

April 5, 1960

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2,931,313

PUMP

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2 Sheets-Sheet 1

FIG. 1.

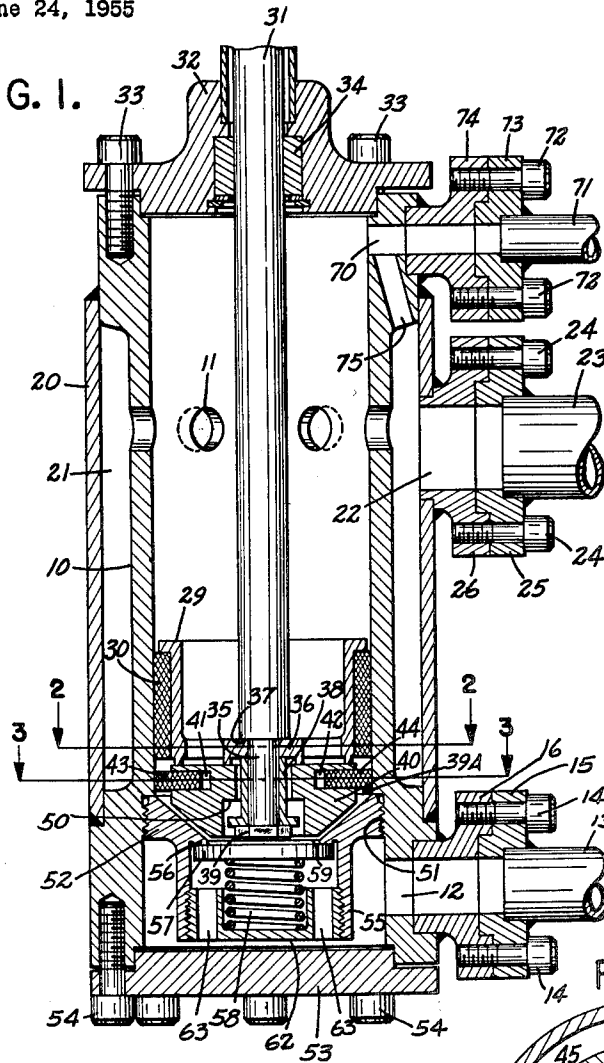


FIG. 2.

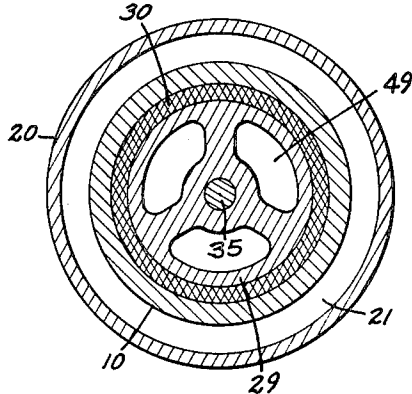
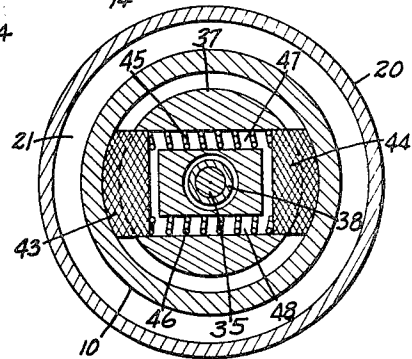


FIG. 3.



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2 Sheets-Sheet 2

FIG. 4.

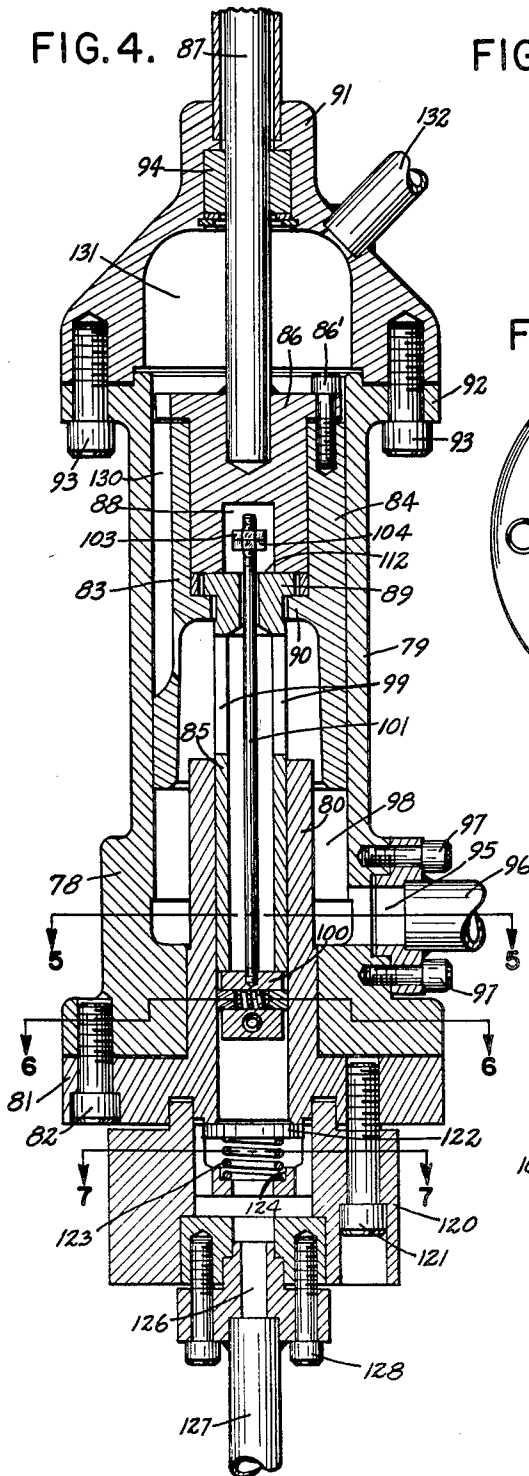


FIG. 7.

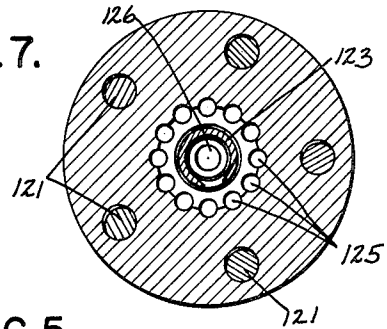


FIG. 5.

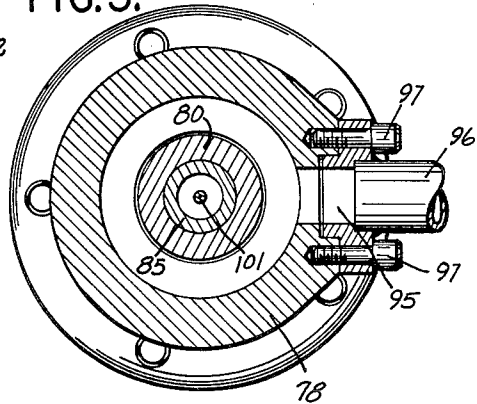
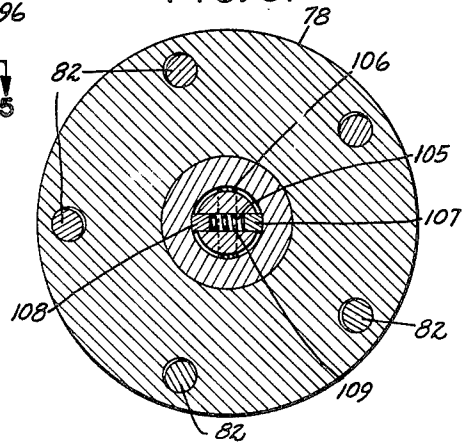


FIG. 6.



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1

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2 Claims. (Cl. 103—178)

This invention relates to pumps and more particularly to liquid transfer and high pressure discharge pumps.

In the handling and pumping of liquids such as liquid oxygen either at low or high pressures, it is necessary to bear in mind in designing and constructing a pump for such usage certain features, to prevent difficulties arising from undesired temperature rises, vapor locking and similar phenomena. It is a primary object of the present invention to provide an improved liquid transfer or high pressure discharge pump in which the above mentioned difficulties are obviated. It is another main object of the invention to provide an improved valve mechanism controllable by the movement of the pump piston for admitting fluid to the compression cylinder of the pump.

There are illustrated in the present application two embodiments which the invention may assume in practice. In each embodiment there is provided a cylinder having spaced inlet and outlet ports, a hollow piston reciprocable in the cylinder, the piston having at least one axial passage therethrough and with a valve slideable relative to the piston and operative either to open or close the passage, means including at least one friction element carried by the valve and biased into engagement with the wall of the cylinder to effect a retarding of the movement of the valve with the piston during at least a portion of the return stroke of the latter, to cause relative movement between them to take place and thus permit flow to take place, to allow the fluid entering through the inlet port to flow through the piston, and thereafter to move the valve with said piston in fixed space relation thereto during the remainder of the return stroke of the latter, said retarding means acting to maintain the valve in its outer limiting position as the piston begins its discharge stroke and until said valve is seated against said piston to close the passage therein. A valve positioned adjacent the discharge end of the cylinder is biased toward a closed position, said valve being opened when the pressure of the trapped liquid overcomes the force of the biasing means to allow fluid to be discharged under pressure as the piston moves through its discharge stroke. A cooling chamber surrounds the cylinder in each instance shown, with a vent means provided in communication with the cylinder and piston to thereby permit the vapors or gases contained above the piston to escape and/or be carried out of the cylinder during the return stroke of the piston.

Other advantages will be apparent from the following more detailed description of the invention when read in conjunction with the attached drawings in which:

Fig. 1 is a central longitudinal view of a pump designed and constructed according to the present invention with some parts in section and others in elevation;

Fig. 2 is a transverse sectional view taken on the plane of line 2—2 of Fig. 1;

Fig. 3 is a similar view taken on the plane of line 3—3 on Fig. 1;

Fig. 4 is a central longitudinal view of another em-

2

bodiment of a pump designed and constructed according to the present invention, with some parts in section and others in elevation;

Fig. 5 is a transverse sectional view taken on the plane of line 5—5 on Fig. 4;

Fig. 6 is a similar view taken on the plane of line 6—6 on Fig. 4; and

Fig. 7 is another transverse sectional view taken on the plane of line 7—7 on Fig. 4.

Referring now more specifically to the drawings and first to the pump structure of Figs. 1 through 3, there is provided an elongated cylinder 10 having a plurality of inlet openings 11 and a single discharge opening 12. A suitable discharge conduit 13 is secured to the cylinder in registry with the discharge opening 12 by means of threaded elements 14 extending through flanges 15 and 16 carried by the conduit and pump cylinder respectively.

An annular cooling jacket 20 encompasses and is secured to the cylinder by suitable means such as for example welding, with the reduced thickness of the cylinder wall adjacent this cooling jacket providing a cooling chamber 21. Cooling jacket 20 is provided with an inlet opening 22, and a conduit 23 in registry therewith is secured to the jacket by means of threaded members 24 extending through flanges 25 and 26 carried by the conduit and jacket respectively.

A hollow piston 29 having a "Dilecto" wear sleeve 30 surrounding it and in engagement with the cylinder wall is reciprocable in the cylinder by means of a piston rod 31 and a suitable driving means which is not shown since it forms no part of the present invention. The piston rod as shown extends upwardly through a head 32 which is secured to one end of the cylinder, the upper end as viewed in Fig. 1, by means of threaded members 33, with a packing element 34 through which the piston rod reciprocates being positioned in a recess in the end of the head nearer the cylinder. The piston rod at its other end has a reduced portion 35 surrounded by a flanged element 36 adjacent a shoulder 37 on the piston rod, and beyond the flanged element there is a sleeve element 38 which is clamped against the flanged element by a nut 39 secured to the reduced portion of the piston rod. The sleeve element loosely guides a poppet-type valve 40, the latter being mounted for limited axial movement. The smaller end of the valve element 40 is recessed to permit limited relative longitudinal movement between the piston rod and the valve.

The valve 40 is formed with a pair of diametrically opposed, transversely extending slots 41 and 42 in which there are positioned, one in each resin bonded laminated fabric members 43 and 44. As seen particularly in Fig. 1, the external diameter of valve 40 is smaller than the internal diameter of the cylinder, this providing an annular passageway 39A between the valve and the cylinder wall. The fabric members 43 and 44 are biased outwardly of the disc into engagement with the wall of the cylinder by a pair of springs 45 and 46, which are positioned in passages 47 and 48 provided in the valve 40, one on either side of its longitudinal axis, and in communication with the slots 41 and 42, and acting against the mutually facing surfaces of the fabric members. As seen best in Fig. 2, there is provided a plurality of passages 49 through the lower end wall of the piston. With the piston and piston rod in the position shown in Fig. 1, the valve 40 is seated against the lower end wall of the piston, to thereby close the passages 49. As the piston rod 31 is initially moved upwardly, as will be explained in greater detail hereinafter, the valve 40 is held in the position shown in Fig. 1 due to the frictional engagement of the members 43 and 44 with the cylinder wall, with the result that the piston is moved upwardly

3

relative to the valve 40 to open passages 49 and permit liquid to pass down through passages 49 and through the passage 39A between the valve and the cylinder wall. As the piston 31 continues to move upwardly, it can be seen that the flanged lower portion of the wear bushing 38 will engage an annular shoulder 50 on the valve 40, which shoulder exists by reason of the enlarged lower bore in said valve with the result that the valve will be carried upwardly in spaced relation to the piston throughout the remainder of the return stroke of the piston rod, with liquid flowing freely through the axial passages 49 in the piston.

Adjacent its lower end the cylinder 10 is internally threaded at 51 and has an externally threaded valve housing or casing 52 threaded into it. A cap or cover plate 53 is secured to the lower end of the cylinder by means of threaded members 54 to thereby seal this end of the cylinder. As seen best in Fig. 1, the valve housing 52 is hollow, with the upper portion of the annular wall thereof tapering downwardly and inwardly to a point inwardly of its lower wall portion 55 to form an annular shoulder 56. A circular discharge valve 57 is biased by means of a spring 58 into seating engagement with the annular shoulder 56 which surrounds the central passage 59 in the valve housing to normally prevent the flow of liquid through the latter passage. The lower end of spring 58 seats in a cut out portion of a block 62 which is threaded into the lower end of the hollow valve housing 52. Block 62 is provided with passages 63 which are in communication with the passage 59 in the valve housing and also in communication with the discharge opening 12 of the cylinder.

In the operation of the pump structure thus far described, with the parts as shown in Fig. 1, i.e. with valve 40 seated against the piston to close the passages 49 therein, liquid to be pumped flows through the inlet opening 22 into the cooling chamber 21 which surrounds the cylinder and also through the openings 11 into the cylinder, to thus fill the cylinder between the lower end of the piston and the upper end of the cylinder. As the upward or return stroke of the piston rod is initiated, the passages 49 in the piston 29 are opened, by reason of the upward movement of the piston relative to the valve 40, which is held in a fixed position due to the frictional engagement of members 43 and 44 with the cylinder wall, to thus allow the liquid to flow downwardly through the passages 49 into the lower portion of the cylinder. As the piston rod continues its return stroke, the flanged portion of the wear bushing 38 engages the shoulder 50 on the valve 40 to move the latter upwardly along with and in spaced relation to the piston 29, with the result that liquid continues to flow through the passages 49 into the lower portion of the cylinder throughout the remainder of the return stroke of the piston. As the piston rod 31 reaches its top dead center position, which can either be with the lower end of the piston substantially opposite the inlet openings 11 or above that point, depending on the pump design, the space below the piston is completely filled with liquid.

As the piston rod begins its downward or discharge stroke, the valve 40 again remains in a fixed position due to the frictional gripping action of the members 43 and 44. As the piston rod continues its discharge stroke the lower end wall of the piston will engage the upper surface of the valve 40 thereby effecting closure of the passages 49. Thus, with the passages 49 closed, continuing downward movement of the piston will exert pressure on the liquid trapped between the piston and the discharge valve 57 and overcome the force of the spring 58, at which time the valve 57 will be displaced downwardly and the liquid will be discharged through the passages 59 and 63 and out through the cylinder discharge port 12.

As shown in Fig. 1, the cylinder 10 is provided with an additional opening 70 above the inlet openings 11

4

with a suitable conduit 71 being secured to the cylinder in registry with opening 70 by means of threaded members 72 extending through flanges 73 and 74 carried by the conduit and cylinder respectively. A passage 75 which extends between and communicates with the cooling chamber 21 and the passage 70 is provided in the cylinder wall with the result that any vapors or gases which might otherwise be trapped in the pump and forced out with the liquid can escape from the cylinder, apart from the liquid discharge, through conduit 71 either via the opening 70 or through the cooling chamber 21 and the passageway 75.

From the foregoing description of the pump structure embodied in Figures 1-3, it can be seen that I have provided a greatly simplified and compact liquid transfer pump in which a liquid can be effectively pumped wholly free of any vapor or gases.

Looking now at the pump embodiment disclosed in Figs. 4 through 7, there is illustrated a pump designed primarily for pumping liquids at high pressures. A cylinder structure indicated generally by the reference numeral 78 includes an outer section 79 and an inner section 80. The inner section is flanged at 81 adjacent its lower end and secured to the outer section by means of threaded members 82 or the like. A piston indicated generally by the reference numeral 83 is reciprocable within the cylinder and is constructed in several parts, providing an outer portion or section 84 which slidably engages the wall of cylinder section 79 and an inner section or portion 85 which slidably engages the wall of cylinder section 80. One part or section 86 of the piston to which part a piston rod 87 is secured by suitable means such as welding is flanged at its upper end and secured to the outer piston portion 84 as by threaded members 86' or the like. Piston section 86 is cut away to provide a central bore or recess 88 for purposes which will be apparent as the description further unfolds, with the upper end of piston section 85 being flanged at 89 and with this flanged portion being positioned between the lower end of piston section 86 and an annular interned shoulder 90 formed on piston section 84. It is apparent therefore that the several piston sections are securely held together and move as a unit.

Piston rod 87 extends through a housing 91 which is secured to the upper flanged portion 92 of the cylinder by means of threaded elements 93, with a suitable packing element 94 being positioned within a central bore in the housing and surrounding the piston rod. Cylinder 78 is provided with an inlet port 95 communicating with a supply conduit 96 secured to the cylinder in registry with the port 95 by means of threaded elements 97. Liquid to be pumped thus flows into the pump through the inlet port 95 and into the annular chamber 98 which is formed by the space between the walls of the outer and inner cylinder sections 79 and 80 and thence, through passages 99 which are provided in the wall of the hollow piston section 85, into the latter. With the parts in the position shown in Fig. 4 it can be seen that a valve 100 is seated against the lower end of piston 85 to thereby prevent any liquid which flows into the piston as above explained from escaping through the lower end thereof. A rod 101 which is secured at its lower end to the valve 100 extends upwardly through the piston section 85 and terminates in the chamber 88 formed in the piston section 86. A pair of lock nuts 103 and 104 are screwed on the threaded upper end of the rod to provide a limiting means for purposes hereinafter explained.

Valve 100 is slightly smaller in diameter than the internal diameter of cylinder section 80 to thus provide a slight clearance between the valve and the cylinder wall, and the disc is provided with a pair of transversely extending bores 150 and 106 which lie one above and at right angles to each other. A pair of resin bonded laminated fabric elements 107 and 108 is positioned in opposite ends of each of the bores, with springs 109 which

5

are positioned intermediate the fabric elements acting on their mutually facing end surfaces to bias them outwardly into engagement with the wall of the cylinder section 80.

In the operation of the parts thus far described, it can be seen that as the piston rod 87 moves downwardly, as viewed in Fig. 4, the lower end surface of the piston section 85 is in engagement with disc valve 100 to thus prevent any liquid from flowing axially upwardly through the bore of the latter, and to compel the downward displacement of fluid. On the other hand, as the piston rod 87 is moved upwardly the frictional engagement of the pairs of elements 107 and 108 with the wall of cylinder section 80 holds the valve 100 stationary while the piston 85 moves upwardly relative to the valve thus permitting liquid to flow through the open bottom end of the piston section 85. As the piston rod continues its upward movement, it can be seen that the upper end of piston section 85 engages the lower surface of nut 104 carried by the rod 101 to thereby move the disc 100 upwardly in fixed spaced relation to the piston 85 through the remainder of the upward movement of the piston rod, with liquid continuing to flow into cylinder section 80 below the piston 85.

A discharge valve supporting structure 120 is secured to the flanged lower portion 81 of the inner cylinder section 80 as by means of threaded elements 121. A circular discharge valve element 122 of a larger diameter than the internal diameter of cylinder section 80 is biased upwardly into engagement with the end surface of the latter by means of a spring 123, the lower end of which is seated in a cut out portion 124 of the valve housing 120. Valve housing 120 is provided with a series of circumferentially spaced longitudinal (axially extending) openings 125 the outer half of each of which lies outside the periphery of valve 122. The openings 125 communicate with a passage 126 and a conduit 127 which is secured to the lower portion of housing 120 by means of threaded element 128.

In operation, it can be seen that as the piston rod 87 is moving upwardly or through its return stroke, the valve 100 is moved in spaced relation to the piston 85 to thereby allow liquid flowing through the inlet port 95 to flow downwardly through the hollow piston 85 and into the cylinder section 80 below. The piston rod 87 continues through its return stroke until the lower end of piston 85 reaches a point short of the upper end of cylinder section 80. When the piston rod reaches its upper dead center and begins its downward stroke, the valve 100 remains stationary, due to the frictional engagement of the pairs of elements 107 and 108 on the wall of cylinder section 80, until the lower end of the piston 85 directly engages the valve 100, at which time the lower end of the piston is closed off and no liquid can pass therethrough. At this point the liquid trapped between the piston 85 and the valve 122 is subjected to pressure as the piston continues its downward movement and the pressure exerted by the spring 123 is overcome, and the valve 122 is displaced downwardly and the liquid is discharged under pressure through the passages 125 and 126, and outwardly through the conduit 127. With the piston 85 limited in its upward or return stroke so that a substantial length of it is in engagement with the inner periphery of cylinder section 80, the tendency of the liquid under pressure to flow back between the piston and cylinder and out through the inlet passages to cause the upper end of the cylinder to become grooved or worn away by the leakage of liquid under high pressure is much diminished.

6

As seen in Fig. 4, the outer piston section 84 is provided with a passageway 130 which communicates with the hollow piston section 85 at the upper end of the space in the latter to which entering liquid attains, as well as with the chamber 98 surrounding it at its lower end, and also with the chamber 131 of the head 91. A suitable conduit 132 is provided in the head 91 in communication with the chamber 131 therein with the result that any gases or vapors which tend to be trapped in the pump can escape or be forced upwardly through the passageway 130 and out through the conduit 132.

While there are in the present application specifically described two embodiments which the invention may assume in practice, these are disclosed for purposes of illustration and that the invention may be modified and embodied and practiced in various other forms and ways without departing from its spirit or the scope of the appended claims will be appreciated.

What I claim is:

1. In a pump, a cylinder having spaced inlet and outlet ports, a piston reciprocable in said cylinder and having at least one passage therethrough, valve means within said cylinder and engageable with said piston to close said passage, means including friction elements carried by said valve means biased into engagement with the wall of said cylinder for rendering said valve means inoperative to close said passage during the return stroke of said piston, a rod secured to said valve means, said rod extending upwardly through said piston and being mounted for axial sliding movement therein and having an enlarged end portion remote from said valve means, said piston upon the initiation of its return stroke being moved relative to said valve means until the end of said piston nearer said enlarged end portion of said rod engages the latter to move said valve means in spaced relation with said piston.

2. In a pump, a cylinder having inlet and outlet ports, a hollow piston having an axial passage therethrough reciprocable in said cylinder, valve means within said cylinder and associated with said piston, said valve means engageable with said piston to close said axial passage during the discharge stroke of said piston, a friction element carried by said valve means and slidably contacting the inner periphery of said cylinder, means acting on said friction element for biasing it toward said cylinder, said friction element causing said valve means to remain in a substantially fixed position during a first portion of the return stroke of the latter to open said passage and permit fluid to flow into the space between said valve means and said piston, a rod connected to said valve means and extending through at least a portion of said hollow piston, said rod being provided with an enlargement at a point remote from its valve connecting portion, and said piston being provided with a shoulder for engagement with said enlarged portion of said rod to cause the valve means to move in fixed spaced relation with said piston through the remainder of the return stroke of the latter.

References Cited in the file of this patent

UNITED STATES PATENTS

1,402,222	Evans	Jan. 3, 1922
1,825,843	Zimmerman	Oct. 6, 1931
2,249,359	Hettinger	July 15, 1941
2,344,005	Sundholm	Mar. 14, 1944
2,390,832	Ginter	Dec. 11, 1945
2,396,878	Plumb	Mar. 19, 1946