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FUEL INJECTION PUMP

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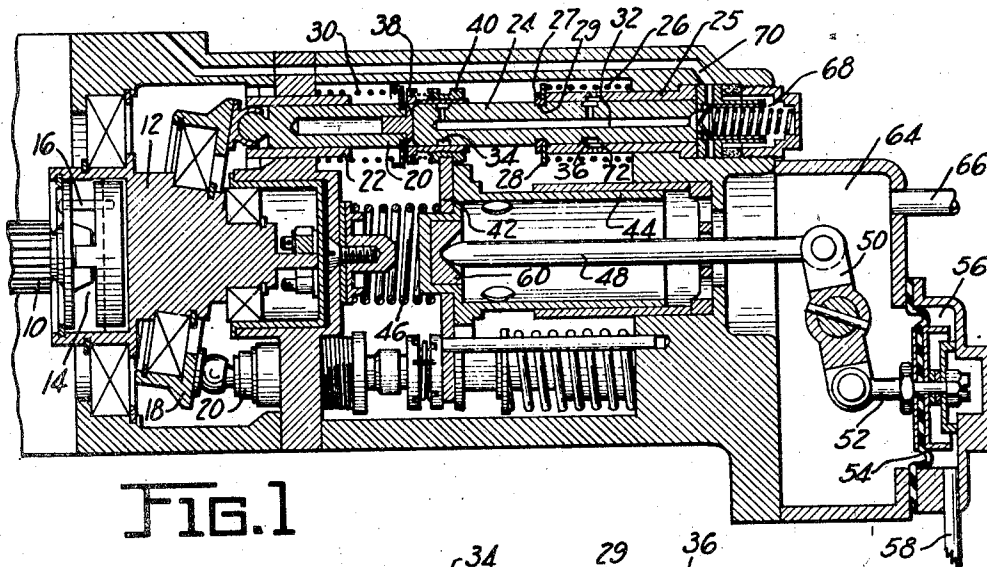


FIG. 1

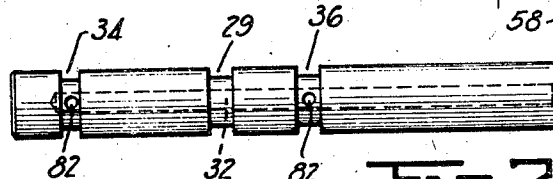


FIG. 2

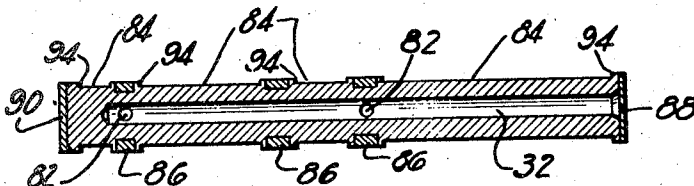


FIG. 3

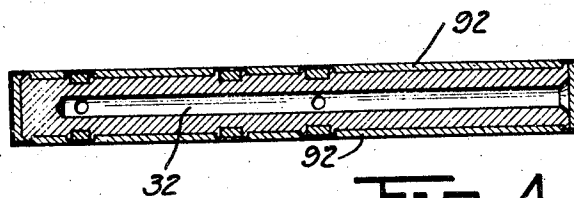


FIG. 4

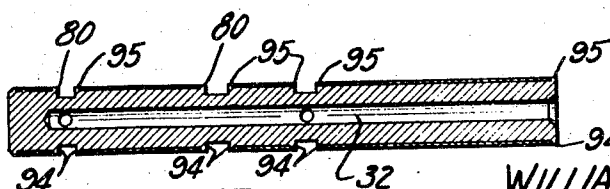


FIG. 5

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FUEL INJECTION PUMP

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8 Claims. (Cl. 103—154)

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This invention relates generally to pumping devices and particularly to the pumping plunger thereof.

Plungers of this character have a tendency to excessive wear and in order to reduce such wear it has heretofore been proposed to variously plate said plunger with relatively hard, wear resisting material. However, it has been found that a number of difficulties have been encountered with such plungers particularly when plated with chromium, among these being peeling of the plating. This fault is particularly serious in plungers for fuel injection pumps wherein the fuel, especially fuel containing ethyl fluid, comes into contact with the plating of the plungers. Additional difficulty is encountered with plungers having certain fuel cut-off edges, which may be annular or inclined relative to the axis of the plunger, to provide sharp cutting off or control of the fuel. Should the plungers be first plated with chromium and fuel grooves later cut or ground in to provide the required fuel passages the above mentioned peeling occurs, particularly at the outer or cut-off corners of the grooves. Another method heretofore proposed for producing plungers for fuel injection pumps is to form the plungers and cut the grooves therein and then plate the plungers with chromium. However, plungers of this character are not satisfactory because the chromium breaks down and crumbles at the cut-off corners of the grooves so that said corners are no longer sharp and effective to provide the extremely sharp and accurate control or cut-off of fuel required in fuel injection pumps. In either case the small pieces of chromium which flake or break off often become wedged between the plunger and the sleeves or other parts of the pump within which said plungers operate and cause sticking of the plunger which, in some cases, renders it wholly inoperative. Also, particles of dirt or other foreign matter in the fluid being pumped tend to lodge on the rounded or broken-down corners and to be wedged thereby between the plunger and its cylinder, causing the plunger to stick.

It is therefore an important object of the invention to provide plated plungers in which the above mentioned difficulties are overcome.

It is a further object of the invention to provide a simple, effective and reliable device of this character having maximum wearing qualities and wherein sharp cut-off edges will not break down under normal operating conditions.

It is another object of the invention to pro-

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vide a device of this character having chromium plating which will not peel or flake off.

It is a further object of the invention to provide a simple and effective method for manufacturing said devices.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawing, which represents a preferred embodiment of said invention. After considering this example, skilled persons will understand that many variations may be made without departing from the principles disclosed; and I contemplate the employment of any structures, arrangements, modes of operation, or methods of manufacture that are properly within the scope of the appended claims.

Referring to the drawing:

Figure 1 is a sectional view of a fuel injection pump employing pump plungers embodying the present invention; and

Figures 2 to 5 inclusive illustrate the plunger at various stages in the manufacture thereof in accordance with the present invention.

Throughout the drawing similar reference characters represent similar parts except where said parts are modified in structure and operation, in which case they are given further differing reference characters.

Referring first to Figure 1 the fuel injection pump shown therein is similar to the pump shown in Figure 7 of Le Roy J. Evans application Serial No. 475,783 for a Charge forming device, filed February 13, 1943. Inasmuch as the general construction and operation of said pump is fully described in said application only a brief description thereof will be given herein.

The pump includes a main drive shaft 10 which drives a member 12 through a universal coupling of known construction, indicated at 14. A locating pin 16 is provided to prevent incorrect assembly of the coupling which would change the timing of the injection pump relative to the engine. A wobble plate 18, mounted on the member 12, is slidably engaged by a plurality of tappets 20 reciprocally mounted in bushings 22 spaced around the periphery of the injection pump. Pump plungers 24 are coaxially arranged relative to the tappets 20 and are slidably received in bushings 25 which form the individual pump cylinders. In view of the fact that each of the tappet and plunger assemblies and the control mechanism therefor are all alike, the following description will be directed to the upper plunger and tappet shown in Figure 1. A

spring 26 engages a washer 27 mounted on a horse-shoe or split spring retainer 28 received in a groove 29 in the plunger 24. The spring 26 urges the plunger 24 to the left and maintains the plunger and tappet in constant contact with each other and maintains the tappet against the wobble plate 18. The plunger and tappet are preferably made as separate abutting pieces rather than as one piece, so that minor variations in alignment of the bushings 22 and 25 may be accommodated without tending to bind the assembly. A spring 30 is provided to move the tappet out of engagement with the wobble plate in the event the plunger 24 becomes stuck.

The pumping plunger 24 is provided with a central bore 32 in communication with a pair of spaced annuli 34 and 36. A by-pass sleeve 38 is slidably mounted on the plunger 24 and is provided with a grooved member 40 threaded thereon which is adapted to be carried by a plate 42. The plate 42 is secured to a slidably mounted piston 44 which is urged to the right by a spring 46 and is moved to the left against the spring by a rod 48 pivotally connected to one end of a lever 50 having its other end pivotally connected to a link 52 secured to a diaphragm 54 which forms a movable wall of a chamber 56 connected by a passage 58 to a venturi in the induction passage of a charge forming device or other source of variable pressure, not shown, whereby the effective fuel delivery of the pump is controlled, as described in the above mentioned application Serial No. 475,783. The left end of rod 48 is of a rounded conical shape and is abuttingly received in the rounded conical depression in a member 60 secured to the piston 44. This construction facilitates assembly and permits the necessary slight rocking movement of rod 48 upon movement of lever 50. The interior of the housing of the pump forms a fuel reservoir 64 which receives fuel from a suitable source through a pipe 66.

The upper plunger of Figure 1 is shown therein in its extreme right hand position corresponding to the end of the stroke. Upon rotation of the wobble plate 18, the plunger 24 will move to the left until the annulus 34 passes to the left of the by-pass sleeve 38. At this time, fuel enters through annulus 34 and bore 32 to fill the fuel pumping space to the right of the end of plunger 24. Upon movement of the plunger to the right, fuel will be pumped back out of the annulus 34 until it passes into lapped relation with by-pass sleeve 38 which determines the beginning of injection. Further movement of the plunger forces the trapped fuel past a spring loaded check valve 68 into a passage 70, thence through a nozzle supply pipe and nozzle, not shown, which discharges the fuel under high pressure into the engine cylinder. Fuel is discharged from the nozzle until the annulus 36 passes into registry with an annulus 72 connected with the reservoir 64, whereupon the remaining fuel in the cylinder of plunger 24 is pumped into the reservoir 64. This arrangement suddenly relieves the pressure of the fuel being pumped and quickly cuts off injection, thereby eliminating dripping at the nozzle. Preferably the annulus 36 and annulus 72 are brought into registry shortly before the end of the stroke of the plunger 24 so that the latter portion of the stroke, which is at a rapidly decreasing plunger velocity and which would produce a decreasing fuel injection pressure, will not be utilized for injecting fuel into the engine. This confines the injection period to the relatively high velocity period of the plunger and the result-

ing high injection pressure period, whereby better atomization at the nozzle is obtained.

As is well known in the art, the timing of the fuel injection periods for the individual plungers must be extremely accurate so that equal quantities of fuel will be delivered to the individual engine cylinders. As a consequence the annuli 34 and 36 of the respective plungers must be accurately spaced relative to associated parts of the pump as well as to each other. Slight variations in such spacing will disturb the equality of the fuel charges delivered by the individual plungers which will adversely affect the operation of the engine. Likewise the breaking down of the cut-off or outer edges of corners 80 of the plunger annuli will obviously change the effective stroke of a plunger and will produce unequal distribution of fuel to the individual cylinders. The cut-off corners therefore must be sharp so that there is a sharp cut-off of fuel when said annuli pass into and out of operative association with the sleeve 38 and the annulus 72 of the bushing 26.

The method of manufacturing the present plunger in order to provide the necessary wearing qualities, the sharp cut-off edges that will not rapidly break down, and a chromium or other plated surface have no exposed edges to flake or chip, comprises the taking of a piece of cylindrical bar stock of relatively soft steel, preferably stainless steel, roughing it, that is, machining or grinding it to a diameter somewhat larger than the dimensions of the finished plunger will be, and cutting in the fuel grooves or annuli 34, 36 and the spring retainer groove 29 which are left slightly undersize. Next the bore 32 and the cross holes 82 are drilled, the device then appearing substantially as shown on Figure 2. The plunger is then heat treated, following which it is roughed or cut down again to eliminate the scale, and the reliefs 84 are cut or ground for reception of the chromium plating, leaving flanges or lands 94 which will constitute shoulders in the finished device. Plugs 86 of lead or other soft material of suitable character are put into the annuli, a plug 88 of like material is used to cover the open end of the bore 32, and the opposite end of the plunger is capped by a plug 90, the device then appearing as shown in section in Figure 3. In Figure 4 the device is shown in section as it appears after being plated with chromium or other suitably hard, wear resisting material which is indicated at 92. The plated plunger is then machined or ground to a slightly oversized dimension, after which the plugs are removed and the substantially completed plunger appears as shown in Figure 5. It is to be noted that the outer peripheral surfaces 95 of the flanges 94 are exposed and are in the same plane as the outer surface of the plating. When the last described step is completed the plunger is slightly oversize, preferably from .0001 to .00015, only enough material being left for lapping. Next the annuli are cut or ground to size, leaving sharp outer edges 80. Because these edges are of stainless steel or like material they will not break down and as the major portion of the outer cylindrical surface of the plunger is of hard, wear resisting chromium, wearing of the peripheral surfaces 95 will be negligible. Further, the protection afforded the adjacent edges of the chromium plating by the steel flanges or shoulders 94 prevents flaking or breaking down of said plating. The portions of chromium plating adjacent the respective ends of the plunger are also protected by the adjacent steel flanges 94.

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It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and though said invention has been illustrated and described in connection with but one modification thereof it will be apparent that various changes may be made in the form, construction and arrangement of the parts and the method of manufacturing same without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form and method of manufacturing hereinbefore described being merely a preferred embodiment and method of manufacturing. Thus, the fuel cut-off edges instead of being annular could readily be helical or otherwise inclined along the axis of rotation for use in pumps wherein the effective pump stroke is controlled by controlled rotation of the pump plunger, the inclined edge cutting off an escape port at a variable point of the plunger stroke depending upon the rotational position of the plunger. Likewise instead of varying the point of beginning of injection the point of ending injection could be varied. Many other modifications will likewise be apparent to one skilled in the art, and I contemplate the use of all such modifications falling within the scope of the subjoined claims.

I claim:

1. In a plunger for pumps, a plunger body: a layer of hard wear-resisting plating material on said body having an outer bearing surface; said body being provided with sharp edged shoulders of softer material defining the limits of said wear-resisting material and having peripheral surfaces, the plane of said peripheral surfaces being substantially the same as the plane of said outer bearing surface.

2. In a plunger for fuel injection pumps: a body having a relieved portion to provide a fuel passage; a relatively shallow relieved portion of substantial area; a flange between said portions adapted to form a cut-off shoulder having an outer surface and a sharp cut-off edge adjacent the first mentioned relieved portion; and a layer of relatively hard wear-resisting material in the second mentioned relieved portion providing an outer bearing surface in substantially the same plane as the plane of the outer surface of the shoulder; the plunger body being softer than the wear-resisting material.

3. A cylindrical plunger comprising a steel body having a reduced portion; a layer of chromium covering a major portion of said body and a steel shoulder integral with the body between the layer of chromium and the reduced portion, said shoulder having an outer surface lying in substantially the same plane as the layer of chromium, the shoulder being adapted to protect the adjacent edge of the chromium and having a relatively sharp cut-off edge adjacent said reduced portion.

4. In a pump plunger: a cylindrical body having a plurality of longitudinally spaced annular grooves therein; a longitudinal bore extending from one end of the body and closed at the other end; passages connecting the grooves with the longitudinal bore; sharp cut-off shoulders adjacent the groove; said body having relieved portions of substantial area between the grooves; and relatively hard wear-resisting material in the relieved portions the outer surface of which is in substantially the same plane as the outer surface shoulders.

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5. In a fuel pump plunger for fuel injection pumps: a steel body of cylindrical shape; a longitudinal bore through the body open at one end and closed at the other; a pair of longitudinally spaced grooves in the body; passages connecting the grooves with the bore; an intermediate groove in the body; flanges extending outwardly of the body adjacent each side of the grooves and adjacent the ends of the body; and a layer of chromium in the spaces between the flanges, the outer surface of the chromium being in substantially the same plane as the outer surfaces of the flanges.

6. The method of making pump plungers for fuel injection pumps: comprising roughing a piece of stock of relatively soft metal leaving the roughed piece oversize; boring an axial passage partially through the piece from one end thereof; cutting undersized annuli in the piece; drilling cross holes from the bottom of the annuli to the axial passage; heat treating the piece; roughing the piece but still leaving it oversized; cutting relieved portions between the annuli and leaving flanges adjacent each side of the annuli and adjacent the respective ends of the piece; filling the annuli with readily removable material and similarly covering the ends of the piece; filling the relieved portions with a plating of relatively hard wear-resisting material which also coats the flanges, the fillings in the annuli and the end coverings; roughing the plunger to expose the flanges and leave the plunger sufficiently oversize for lapping; removing the fillings from the annuli and the covering material from the ends of the piece; forming the annuli to size; and lapping the plunger to dimension.

7. The combination in a pump: a cylinder; a steel plunger reciprocally mounted in said cylinder and having longitudinally spaced annular grooves therein and a longitudinal bore opening at one end into the cylinder and connected with the plunger grooves, the other end of the bore being closed; a cut-off sleeve adapted to at times cover one of the grooves in the plunger; annular flanges adjacent each side of the plunger grooves and the respective ends of said plunger, the outer edges of the flanges adjacent the grooves being relatively sharp; chromium plating covering the plunger between the flanges, the outer surface of the plating being in substantially the same plane as the outer surfaces of the flanges to thereby provide continuous surfaces adapted to slide within the cylinder and sleeve.

8. The combination in a pump of a cylinder; a plunger reciprocable in said cylinder, said plunger having a profiled portion adapted to provide fuel conducting means; fuel conducting means adapted to at times communicate with said profiled portion; a sharp edged cut-off shoulder forming at least one wall of the profiled portion; and a layer of wear-resisting material on the plunger, the peripheral surface of which is in the same plane as the peripheral surface of the shoulder, the sharp edge of which is adapted to at times pass the end of the fuel conducting means communicating with the profiled portion of the plunger whereby the flow of fuel between the respective fuel conducting means is controlled.

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