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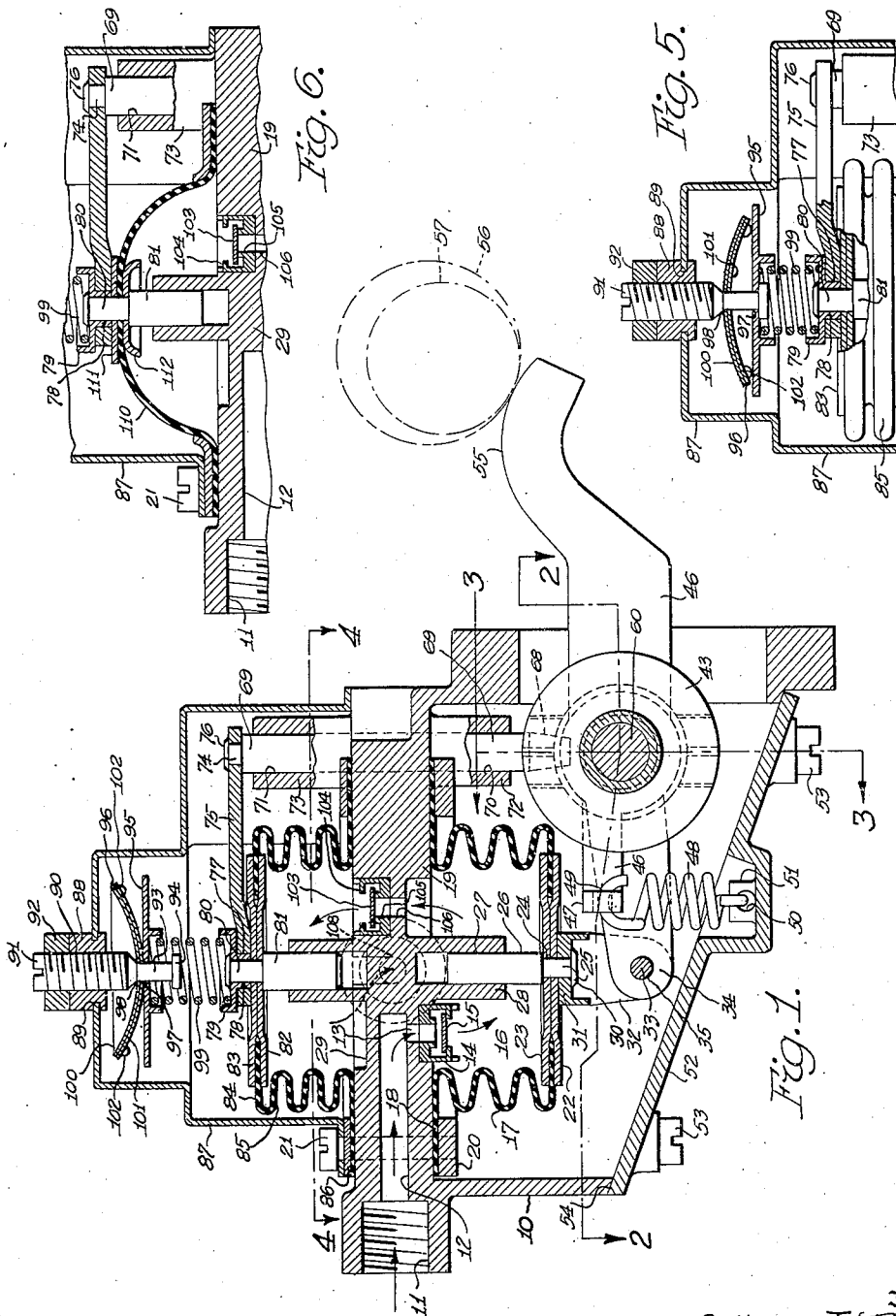
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2,265,613

AUTOMATIC VARIABLE DELIVERY FUEL PUMP

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2 Sheets-Sheet 2

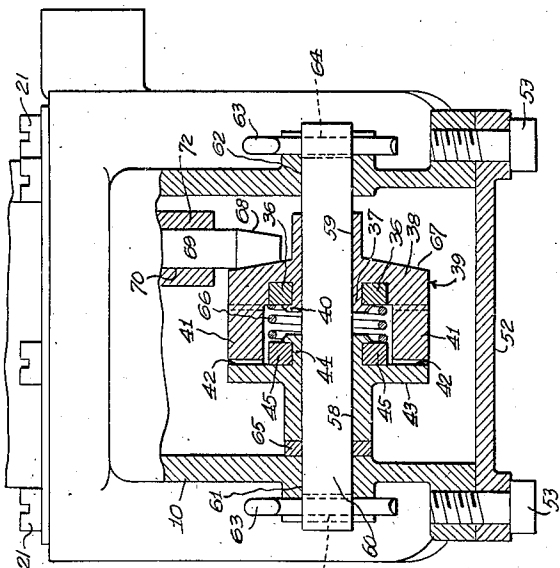


Fig. 3.

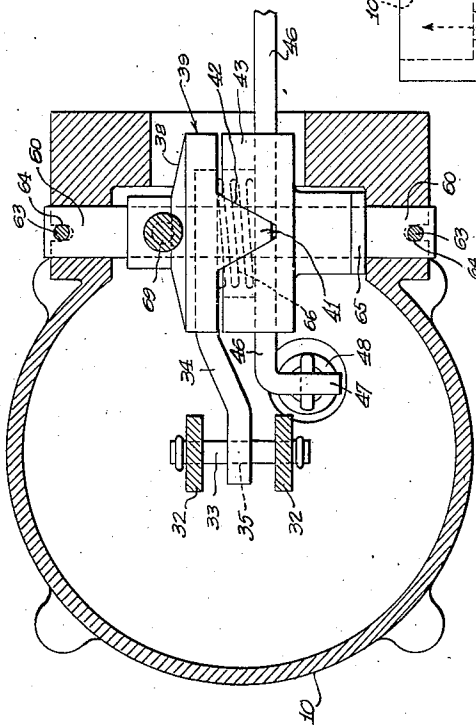


Fig. 2.

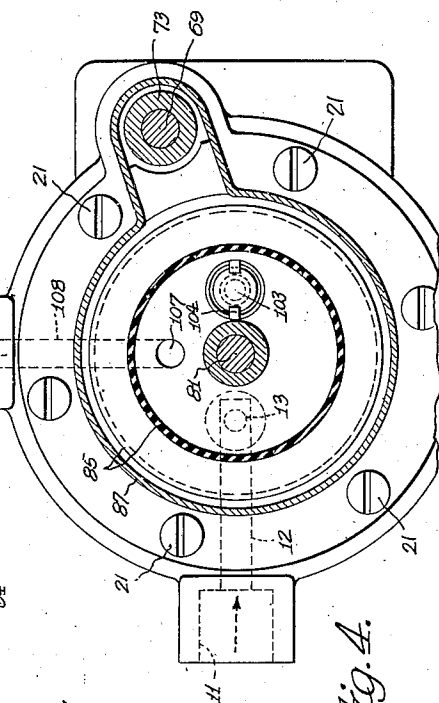


Fig. 4.

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AUTOMATIC VARIABLE DELIVERY FUEL PUMP

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10 Claims. (Cl. 103—38)

This invention relates to pumps and in particular to variable-delivery constant-pressure pumps.

One object of this invention is to provide a variable-delivery pump having means associated therewith for maintaining a substantially constant pressure in the output circuit of the pump regardless of the speed at which the pump is driven.

Another object is to provide a variable-delivery constant-pressure pump employing a bellows mechanism for pumping the fluids and having means responsive to the increase of pressure in the output circuit of the pump for varying the stroke of the pump, thereby maintaining a substantially constant pressure in the output circuit thereof.

Another object is to provide a variable-delivery constant-pressure pump having an automatically-adjustable lost motion connection between the actuating mechanism and the pumping mechanism, this lost motion connection being automatically adjustable in response to an increase in pressure in the output circuit of the pump so that the pump stroke is automatically reduced with an increase in output pressure while the actuating stroke remains the same.

Another object is to provide a variable-delivery constant-pressure pump as set forth in the preceding objects wherein a thermostatic element is interposed for automatically increasing the stroke-varying pressure in order to overcome the vapor lock condition sometimes occurring when the motor is operated under higher than normal temperatures, so that the pump will continue to operate at full stroke until the output pressure rises to a higher level than the normal level at which the stroke-reducing mechanism becomes operative at normal temperature.

In the drawings:

Figure 1 is a central vertical section through a preferred embodiment of the pump of this invention.

Figure 2 is a horizontal section approximately along the line 2—2 in Figure 1 showing the lost motion connection which is automatically adjustable to provide a variable stroke for the pump.

Figure 3 is a vertical section taken along the line 3—3 in Figure 1 and comprising a longitudinal section through the lost motion connection.

Figure 4 is a horizontal section through the upper bellows of the pump taken along the line 4—4 in Figure 1.

Figure 5 is a fragmentary vertical section of

the upper part of Figure 1, but showing the thermostatic mechanism after it has operated in response to a predetermined rise in temperature to increase the pressure level at which the stroke reduction becomes effective.

Figure 6 is a fragmentary view of a modification of Figure 1 employing a dome-like diaphragm instead of a bellows.

General arrangement

In general, the variable-delivery constant-pressure pump of this invention consists of a pumping device, such as a bellows, which is actuated from a cam shaft through a lost motion connection. This lost motion connection determines the stroke which shall be applied to the pumping mechanism independently of the stroke applied by the cam shaft.

The lost motion connection is varied automatically in its adjustment in response to the rise of pressure in the output circuit of the pump. When the pressure increases to a predetermined level, a cam mechanism permits the lost motion device to open more or less, according to the output pressure attained. As the lost motion device opens, the stroke actually applied to the pumping mechanism is automatically reduced even though the stroke of the cam shaft remains constant.

As a further feature, the pump is equipped with a thermostatic device which automatically increases the stroke-reducing pressure to a higher level in response to a rise in temperature. This feature is especially important in fuel pumps, where high operating temperatures often create vapor locks and consequently prevent the pump from delivering the proper amount of fuel to the engine. With the thermostatic device of this invention, the operating level of the pump is automatically stepped up to a higher pressure level when the temperature reaches a predetermined height.

The variable-delivery constant-pressure pump of this invention is particularly valuable in use as a fuel pump for internal combustion engines, especially gasoline engines. In such engines, it is very important that a reasonably constant output pressure shall be maintained, so that the engine will always be supplied with fuel throughout a wide range of operating conditions from slow speed idling to high speed driving. Hitherto, with known fuel pumps, the output pressures have varied through wide ranges and this variation has interfered with the proper functioning of the engine. With the pump of the present

invention, however, the static pressure in the output circuit remains substantially constant regardless of the power input variation over a wide range of speeds. This results from the variation of the pump stroke in response to the expansion and contraction of the upper bellows and has also been verified by actual experimental tests. Moreover, an outlet pressure adjusting screw is additionally provided to enable outlet pressure of the pump to be adjusted to suit individual carburetor requirements, and also to adjust the thermostatic device.

Pump construction

Referring to the drawings in detail, Figure 1 shows a preferred embodiment of the pump of this invention as consisting of a casing 10 having an intake connection 11 and an intake passageway 12 leading through a port 13, valve body 14, and past the valve member 15 into the pumping chamber 16. The latter is formed by a bellows 17 having one end 18 secured to the interior wall 19 of the pump casing 10 by an annular clamping member 20 held thereagainst by the clamping screws 21.

The opposite end of the bellows 17 is securely clamped between disks 22 and 23, which in turn are provided with bores 24 for receiving the reduced diameter portion 25 of a pin 26, the enlarged portion of which enters a bore 27 in an internal tubular projection 28 of the pump casing 10. The tubular projection 28 extends downwardly from the partition member 29 forming an internal bulkhead in the pump casing 10, and serves as a guide for the reciprocation of the pin 26. The opposite end of the pin 26 is enlarged as at 30 to clamp a yoke 31 against the disks 22 and 23.

The yoke 31 is provided with ears 32 carrying a shaft 33 which in turn engages the driven arm 34 by passing through a bore 35 therein (Figure 2). The driven arm 34 at its opposite end is provided with an eye 36 which is slipped over a sleeve-like projection 37 within the driven cam member 38 of the lost motion device generally designated 39 (Figure 3). The end of the sleeve portion 37 is upset as at 40 to secure the arm 34 tightly to the driven cam member 38.

The driven cam member 38 is provided with triangular tongues 41 (Figure 2) engaging corresponding triangular notches 42 in a driving cam member 43. The latter is provided with an internal sleeve portion 44 carrying the intermediate portion 45 (Figure 3) of a driving arm 46. The inner end of the driving arm 46 is bent as at 47 and has a coil spring 48 connected thereto as at 49 (Figure 1), the opposite end of the spring being anchored as at 50 to the lug 51 on the inside of the casing cover plate 52. The latter is secured by the screws 53 to the rim 54 of the casing 10, thus serving as a closure for the latter. The outer end of the driving arm 46 is arched as at 55 (Figure 1) and engages a cam 56 mounted upon the cam shaft 57.

The driving and driven cam portions 43 and 39 (Figure 3) are provided with bores 58 and 59 respectively, which receive a shaft 60 secured within the casing bores 61 and 62 by the pins 63 extending through the end holes 64 in the shaft 60. A washer 65 is interposed between the driving cam member 43 and the interior of the pump casing 10. A coil spring 66 within the driving and driven cam members 43 and 39 serves to urge these members apart, thus tending to cause the triangular tongues 41 in the driven cam 39 to withdraw from the notches 42 in the driven

cam member 43. When this occurs, only a portion of the stroke imparted to the driving cam member by the cam 56 and driving arm 46 will be transmitted to the driven cam 39 and driven arm 34, and thence to the pumping diaphragm 17.

The driven cam 39 is provided with a conical end surface 67 which is engaged by the conical end 68 of an axially reciprocable cam rod 69 which is reciprocable in the aligned bores 70 and 71 of the tubular guide portions 72 and 73 extending in opposite directions from the partition member 29 (Figure 1). The upper end of the cam rod 69 has a reduced diameter portion 74 upon which is mounted an arm 75 secured thereto by the enlargement 76.

The arm 75 extends radially inward and at its inner end is provided with a bore 77 which surrounds the sleeve portion 78 of the spring cap 79, the latter in turn surrounding the reduced diameter portion 80 of the pin 81. Also mounted on the reduced diameter portion 80 and held thereon in a similar way are the twin disks 82 and 83, between which is clamped the end 84 of the upper bellows 85. The opposite end of the upper bellows 85 is clamped against the partition member 29 by an annular member 86 also held in position by the screws 21. The screws 21 also serve to retain in position a cover cap 87 for covering the upper bellows 85 and its associated mechanism.

The cover cap 87 is provided with a threaded plug 88 secured thereto as at 89. Threaded into the bore 90 of the plug 88 is an adjusting screw 91 equipped with a lock nut 92 for holding it in any adjusting position. The lower end of the adjusting screw 91 is provided with a reduced diameter portion 93 terminating in an enlarged head 94 which serves as a retaining flange for a disk 95 having an aperture 97 therein. A bimetallic thermostatic disk 96 is secured as at 98 to the adjusting screw 91. Extending between the disk 95 and the spring cap 79 is a compression coil spring 99 which serves to urge the bellows 85 toward its collapsed position. At the same time, the spring 99 also urges the cam rod 69 downward in a direction causing the lost motion connection 38 to close and take up its lost motion.

The bimetallic disk 96 is composed of two metallic disks 100 and 101 held together at their edges as at 102 and composed of materials of different coefficients of expansion. As a consequence, with a rise in temperature, one disk expands more rapidly than the other, causing the assembly to assume a bowed or cupped condition, as explained below.

The passage of fluid from the lower bellows 17 to the upper bellows 85 is regulated by the valve disk 103 mounted in the valve body 104, the latter being provided with a port 105 aligned with the port 106 in the partition member 29 (Figure 1). Accordingly, the valve member 103 opens upon the compression stroke of the bellows 17, the valve member 15 thereof opening upon the suction stroke.

The partition member 29 (Figure 4) is provided with an outlet port 107 opening into an outlet passageway 108 terminating in an outlet connection 109. The outlet conduit thus formed conducts the fluid from the interior of the bellows 85 to the pipe leading to the carburetor or other point of utilization of the fluid pumped by the pump.

In the modification shown in Figure 6, one or both of the bellows 17 or 85 is replaced by a diaphragm 110. The latter is secured at its outer

edges in exactly the same manner as the bellows 85, but at its center is held between a washer 111 and a cupped washer 112 on the reduced diameter portion 80 of the pin 81. The remainder of the construction is the same as shown in Figure 1 and corresponding parts bear similar reference numerals.

Operation

In the operation of the pump shown in Figure 1, the starting of the engine causes the cam shaft 57 and cam 56 to rotate, moving the driving arm 46 up and down and consequently moving the driven arm 34 and the bellows 17 up and down, provided the lost motion connection 39 is closed, as shown in Figures 2 and 3. This condition will occur when the engine is first started and there is very little pressure within the upper bellows 85, permitting the cam rod 69 to be pushed downward by the coil spring 99, closing the lost motion device 39.

As the bellows 17 expands on the downward stroke of the pin 26, the valve member 15 moves downward off its seat and permits fluid to be drawn through the connection 11 and the passageway 12 through the port 13 into the chamber 16 within the bellows 17. When the pin 26 moves upward, however, and the bellows 17 is thereby collapsed, the fluid within the bellows 17 is forced through the ports 106 and 105 into the interior of the upper bellows 85, lifting the valve member 103 to open this communication.

Due to the pressure of the fluid forced into the interior of the upper bellows 85, the pressure thereon is eventually sufficient to overcome the thrust of the coil spring 99 and expand the bellows 85. This lifts the arm 75 and cam rod 69 when the pressure reaches a predetermined amount. Such an increase in pressure occurs when the amount of fluid being pumped into the bellows 85 is greater than the amount of fluid being taken out through the passageway 108, such as when the pump is pumping more fuel than the engine is capable of using up at an idling speed.

When the cam rod 69 rises in response to an increase in pressure within the upper bellows 85, the elements 38 and 43 of the lost motion device 39 are caused to separate under the urge of the coil spring 66 (Figure 3), moving the triangular tongues 41 out of their notches 42.

When this occurs, the arm 46 and member 43 move for a certain distance before the edge of the notch 42 encounters the edge of the tongue 41. As a consequence, only a part of the stroke of the driving arm 46 is transmitted to the driven arm 34, and the bellows 17 executes only a part of its full stroke.

As a result, the volume of fluid pumped into the upper bellows 85 during a given time interval is considerably reduced, so that the expansion of the bellows 85 is retarded, provided that fluid is being withdrawn from its interior through the port 107 and passageway 108 (Figure 4).

In the event that the engine is idling and the fuel is being pumped into the interior of the bellows 85 much more rapidly than it is being used up by the engine, the bellows 85 will be greatly expanded, causing the cam rod 69 to rise through a substantial distance and permit the elements 38 and 43 of the lost motion device 39 to separate to an extent where no motion whatever is transmitted from the driving arm 46 to the driven arm 34.

When, however, enough fuel has been used up by the engine to reduce the pressure within the upper bellows 85, the coil spring 99 forces the latter downward, and with it, the arm 75 and cam rod 69. This action urges the element 38 toward the element 43, thus causing the tongues 41 to enter the notches 42. When the tongues 41 fully enter the notches 42 (Figure 2), the lost motion is entirely taken up by the lost motion device 39, and the full stroke of the driving arm 46 is transmitted to the driven arm 34, causing the bellows 17 to execute its full stroke.

During very hot weather, the high temperature frequently vaporizes the fuel being pumped, so that the bellows 85 contains a gaseous vapor instead of liquid fuel. This gaseous vapor would serve as a vapor lock and soon bring the engine to a halt, because although the pressure of the vapor within the bellows 85 is still sufficient to expand the latter and raise the cam rod 69, only gas and not liquid fuel would be supplied to the outlet port 107 and passageway 108. Under these conditions, the engine would halt by its lack of sufficient fuel.

To overcome this "vapor lock" condition, the engine provides the thermostatic disk mechanism shown in the upper part of Figure 1. At ordinary temperatures, the bimetallic disks 100 and 101 will assume the upwardly concave condition shown in Figure 1. When a high rise in temperature occurs, however, the metallic element 100, with the greater coefficient of expansion, will expand more rapidly than the metallic element 101, causing the unit 96 to become convex upwardly (Figure 5). Thus the edges of the unit 96 press the disk 95 downward and this additionally compresses the coil spring 99. This is a snap action, due to the fact that the flattening of a disk which is normally concave in one direction causes the disk to become mechanically unstable as it approaches flatness, whereupon the disk suddenly springs into a shape which is concave in the opposite direction. This snap action results in a quick and abrupt shift from one pressure level to the other as the temperature changes.

The effect of this additional compression of the coil spring 99 results in the necessity for the bellows 17 to pump more fluid into the upper bellows 85 to raise the arm 75 and cam rod 69 and open the lost motion device 39. The additional fluid thus pumped relieves the vapor lock condition and supplies the necessary fluid for the engine.

When the temperature returns to normal, the greater contraction of the upper element 100 causes it to contract more rapidly than the element 101, whereupon the bimetallic unit 96 again resumes its upwardly concave condition (Figure 1) and the pump is automatically adjusted to operate the lost motion device 39 at the lower pressure level.

The operation of the modification shown in Figure 6 is similar to that of the main form of the invention shown in Figure 1. This form of the invention, however, is useful where only a short stroke is required and the expansion of a bellows is not needed.

With either form of the invention, the delivery of the pump is automatically altered by the closing or opening of the lost motion device 39, thereby causing the output pressure to remain substantially constant regardless of the increase in the speed of the engine and the consequent

increase in the number of pulsations per minute of the bellows 17.

While I have shown and described my invention in detail, it is to be understood that the same is to be limited only by the appended claims for many changes may be made without departing from the spirit and scope of my invention.

What I claim is:

1. In a variable-delivery pump, a reciprocable pumping device, a driven element connected thereto, a driving element, an oppositely movable lost motion device connected between said elements and including separable portions positively engageable with one another during both directions of said opposite motion, an outlet circuit connected to said pumping device, and means responsive to the attainment of a predetermined pressure in said outlet circuit for moving said separable portions away from one another whereby to loosen said lost motion device and to reduce the stroke of said driven element.
2. In a variable-delivery pump, a reciprocable pumping device, a driven element connected thereto, a driving element, a separable stroke-varying device connected between said elements and including a pair of separable wedge portions having engageable surfaces inclined relatively to their direction of separation, an outlet circuit connected to said pumping device, and means responsive to the attainment of a predetermined pressure in said outlet circuit for separating said stroke-varying device whereby to reduce the stroke of said driven element.
3. In a variable-delivery pump, a reciprocable pumping device, a driven element connected thereto, a driving element, a separable stroke-varying device connected between said elements and including interengaging projections and recesses having mutually engageable surfaces inclined relatively to their direction of separation, an outlet circuit connected to said pumping device, and means responsive to the attainment of a predetermined pressure in said outlet circuit for separating said stroke-varying device whereby to reduce the stroke of said driven element.
4. In a variable-delivery pump, a reciprocable pumping device, a driven element connected thereto, a driving element, a separable stroke-varying device connected between said elements and including interengaging projections and recesses having edges angled relatively to their longitudinal axes, an outlet circuit connected to said pumping device, and means responsive to the attainment of a predetermined pressure in said outlet circuit for separating said stroke-varying device whereby to reduce the stroke of said driven element.
5. In a variable-delivery pump, a casing, a reciprocable pumping member therein having an inlet circuit and an outlet circuit, a driving element connected to said pumping member, a driven element adapted to be connected to a power source, a separable connection having a tapered interlocking projection and recess interposed between said driving and driven elements, means for urging said projection out of said recess to separate said connection, and means responsive to a decline below a predetermined pressure in said outlet circuit for urging said projection into said recess whereby to close said separable connection and increase the stroke of said pumping member, and means responsive to the attainment of a predetermined temperature for raising said predetermined pressure to a higher pressure level.
6. In a variable-delivery pump, a casing, a reciprocable pumping means associated therewith having an inlet circuit and an outlet circuit, a driven arm connected to said pumping means, a power-operable driving arm, and an interengaging tapered tongue and notch connection interposed between said arms.
7. In a variable-delivery pump, a casing, reciprocable pumping means associated therewith having an inlet circuit and an outlet circuit, a driven arm connected to said pumping means, a power-operable driving arm, an interengageable tapered tongue and notch connection interposed between said arms, and means including an expansible device responsive to the attainment of a predetermined pressure in said outlet circuit for moving said tongue out of said notch whereby to reduce the stroke of said driven arm relatively to the stroke of said driving arm.
8. In a variable-delivery pump, a reciprocable pumping device, means for reciprocating said pumping device, an outlet circuit connected to said pumping device, means responsive to the attainment of a predetermined pressure in said outlet circuit for reducing the stroke of said pumping device, and means including snap-action mechanism responsive to the attainment of a predetermined temperature for abruptly raising said predetermined pressure to a higher pressure level.
9. In a variable-delivery pump, a reciprocable pumping device, a driven element connected thereto, a driving element, a lost motion device connected between said elements, an outlet circuit connected to said pumping device, means responsive to the attainment of a predetermined pressure in said outlet circuit for reducing the stroke of said pumping device, resilient means for controlling said predetermined pressure, and means including snap-action mechanism connected to said resilient means and responsive to the attainment of a predetermined temperature for abruptly altering the thrust thereof whereby to abruptly raise said predetermined pressure to a higher pressure level.
10. In a variable-delivery pump, a casing, a reciprocable pumping member therein having an inlet circuit and an outlet circuit, a driving element connected to said pumping member, a driven element adapted to be connected to a power source, a separable connection having a tapered interlocking projection and recess interposed between said driving and driven elements, means for urging said projection out of said recess to separate said connection, means responsive to a decline below a predetermined pressure in said outlet circuit for urging said projection into said recess whereby to close said separable connection and increase the stroke of said pumping member, and means responsive to the attainment of a predetermined temperature for raising said predetermined pressure to a higher pressure level.

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