby the material confined within said material receiving chamber will be forced out and expelled through the outlet rod as the pumping cylinder moves in a direction so as to engage the inlet rod more deeply thereby effecting a decrease in the volume of the material receiving space within the pumping cylinder between the opposed inner ends of said stationary rods.

6. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials comprising a support, a cylinder slidably mounted on said support for reciprocating movement thereon, stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, the said rods each having passages therethrough for flow of material from one of the rods through a material receiving chamber intermediate of the cylinder and out of the other rod as the material is pumped from said chamber upon reciprocation of the cylinder on said rods, separate valve means for controlling inlet of material to said chamber from one of said rods and flow of material out of said chamber through the other of said rods, cam mechanism for reciprocating said pumping cylinder on said rods and said support and for actuating said valve means, said cam mechanism being so constructed and arranged as to effect movement of the pumping cylinder to decrease the volume of the material receiving chamber within the cylinder during the pumping stroke and to maintain the cylinder stationary for a short interval at the end of the pumping stroke while actuating the inlet and outlet valves to close the outlet valve and to open the inlet valve, and to maintain the cylinder stationary at the end of the filling stroke while actuating

the inlet and outlet valves to close the inlet valve and open the outlet valve.

7. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials, supplied to said pump under pressure, comprising a support, a cylinder slidably mounted on said support for reciprocating movement thereon, stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, the said rods each having passages therethrough for flow of material from one of the rods through a material receiving chamber intermediate of the cylinder and out of the other rod as the material is pumped from said chamber upon reciprocation of the cylinder on said rods, separate valve means for controlling inlet of material to said chamber from one of said rods and flow of material out of said chamber through the other of said rods, cam mechanism for reciprocating said pumping cylinder on said rods and said support and for actuating both said valve means, said cam mechanism being so constructed and arranged as to effect movement of the pumping cylinder to decrease the volume of the material receiving chamber within the cylinder during the pumping stroke and to maintain the cylinder stationary for a short interval at the end of the pumping stroke while actuating the inlet and outlet valves to close the outlet valve and to open the inlet valve, to constrain movement of tne cylinder in the opposite direction during the filling stroke as the cylinder is retracted by pressure of material being forced into the material chamber, and to maintain the cylinder stationary at the end of the filling stroke while actuating the inlet and outlet valves to close the inlet valve and open the outlet valve.

8. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials, supplied to said pump under pressure comprising a support, a plurality of cylinders slidably mounted on said support for reciprocating movement thereon, each of said cylinders having stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, said rods each having passages therethrough for flow of material from one of the rods through a material receiving chamber intermediate of the cylinder and out of the other rod as the material is pumped from said chamber upon reciprocation of the cylinder on said rods, valve means for controlling inlet of material to said chamber through the other of said rods, cam mechanism for reciprocating said pumping cylinders on their respective rods and said support and actuating said valve means, said cam mechanism being so constructed and arranged as to effect movement of the pumping cylinders to decrease the volume of the material receiving chamber within one of the pumping cylinders during its pumping stroke and to simultaneously constrain the movement of another of the pumping cylinders during its filling stroke while being motivated by the pressure of the incoming material within the material receiving chamber, said cam mechanism acting to keep the first-named pumping cylinder stationary for a short interval at the end of its pumping stroke while actuating the inlet and outlet valves to close the outlet valve and to open the inlet valve, and to maintain the said first-named cylinder stationary at the end of its filling stroke while actuating its inlet and outlet valves to close the inlet valve and open the outlet valve.

9. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials comprising a support, two cylinders slidably mounted on said support for reciprocating movement thereon, each of said cylinders having stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, said rods each having passages therethrough for flow of material from one of the rods through a material receiving chamber intermediate of the cylinder and out of the other rod as the material is pumped from said chamber upon reciprocating of the cylinder on said rods, valve means for controlling inlet of material to said chamber from one of said rods and flow of material out of said chamber through the other of said rods, cam mechanism for simultaneously reciprocating said pumping cylinders on their respective rods and said support, said cam mechanism being so constructed and arranged as to cause the speed of movement of one pumping cylinder to be gradually reduced as it nears the end of its pumping stroke and at the same time to gradually increase the speed of the other pumping cylinder so that the combined action of the two pumping cylinders will result in uniform volume delivery of material from the outlet of the pump.

10. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials, supplied to said pump under pressure, comprising a support, a plurality of cylinders slidably mounted on said support for reciprocating movement thereon, each of said cylinders having stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, the said rods each having passages therethrough for flow of material from the larger rod through a material receiving chamber intermediate of the cylinder and out of the smaller rod as the material is pumped from said chamber upon reciprocation of the cylinder on said rods, blocks disposed externally of said cylinders at opposite ends thereof and fixedly supporting said rods, branched passages in said blocks communicating with the passages in the associated rods, valves in said branched passages for controlling inlet of material to said chamber from the larger of said rods and flow of material out of said chamber through the smaller rods, cam mechanism for simultaneously reciprocating said pumping cylinders on their respective rods and said support and for actuating said valves, said cam mechanism being so constructed and arranged as to effect movement of the pumping cylinders to decrease the volume of the material receiving chamber within one of the pumping cylinders during its pumping stroke and to simultaneously constrain the movement of another of the pumping cylinders during its filling stroke while being motivated by the pressure of the incoming material within the material receiving chamber, and at the same time acting to keep the first-named pumping cylinder stationary for a short interval at the end of its pumping stroke while actuating its inlet and outlet valves to close the outlet valve and to open the inlet valve and

to maintain the said cylinder stationary at the end of the filling stroke while actuating the inlet and outlet valves to close the inlet valve and open the outlet valve.

11. Positive displacement pump for pumping plastic, doughy, pasty, or viscous materials, supplied to said pump under pressure, comprising a support, two cylinders slidably mounted on said support for reciprocating movement thereon, each of said cylinders having stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, the said rods each having passages therethrough for flow of material from the larger rod through a material receiving chamber intermediate of the cylinder and out of the smaller rod as the material is pumped from said chamber upon reciprocation of the cylinder on said rods to cause the larger rod to enter the cylinder more deeply, blocks disposed externally of said cylinders at opposite ends thereof and fixedly supporting said rods, branched passages in said blocks communicating with said passages in the associated rods, valves in said branched passages for controlling inlet of material to said chamber from the larger of said rods and flow of material out of said chamber through the smaller rods, a set of cams for reciprocating said pumping cylinders on said rods and said support, and another set of cams for operating the inlet and outlet valves, the cylinder actuating cams being so constructed and arranged as to effect a movement of the pumping cylinders to decrease the volume of the material receiving chamber within one of the pumping cylinders during its pumping stroke and to simultaneously constrain the movement of the other pumping cylinder during its filling stroke, and at the same time acting to keep the first pumping cylinder stationary for a short interval at the end of its pumping stroke while the inlet and outlet valves are actuated to close the outlet valve and to open the inlet valve and to maintain the cylinder stationary at the end of the filling stroke while the inlet and outlet valves are actuated to close the inlet valve and open the outlet valve.

12. Positive diplacement pump for pumping plastic, doughy, pasty or viscous materials comprising a support, two cylinders slidably mounted on said support for reciprocating movement thereon, each of said cylinders having stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, the said rods each having passages therethrough for flow of material from the larger rod through a material receiving chamber intermediate of the cylinder and out of the smaller rod as the material is pumped from said chamber upon reciprocation of the cylinder on said rods to cause the larger rod to enter the cylinder more deeply, blocks disposed externally of said cylinders at opposite ends thereof and fixedly supporting said rods, branched passages in said blocks communicating with said passages in the associated rods, valves in said branched passages for controlling inlet of material to said chamber from the larger of said rods and flow of material out of said chamber through the smaller rods, a set of cams for reciprocating said pumping cylinders on said rods and said support, and another set of cams for operating the inlet and outlet valves, the cylinder actuating cams being so constructed and arranged as to cause the speed of movement of one pumping cylinder to be gradually reduced as it nears the end of its pumping stroke and at the same time to gradually increase the speed of the other pumping cylinder so that the combined action of the two pumping cylinders will result in uniform volume delivery of material from the pump.

13. Positive displacement pump for pumping plastic, doughy, pasty or viscous materials, supplied to said pump under pressure, comprising a support, two cylinders slidably mounted on said support for reciprocating movement thereon, each of said cylinders having stationary rods extending axially inwardly of the cylinder from its opposite ends, said rods being of different diameters and each having sliding engagement with the portion of the cylinder within which it is accommodated, said rods each having passages therethrough for flow of material from one of the rods through a material receiving chamber intermediate of the cylinder and out of the other rod as the material is pumped from said chamber upon reciprocation of the cylinder on said rods, valve means for controlling inlet of material to said chamber from one of said rods and flow of material out of said chamber through the other of said rods, cam mechanism for simultaneously reciprocating said pumping cylinders on their respective rods and said support, other cam means for actuating said valve means, the cams for actuating said pumping cylinders being so designed and arranged that as one cylinder nears the end of its pumping stroke its speed is gradually reduced and at the same time the speed of movement of the other cylinder is gradually increased so that the combined pumping action of the two pumping cylinders affords a constant volume delivery from the outlet of the pump, there being a short interval of time at the beginning and end of each pumping stroke during which the pumping cylinder is stationary and at which time the valve mechanism is operated, and a remaining interval of time during which the return stroke of the pumping cylinder is effected and the cylinder is filled with material under the influence of outside pressure, the said return stroke of said pumping cylinder being accomplished in a shorter interval of time than that required for the pumping stroke.

14. A positive displacement pump for pumping plastic, doughy, pasty or viscous materials, having a cylinder, a rod having a passage therethrough, one end of said rod being so shaped that streamline flow of material will result through the rod and out through the inner bore of said cylinder, or vice versa, when the rod is disposed in closely fitting engagement within the bore of the said cylinder.

15. A positive displacement pump for pumping plastic, doughy, pasty or viscous materials, having a cylinder, a rod having a central passage, and a tip having a plurality of raised wedge elements extending longitudinally of the rod and disposed in spaced relation to one another circumferentially of the tip, the tapered sides of adjacent wedge elements converging in a direction away from the tip end of said wedges to form channels which connect with oblique passages communicating with the central passage in the rod, the disposition of said channels, passages and surfaces for directing the flow of material all being such as to prevent lodging of material and

insure streamline flow of material through the rod and over the tip in either direction when said rod is disposed in closely fitting engagement within the bore of a cylinder.

16. A positive displacement pump for pumping plastic, doughy, pasty or viscous materials, having a cylinder, a rod having a central passage, and a tip member at one end of said rod, said tip member having a plurality of raised wedge members extending longitudinally of the rod and disposed in spaced relation to one another circumferentially of the tip member, the tapered sides of adjacent wedge members converging in a direction away from the tip end of said wedges to form channels which connect with oblique passages communicating with the central passage in the rod, and a conical portion extending well in advance of said wedge members, the surface of said conical portion being arranged so as to deflect material flowing thereover into said channels between said wedge members, the disposition of said channels, passages and surfaces for directing the flow of material all being such as to prevent lodging of material and to insure streamline flow of material through the rod and over the tip member in either direction, when said rod and said tip member are disposed in closely fitting engagement within the bore of said cylinder.

17. In a positive displacement pump for pumping plastic, pasty, doughy or viscous materials, in combination with a pumping cylinder to be reciprocated and formed with two aligned bores of different diameter extending inwardly of the cylinder from its opposite ends, the bores communicating with each other at their inner ends; stationary rods having cylindrical end portions in said bores and on which portions said cylinder is reciprocated; each of said rods having a central passage communicating with the outer end of the rod; and means at the inner tip ends of said rods disposed in spaced relation to each other in the internal bore of the cylinder to form a material receiving chamber between the rods, said means at the tip end of each rod comprising a plurality of raised wedge members extending longitudinally of the rod and disposed in spaced relation to one another circumferentially of the rod, the tapered sides of adjacent wedge members converging in a direction away from the tip end of said wedges to form channels which connect with oblique passages communicating with the central passage in the rod, the disposition of said channels, passages and surfaces for directing the flow of material all being such as to prevent lodging of material and insure streamline flow of material through the rods and their tip portions in either direction as material is forced into and out of said material receiving chamber in the pumping cylinder during the reciprocation of the cylinder on said rods.

18. A pumping member comprising an integral elongated body having cylindrical end portions of different diameters, each of said end portions being formed with a central passage for flow of material through the ends of the body, and an intermediate portion of smaller diameter than that of either of said cylindrical end portions forming a neck portion connecting the cylindrical end portions together, the ends of said cylindrical portions adjacent the ends of said neck portion having spaced longitudinally-extending raised wedge members, the tapered sides of adjacent wedge members converging in a direction away from the tip end of said wedges to form channels which connect with oblique passages communicating with the central passage in the particular end portion, the disposition of said channels, passages and surfaces for directing the flow of material all being such as to prevent lodging of material and insure streamline flow of material through the pumping member in either direction.

19. In a positive displacement pump for pumping plastic, doughy, pasty or viscous materials, in combination with a pumping cylinder to be reciprocated formed with two aligned communicating bores of different diameter extending inwardly of the cylinder from its opposite ends; a stationary pumping member including two cylindrical sections in said bores and on which sections said cylinder is reciprocated; said pumping member being formed with central passages in its opposite end portions for endwise flow of material; and an intermediate portion of smaller diameter than that of either of said cylindrical sections forming a neck portion connecting the cylindrical sections together, the ends of said cylindrical sections adjacent the ends of said neck portion having spaced longitudinally-extending raised wedge members, the tapered sides of adjacent wedge members converging in a direction away from the tip end of said wedges to form channels which connect with oblique passages communicating with the central passage in the particular end portion of the pumping member, the disposition of said channels, passages and surfaces for directing the flow of material all being such as to prevent lodging of material and insure streamline flow of material through the pumping member in either direction as material is forced into and out of a material receiving chamber in the pumping cylinder during the reciprocation of the cylinder on said pumping member.

20. A positive displacement pump for pumping plastic, doughy, pasty or viscous materials, having a cylinder with bores of different cross-sectional areas at opposite ends, a rod having tips to fit slideably within said bores respectively, each tip having an axially disposed passage extending inward from the end of the rod and having an oblique passage from the end of said axial passage terminating in an opening in a wedge-shaped recess on the surface of the tip, and a reducing surface on said rod extending from the wedge-shaped recess on the tip of larger cross-section toward the wedge-shaped recess on the tip of smaller cross-section.

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