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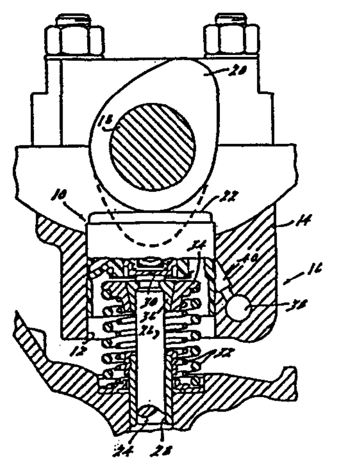
(54) **Lash adjuster with embedded wear face.**

(57) A bucket tappet (10) is provided for direct-acting valve gear having a molded body portion (46) formed of a lightweight material, preferably plastic, having a thermal expansion suitable for use in an aluminium engine head. The body of the tappet includes a tubular wall (48), an inner tubular hub (52), and a transverse end wall (50) joining and supporting the hub within the outer tubular wall. The body of the tappet has a cam face member (54) formed of hardened material, preferably steel or iron-based, embedded therein for providing a cam contacting surface (22). A hydraulic lash adjusting piston/plunger assembly (64) formed of steel is received within the tubular hub. Leakdown control surfaces (70) within the lash adjuster are formed on the mating interfaces between the steel piston (72) and plunger (66).



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LASH ADJUSTER WITH IMBEDDED WEAR FACE

INTRODUCTION

The present invention relates generally to hydraulic lash adjusters and, more particularly, to lightweight adjusters applied within direct-acting valve gear.

BACKGROUND OF THE INVENTION

Valve gear of the direct-acting type employs tappets having one end thereof contacting the engine camshaft and the other end contacting the end of the stem of the combustion chamber valve. Direct-acting valve gear offers the advantage of low mass, fewer working parts and higher stiffness due to the elimination of the rocker arm and/or push rods. Low mass and high stiffness result in a high natural resonant frequency which allows the valve gear to attain higher RPM's before valve mismotion occurs. Direct-acting valve gear also permits the use of lighter valve spring loads for a given valve motion and engine speed, as compared with those used in other valve gear arrangements. The low mass and high stiffness of the system also permits valve lift velocities and accelerations which increase the area under the valve lift curve and thus provide increased specific engine output. Although other overhead cam configurations can be made to have comparable lift velocities and accelerations, a direct-acting valve gear arrangement offers the additional advantage of permitting rotation of the cam contacting surfaces as the lifter rotates, which is not possible with rocker arm type valve gear arrangements. Direct-acting valve gear arrangements, therefore, permit higher cam contact streses.

In addition, the cam profile for other overhead cam valve gear arrangements with high lift accelerations and velocities is more complex than that required for direct-acting valve gear. The simpler cam profile requirement of direct-acting valve gear results in less manufacturing difficulties and less cost in the valve gear when high velocities and accelerations are desired.

Tappets for direct-acting valve gear are received in a guide bore provided in the engine above the combustion chamber and reciprocated therein in a film of engine lubricant provided to the guide bore. Tappets for direct-acting valve gear must have a sufficient diameter to shroud the valve spring and provide adequate lift. Accordingly, tappets for direct-acting valve gear generally have a length-to-diameter ratio in the order of magnitude of one. When the tappet bore is formed in cast iron, the body of the tappet may be formed from a suitable iron-based material or alloy steel to match the hardness and the thermal expansion properties of the guide bore.

It has long been desired to find a way to provide a tappet for direct-acting valve gear of substantially lower weight than iron or steel and yet provide a tappet having similar durability and wear properties. Lower weight tappets permit greater valve acceleration for a given valve spring load.

Moreover, where the engine combustion chamber head is formed of aluminum, it is desirable that the tappet for such a direct-acting valve gear application match the surface wear and thermal expansion properties of the aluminum engine head in order to prevent excessive oil flow at engine operating temperatures. Tappets of iron or steel possess the requisite durability and surface wear resistance but exhibit a substantially lesser coefficient of thermal expansion. Thus, if the iron or steel tappets are optimally sized to the tappet guide bore when the engine is cold, upon the engine reaching normal operating temperatures, the tappet will fit loosely in the guide bore. Conversely, if an iron or steel tappet is optimally sized to fit the tappet guide bore in the aluminum engine head at normal engine operating temperatures, assembly at room temperature will be impossible because of an interference fit. Furthermore, if the assembly is performed with the engine head at normal engine operating temperatures and optimum clearances, the tappet will be seized in the guide bore upon the engine cooling after such assembly.

It has, therefore, been desirable to find a way to provide hydraulic lash adjusting tappets for direct-acting valve gear in engines having combustion chamber heads of aluminum or similar lightweight high-thermal expansion type materials. It has further been desirable to provide a hydraulic lash adjusting tappet for direct-acting valve gear with engines having aluminum heads in which the tappet will be capable of operating against a camshaft formed of hardened iron-based material. This generally requires that the cam face of the lightweight tappet be compatible in hardness and wear properties with the hardened face of the cam lobe. Furthermore, it has been desirable to find a way to economically and conveniently provide in such a hydraulic lash adjusting tappet a controlled leakdown clearance, yet provide a lightweight tappet body.

BRIEF DESCRIPTION OF THE INVENTION

The present invention overcomes many of the above-described shortcomings of the prior art by providing a hydraulic lash adjusting tappet for use in the valve gear of an internal combustion engine including body means molded of a material having a coefficient of thermal expansion not less than 22 x 10^{-6}/unit length/°C as measured in the range of 20-100°C, such as plastic or aluminum. A face member is entrained within the body means by the molding thereof and defines a reaction surface which, in application, contacts a cam lobe. Finally, hydraulic lash adjusting means are provided which operatively associate with the body means and define a second reaction surface which, in application, will contact an associated engine valve gear component. In operation, the second reaction surface is movable with respect to the face member reaction surface for lash adjustment of the valve gear. This arrangement provides the advantage of an extremely lightweight, inexpensive hydraulic lash adjuster which will perform satisfactorily in the environment of a typical internal combustion engine.

In its preferred embodiment, the present invention provides a hydraulic lash adjusting tappet of the type used in direct-acting valve gear for internal combustion engines operating at high RPM. The hydraulic tappet of the present invention is of the type having a general configuration known as a "bucket" tappet where the body of the tappet has a diameter substantially larger than that of the hydraulic plunger contained therein. The tappet of the present invention has a greater mass, or body, portion thereof having the outer periphery thereof compatible for being slidably received in direct contact with a guide bore formed in an aluminum engine head. The tappet of the present invention contains a hydraulic lash adjusting unit in the form of a plunger-piston assembly formed of steel and employs a one-way valve means and a high-pressure oil chamber therein for providing lash adjustment.

A reservoir is formed in the plastic body in the region surrounding one end of the plunger assembly. The tappet of the present invention has a steel alloy member provided on the cam face of the tappet for wear resistance and compatibility with the driving surface of a hardened iron-based engine cam. The face member is generally cup-shaped and embedded within the body during its molding process. This construction enables the tappet to be slidably compatible with the guide bore and further to match the thermal expansion characteristics of the aluminum engine head to maintain the proper running clearance between the tappet and the guide bore for necessary directional control and lubrication between the sliding surfaces without excessive oil flow at high temperatures.

The body of the present tappet has a generally tubular outer wall construction and an annular hub disposed within the outer wall and spaced therefrom with an end wall extending transversely therebetween. A web structure extends radially inwardly from the outer wall to support the hub. The hydraulic plunger and piston assembly are received in the inner hub, and a portion of the hydraulic reservoir is formed between the inside face of the web, the end of the piston and inner periphery of the hub. This unique construction provides for a relatively larger diameter of the outer periphery of the tappet body, yet provides for ease of manufacturing in that the outer wall, hub and web may be formed integrally. The hydraulic lash adjusting assembly is preassembled and inserted into the hub and retained therein.

The unique construction of the present tappet further provides an arrangement wherein the tightly controlled leakdown surfaces between the piston and plunger of the lash adjusting unit are formed in the iron-based or steel parts. The use of the intermediate plunger therefore makes the use of a lightweight body practical over the range of normal engine operating temperatures. The present invention thus provides a solution to the problem of providing a lightweight tappet for use in direct-acting valve gear and one that is compatible with material of an aluminum engine head and functionally compatible with the hardened iron-based engine camshaft, all providing adequate wear resistance leakdown surfaces.

In several alternative embodiments of the invention, various face member configurations are disclosed in which the skirt portion of the face member can be circumferentially continuous or segmented to profide retention surfaces operative to react against the material of the body to prevent relative movement therebetween. The skirt circumscribes a generally disc-shaped face portion of the face member and can be embedded within the outer wall or the annular hub of the body. Finally, the face portion of the face member is substantially co-extensive with the nominal cross-sectional area of the outer annular wall to maximize potential contact area with the cam.

These and other aspects and advantages of the invention will become apparent upon reading the following Specification which, along with the patent drawings, describes and discloses a preferred and several alternative embodiments of the invention in detail.

A detailed description of the embodiments of the invention makes reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a cross-sectional portion of the direct-acting valve gear of an internal combustion engine illustrating the tappet as installed in the engine;

FIGURE 2 is a cross-sectional view of a typical prior art steel-bodied bucket tappet;

FIGURE 3 is an end view of the plunger end of the preferred embodiment of the hydraulic tappet of the present invention;

FIGURE 4 is a cross section taken along section indicating lines 4-4 of FIGURE 3 and shows the tappet with the hydraulic lash adjusting means assembled therein;

FIGURE 5 is a cross-sectional view of the face member shown in assembly in FIGURE 4;

FIGURE 6 is an alternative embodiment of the face member of FIGURE 5;

FIGURE 7 is a second alternative embodiment of the face member of FIGURE 5;

FIGURE 8 is a cross-sectional view taken along section indicating lines 8-8 of FIGURE 7 and shows the interfitting relationship between the material forming the lash adjuster body and the retention surfaces defined by the skirt portion of the face member;

FIGURE 9 is a view similar to FIGURE 3 and shows an alternative embodiment of the tappet;

FIGURE 10 is a section view taken along section indicating lines 10-10 of FIGURE 9;

FIGURE 11 is a view similar to FIGURE 3 and shows another alternative embodiment of the invention; and

FIGURE 12 is a section view take along section indicating lines 12-12 of FIGURE 11.

DETAILED DESCRIPTION OF THE PREFERRED AND ALTERNATIVE EMBODIMENTS OF THE INVENTION

Referring to FIGURE 1, a hydraulic lash adjusting tappet 10 is slidably received in a guide bore 12 provided in a cylinder head 14 of an internal combustion engine 16. A camshaft 18 having a cam lobe 20 contacts the upper end or cam face 22 of the tappet. A typical combustion chamber valve 24 is shown seated on a valve seating surface formed in the cylinder head, with a stem portion 26 of the valve extending substantially vertically upwardly through a valve guide 28 formed in the cylinder head, with the upper end 30 of the valve stem contacting the lower end of the tappet. The valve is biased to the closed position by valve springs 32 having their lower ends registered against the exterior of the upper portion of valve guide 28 and their upper ends in contact with a retainer 34 secured to the valve stem adjacent its upper end and retained thereon in a suitable manner as, for example, by the use of a split keeper 36, which is well-known in the art. A supply of lubricant is provided to tappet 20 from a pressurized source (not illustrated) through a gallery 38 and a passage 40 interconnecting gallery 38 and guide bore 12.

Referring to FIGURE 2, a typical all-steel prior art bucket tappet is illustrated in which a hardened steel or iron cap 42 is affixed to a mild steel body 44 by welding the circumferential joint 43 therebetween. This type of assembly is thoroughly treated in prior art Patent 4,270,496.

Referring to FIGURES 3, 4, and 5, the presently Preferred Embodiment of the tappet 10 is shown wherein the body, indicated generally at 46, is shown as formed preferably integrally with an outer tubular wall portion 48 having a transverse end wall 50 extending generally radially inwardly from the inner periphery of the outer tubular wall portion at a location adjacent the upper end thereof (as viewed in FIGURE 4). The end wall 50 has formed preferably integrally therewith a tubular hub portion 52 extending axially from the end wall in a downward direction. The end wall isolates hydraulic pressure inside hub 52 from a face member 54 cam face 22. Cam face 22 defines a face member reaction surface which, in application, contacts cam lobe 20. The hub 52 has the inner periphery thereof extending in general parallel relationship to the outer periphery of the tubular wall portion 48. The outer periphery of the tubular wall portion 48 is sized to be received in the tappet guide bore 12 (FIGURE 1) in a generally closely fitting relationship. At least one web 56 is provided to support hub 52 which extends radially outwardly therefrom to the inner surface of wall 48.

In the presently preferred practice of the invention, the outer wall portion 48, end wall 50, hub portion 52, and web 56 are formed integrally from a suitable lightweight material having a coefficient of thermal expansion of at least 22.0×10^{-6}/unit length/°c, as measured in the range 20 to 100°c. The outer surface of the tubular wall portion has a wear-resistant surface formed thereon as, for example, by anodic hard-coating electrolysis metal plating (in the case of an aluminum body), or, the surface of a high silicon aluminum alloy in order to have the surface hardness value of at least 8 (topaz) as measured on the Mohs' scale. In the presently preferred practice, the integrally formed body, web, end wall, and hub are formed of a material having a bulk density less than

2.85 g/cu c, such as graphite reinforced plastic. The material may include wear additives such as graphite fibers/particulates, Teflon or fiberglass. As is well-known to those dealing in the specification of plastic materials for high-temperature applications, additives can be included to enable matching of thermal expansion coefficients of the plastic and the metal face member 54.

Cam face member 54 is a relatively thin disk-shaped face portion 58 and a generally annular skirt portion 60 depending from the radially outward-most portion thereof. Skirt portion 60 has formed therein a number of circumferentially spaced, radially directed passageways 62. Body 46 is injection-molded to entrain or capture face member 54 wherein material comprising body 46 flows through passageway 62 and to establish intimate contact with the retention surfaces defined thereby. Thus, after the material, molded into the form defined by body 46 takes a set, face member 54 is permanently joined to body 46 and restained from relative displacement with respect thereto. Although retention surfaces of the preferred embodiment are manifested by bores or passageways 62, as will be seen hereinbelow, retention surfaces can be defined any number of ways within the spirit of the present invention. In the presently preferred practice of the invention, the cam face member 54 is formed of material, having a bulk density not less than 7.5 g/cu c and a surface hardness value on the face member reaction surface or cam face 22 thereof of at least 89, as measured on the Rockwell 15 IN scale for a minimum effective depth of at least 0.012 inches (0.3 millimeter). However, it is to be understood that materials having a bulk density less than 7.5 g/cu c may be employed for the cam face member provided the surface hardness thereof is maintained. The cam face member is preferably formed of an iron-base material as, for example, a steel alloy having a desired amount of chromium added thereto for providing a desired corrosion resistance; however, a suitably hard ceramic or cermet material may alternatively be employed for base member 54, if desired. In the presently preferred practice of the invention, the body member 46 preferably has a bulk density less than 40% of the bulk density of the cam face member 54, although the bulk density of the body member 46 to the bulk density of the cam face member 54 can be greater than 40% if a suitably hard, lightweight material is employed for the cam face member.

The body 46 has a hydraulic lash adjusting unit indicated generally at 64 slidably received in the inner periphery of the hub 52 in a generally closely fitting relationship. The hydraulic lash adjusting unit 64 comprises a generally cup-shaped plunger member 66 having the open end thereof disposed adjacent the end wall 50 and the closed end extending axially slightly downwardly from the lower end of hub 52 and transversely thereacross to provide a second reaction surface 68 for contacting upper end 30 of valve stem portion 26 (see FIGURE 1). The plunger 66 has a precision bore 70 provided on the inner periphery thereof which bore is maintain in tight tolerances of diameter, circularity, and surface finish. The plunger has received therein in precision sliding contact therein a piston member 72 having the outer periphery thereof sized to interfit the plunger bore 70 in closely controlled clearance to provide control of the passage or leakdown of hydraulic fluid between the bore 70 and the piston 72. The piston 72 has a generally cup-shaped configuration with the open end thereof disposed upwardly adjacent end wall 50 of body 46 and has an interior cavity 74 provided therein with a vertically extending passage 76 extending downwardly through the closed end of piston 72. A one-way valve means, in the form of a check ball 78, is disposed to contact the lower end periphery 80 of the passage 76 for which periphery 80 provides a valve seat for the check valve 78. The check valve is retained by a cage 82 attached to the lower end of piston 72. A spring 84 is provided between the cage 82 and the check ball for biasing the check valve 78 to the closed position against valve seat 80.

An annular recess 86 is provided in the inner periphery of hub 52 of body 46 adjacent the upper or end wall end thereof for providing a portion of a reservoir for hydraulic fluid. At least one bypass passage 88 is provided preferably for communicating the annular recess 86 with the cavity 74 provided in the piston 72 to provide a divided chamber hydraulic fluid reservoir for supplying the check valve 78, the reservoir communicating with the passage 76. Web 56 extends radially inwardly from wall portion 48 to the hub 52 and has formed therethrough a hydraulic fluid passage 90 which communicates with annular recess 86 from a fluid collecting recess or groove 92 provided in the outer periphery of tubular wall 48 of the body 46.

In operation, valve 20 is biased in a closed position by springs 32 and, upon rotation of the camshaft 18 in timed relationship to the events of the combustion chamber to the position shown in solid outline in FIGURE 1, the upper surface of the tappet 10 is registered against the base circle portion of the cam with lobe 20 wherein so not to contact the upper or cam face 22 of the tappet. Upon rotation of the camshaft 18 to the position shown in dashed outline in FIGURE 1, the cam lobe 20 contacts upper face 22 of the tappet, causing the tappet to move downwardly to the position indicated in dashed outline thereby opening the combustion chamber valve 24. Upon subsequent rotation of the camshaft to return to the solid line position of FIGURE 1, the valve event is complete, and the valve is reseated on the valve seat.

Although the embodiment of FIGURE 3 illustrates the invention in its presently preferred form, wherein the end wall 50 of body 46 has a plurality of weight-reducing holes 94 provided thereabout in circumferentially spaced arrangement, it will be understood that other shapes and configurations may be employed for reducing the weight of end wall 50 and web 56. The end wall 50 in the presently preferred practice is solid in the region extending transversely across the upper end of the hub 52. However, it will be understood that the solid portion of the end wall 50 across the end of hub 52 may be omitted if the cam face member 54 is fluidly sealed to the outer wall about its periphery and mechanically restrained against the force of the high-pressure hydraulic fluid.

In operation, with the engine cam lobe 20 in a position shown in FIGURE 1, the plunger spring 96, aided by hydraulic pressure, urges the piston 72 in an upward direction maintaining the upper end thereof in contact with the undersurface of the end wall 50 and urges the plunger 66 in the downward direction until the reaction surface 68 thereof contacts the upper end 30 of the valve stem 26, thereby eliminating lash in the valve gear. This causes an expansion of a high-pressure chamber 98 formed between the closed ends of plunger 66 and piston 72, which draws open the check ball 78 to a position spaced from valve seat 80 thereby permitting flow into the chamber 98. Upon cessation of the expansion of chamber 98, the check ball 78 closes under the biasing of spring 84. Upon subsequent rotation of cam lobe 20, the ramp of the cam lobe begins to exert a downward force on the upper face 22 of the tappet 10, tending to compress the piston 72 into the bore 70 in the plunger 66, which compression is resisted by fluid trapped in chamber 98. The fluid trapped in chamber 98 prevents substantial movement of the piston 72 relative to the plunger 66 and transmits the motion through the bottom face 68 of the plunger onto the top 30 of the valve stem 26. It will be understood by those having ordinary skill in the art that a minor movement of the plunger 66, with respect to the piston 72, occurs, the magnitude of which is controlled by the amount of fluid permitted to pass between precision bore 70 and the outer surface of piston 72 (leakdown surfaces). The piston 72 and plunger 66 thus act as a rigid member transmitting further lifts of the cam lobe 20 for opening the valve 24.

Lash adjusting unit 64 can be held in assembly within hub 52 in a number of ways. For example, a radially inwardly opening circumferential groove can be formed within hub 52 and a snap ring fitted therein to limit the downward displacement of lash adjusting unit 64. Alternatively, the lowermost portion of hub 52 can be deformed radially inwardly to likewise define a downward limit of travel for lash adjusting unit 64. Still another alternative means of retention is described in United States Patent 4,373,477. However, a particularly advantageous approach to the retention of lash adjusting unit 64 is in the application of a bottlecap-type retainer 100 which is characterized by a plurality of radially inwardly directed tangs 102 lanced inwardly from a skirt portion 104 thereof. In assembly, retainer 100 is aligned concentrically with hub 52 and inserted thereover by displacing it upwardly until the uppermost surface of a body portion 102 abuts the lowermost surface of hub 52. In so doing, tangs 102 penetrate the outer surface of hub 52 and establish an extremely tenacious interfit therewith. Base portion 106 defines a passageway 108 therethrough in register with the bore defined by hub 52 but of slightly smaller diameter. The lowermost portion of plunger 66 has an area of reduced diameter forming a shoulder 110 which, contacts base portion 106 of retainer 100 when lash adjusting unit 64 is in its lowermost limit of travel. Use of the bottlecap-design, retainer 100 is considered particularly attractive in the practice of the preferred embodiment of the invention inasmuch as the plastic body material is relatively soft. The outer circumferential surface of hub 52 can be designed in a uniform, easily moldable configuration inasmuch as the tangs 102 can easily penetrate the surface thereof. This eliminates the needs for machined or molded contours molded in the hub 52 for mating or receiving the retainer as is required in other design types. For clarity of underlying detail, FIGURE 3 is illustrated with retainer 100 removed.

Referring to FIGURE 6, the alternative embodiment of the cam face member is illustrated at 112, which is substantially identical to face member 54, with the exception that the outer peripheral portion of skirt portion 60 is removed to establish a circumferential step 14 between the skirt portion 116 and face portion 118. In the embodiment of the cam face member illustrated in FIGURE 5, the outer diameter of skirt portion 60 is slightly less than the outer diameter of outer tubular wall portion 48 to enable the plastic material thereof to circumferentially embrace substantially the entire outer surface of skirt portion 60. However, in so doing, a small amount of cam face 22 surface area has been sacrificed. The cam face member 112 embodiment of FIGURE 6 overcomes that shortcoming by providing step 114 which renders the cam face 120 of cam face member 112 substantially co-extensive with the nominal cross-sectional area of wall portion 48.

Referring to FIGURES 7 and 8, a second alternative embodiment of cam face member is illustrated generally at 122 including a face portion 124 and a skirt portion 126. Face portion 124 defines a cam face 128 which, in application, is substantially co-extensive with the nominal cross-sectional area of outer tubular wall portion 48. Skirt portion 126 has a diameter less than that of face portion 124 and is joined thereto through a downwardly inwardly converging transitional portion 130. The cam face member 122 of FIGURE 7, not only presents a maximized cam face 128 area to cam lobe 20, but also tolerates a degree of thermal expansion coefficient mismatch between the body 46 and cam face member 122. Skirt 126 has a number of circumferentially spaced generally trapezoidally shaped reliefs 132 formed therein and defines complementary pairs of retention surfaces 134 thereby. Retention surfaces 134 are substantially axially misaligned whereby, once injection-molded with a body

46', intimately embrace the material thereof which has flowed adjacent thereto. Although the skirts illustrated in FIGURES 5, 6, and 7 extend substantially parallel to the axis of body 46, it is contemplated that they could be angled inwardly or outwardly to effectively increase the retention surface area of the cam face member.

Referring now to FIGURES 9 and 10, an alternative embodiment of the tappet 10 of the present invention is illustrated as having a body indicated generally at 136 and a cam face member illustrated generally at 138. No lash adjusting unit is illustrated for the sake of simplicity. Body 136 comprises an outer tubular portion 140, a tubular hub portion 142, and a plurality of circumferentially spaced webs 144 integrally interconnecting outer and hub portions 140 and 142, respectively. Cam face member 138 includes a face portion 146 and an annular skirt portion 148, depending downwardly therefrom at a point radially intermediate the center and the outside circumference of face portion 146. Hub portion 142 is provided within area of increased diameter 150 within which is moldingly entrained skirt portion 148. Skirt portion 148 has a number of circumferentially spaced, radially directed passageways 152 formed therein which establish retention surfaces in intimate contact with the material of hub 142 which has flowed therethrough during the molding process. A fluid passage 90' extends through one of the webs 144 in a manner described hereinabove in relation to the embodiment illustrated in FIGURES 3 and 4. Skirt 148 includes a local discontinuation 154 aligned with passageway 90' to prevent the obstruction thereof. When provided with lash adjusting unit 64, the embodiment of the invention illustrated in FIGURE 10 operates substantially identically as that described hereinabove.

Referring now to FIGURES 11 and 12, still another alternative embodiment of the tappet 10 of the present invention is illustrated as having a body indicated generally at 154 and a cam face member 156. The embodiment of FIGURE 12 has structure very similar to that illustrated in FIGURE 4 including an outer tubular portion 158, a hub portion 160, and an integrally interconnecting plurality of circumferentially spaced webs 162. Body 154 has an area of increased diameter 164. Cam face member 156 comprises a face portion 166 and a tubular skirt portion depending therefrom at a point nearly radially co-extensive with the outer circumferential edge of face portion 166. A plurality of radially directed passageways 170 are formed within skirt 168 and are entrained within the area of increased diameter 164 during the molding process of body 154 when the material therecomprising flows through passageways 170. As in the case of the embodiment illustrated in FIGURES 9 and 10, when the tappet body illustrated in FIGURE 12 is provided with a lash adjuster unit 64, its operation is substantially as described hereinabove.

The novel construction of the present tappet provides lash adjustment by precision fit of a piston in a bore formed in the plunger slidably received in the hub and thus eliminates the need for precision fitting leakdown control surfaces on the interior of the tappet hub. The area, surrounding the plunger between the web and the tubular wall of the body and the cam face member, provides a reservoir for fluid to supply the one-way check valve for hydraulic lash adjustment. The tappet of the present invention provides a unique, lightweight tappet adapted for direct contact with the surfaces of a guide bore provided in an aluminum engine cylinder head. The body of the tappet of the present invention has the outer periphery thereof provided with a hard surface or hard coating to be slidingly compatible with the properties of the aluminum engine head. The tappet is formed of a suitable lightweight material, having surface hardness properties compatible with those of the surface of the aluminim engine head and the tappet material matching the coefficient of thermal expansion of the aluminum engine head, to maintain control of the clearances therebetween for providing proper guidance during reciprocation of the tappet and maintenance of an adequate lubricant film therebetween. The tappet of the present invention employes a hardened, iron-base, cam-face member moldingly attached to the body for wear-resistant driving contact, compatible with the surface of the engine cam formed of iron-based material having a hardened surface.

It is to be understood that the invention has been described with reference to specific embodiments, which provide the features and advantages previously described, and that such specific embodiments are susceptible of modification, as will be apparent to those skilled in the art. Accordingly, the foregoing description is not to be construed in a limiting sense.

CLAIMS

WHAT IS CLAIMED IS:

1. A hydraulic lash adjusting tappet (10) for use in the valve gear (18, 24) of an internal combustion engine (16), said tappet comprising:

body means (46),

a face member (54) defining a reaction surface (22) adapted for contacting a cam lobe (20), and

hydraulic lash adjusting means (64) operatively associated with said body means and including structure defining a reaction surface (68) adapted for contacting associated components (24) of the engine valve gear, said reaction surface movable with respect to said face member reaction surface for lash adjustment of said valve gear, characterized in that

said body means is formed of moldable material having a relatively high coefficient of thermal expansion such as aluminum or plastic; and

said face member is joined to said body means by molding of said body means about a portion of said face member.

2. The tappet defined in Claim 1 wherein said face member comprises a generally disc-shaped face portion (58) defining said reaction surface and a generally annular skirt portion (60) axially depending from said face portion entrained within said body means.

3. The tappet defined in Claim 1, wherein said body means structure is formed of material having a bulk density less than 2.85 grams per cm^3.

4. The tappet defined in Claim 1, wherein said face member is formed of steel and said body means is formed of material having coefficient of thermal expansion not substantially less than 22 x 10^{-6} per unit length per °C as measured in the range 20-100°C.

5. The tappet defined in Claim 1, wherein said face member defines retention surfaces (62) operative to react against the material of said body means thereadjacent for preventing relative movement therebetween.

6. A hydraulic lash adjusting tappet for use in the valve gear of an internal combustion engine, said tappet comprising:

body means formed of material having a coefficient of thermal expansion not substantially less than 22 x 10^{-6} per unit length per °C as measured in the range 20-100°C including structure defining,

(i) an outer annular wall (48),

(ii) an annular hub disposed (52) within said annular wall and spaced therefrom, and

(iii) a portion (56) interconnecting said wall and hub;

a face member defining a reaction surface adapted for contacting a cam lobe and joined to said body means by molding of said body means about a portion of said face member; and hydraulic lash adjusting means movably received within said hub and including structure defining a reaction surface adapted for contacting associated components of the engine valve gear, said reaction surface extending generally parallel to said face member reaction surface and movable with respect thereto for lash adjustment of said valve gear.

7. The tappet defined in Claim 6, wherein said face member is formed of steel and said body means outer wall, hub and interconnecting portion are formed of substantially plastic material.

8. The tappet defined in Claim 6, wherein said body means structure is formed of material having a bulk density less than 2.85 grams per cm^3.

9. The tappet defined in Claim 6 wherein said face member comprises a generally disc-shaped face portion defining said reaction surface and a generally annular skirt portion axially depending from said face portion entrained within said body means.

10. The tappet defined in Claim 9, wherein said skirt portion extends axially into said outer annular wall.

11. The tappet defined in Claim 9, wherein said skirt portion extends axially into said hub.

12. The tappet defined in Claim 9, wherein said skirt is substantially circumferentially continuous.

13. The tappet defined in Claim 9, wherein said skirt has at least one circumferential discontinuation (132).

14. The tappet defined in Claim 9, wherein said skirt defines retention surfaces operative to react against the material of said body means there-adjacent for preventing relative movement therebetween.

15. The tappet defined in Claim 14, wherein said retention surfaces comprise generally radially extending throughpassages (62).

16. The teppet of Claim 9, wherein said face portion is substantially co-extensive with the nominal cross-sectional area of the outer annular wall.

17. A hydraulic lash adjusting tappet for use in the valve gear of an internal combustion engine, said tappet comprising:

(a) body means including structure defining,

(i) an outer annular wall having a wear-resistant surface on the outer periphery thereof,

(ii) an annular hub disposed within said outer wall and spaced therefrom, said hub including an inner surface defining a bore,

(iii) an end wall attached respectively to and extending transversely across one axial end of said hub, and

(iv) web structure extending inwardly from said outer annular wall and supporting said hub, wherein said body means is formed of material having a coefficient of thermal expansion not substantially less than 22.0 x 10^{-6} per unit length per °C as measured in the range 10-100°C;

(b) a face member defining a reaction surface adapted to contact an engine cam, said face member further defining generally axially extending flange means circumscribing at least a portion of said surface and moldingly entrained within said body means radially outwardly of and encompassing said bore, said face member formed of material having a surface hardness value of at least 89 as measured on the Rockwell 15N scale for the reaction surface;

(c) hydraulic lash adjusting means movably received in said bore, said lash adjusting means including structure defining a reaction surface adapted for contacting associated valve gear components, said reaction surface extending generally parallel to said face member reaction surface and movable with respect thereto, said lash adjusting means including means defining a fluid pressure chamber (98) and plunger means including piston structure (72) cooperating with said end wall to form a first fluid portion (74) of a fluid reservoir, and said plunger means including plunger structure (68) cooperating with portions of said hub to form a second portion (86) of said fluid reservoir, and one-way valve means (78, 80) operable to admit fluid to said chamber for altering the position of said reaction surface with respect to said face member reaction surface, said lash adjusting means further including means (96) biasing said reaction surface away from said face member reaction surface, said body means including structure defining at least one bypass channel (88) operable to communicate said first reservoir portion with said second reservoir portion for all positions of said piston structure and said plunger structure in said hub;

(d) said body means including structure defining a fluid passage (90) through said annular wall from said wear resistant surface to said second reservoir portion for communicating fluid to said one-way valve means upon installation of said tappet in an engine and supplying pressurized fluid to said passage; and

(e) means (100) retaining said lash adjusting means in said hub.

18. The tappet defined in Claim 17, wherein said fluid passage defining structure includes a radial web extending between said outer tubular wall and said hub.

19. The tappet defined in Claim 17, wherein said body means structure is formed of material having a bulk density less than 2.85 grams per cm^3.

20. The tappet defined in Claim 17, wherein said face member is formed of steel and said body means, outer wall, hub and web are formed of substantially plastic or aluminum material.

21. A hydraulic lash adjusting tappet for use in the valve gear of an internal combustion engine, said tappet comprising:

body means formed of material having a

coefficient of thermal expansion not substantially less than 22 x 10^{-6} per unit length per °C as measured in the range 20-100°C;

a generally cup-shaped insert member defining a reaction surface adapted for contacting a cam lobe, said insert member further defining at least one recess for receiving body material therein to join said body means and said insert; and

hydraulic lash adjusting means operatively associated with said body means and including structure defining a reaction surface adapted for contacting associated components of the engine valve gear, said reaction surface movable with respect to said face member reaction surface for lash adjustment of said valve gear.

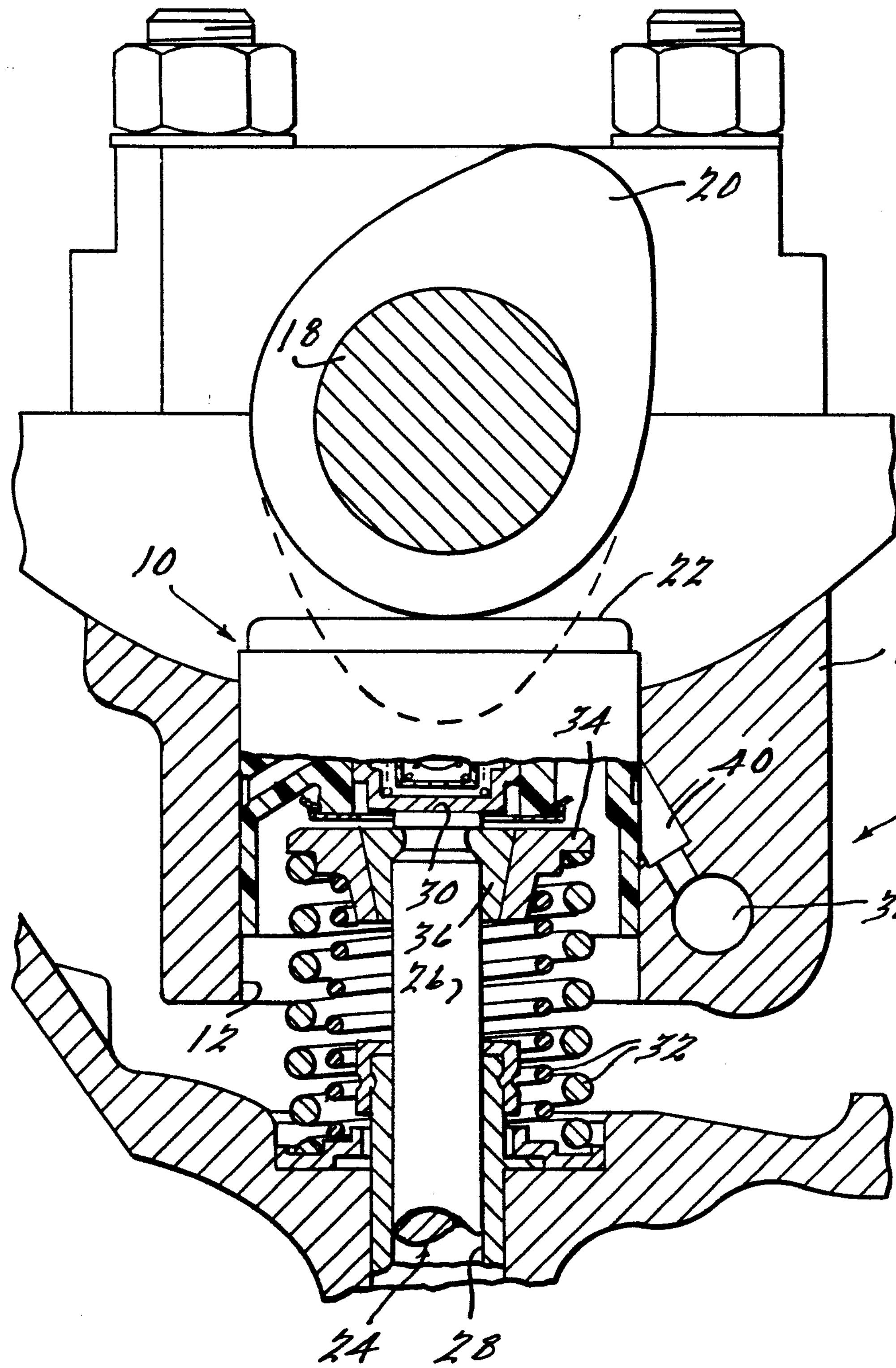

FIG. 1.

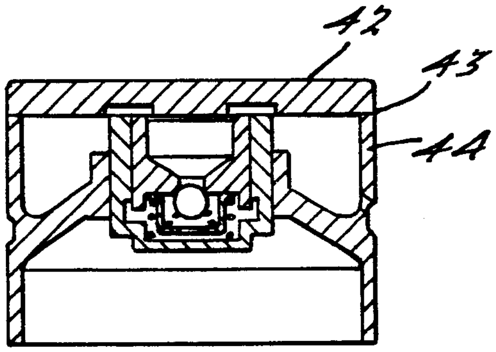

Fig. 2. Prior Art

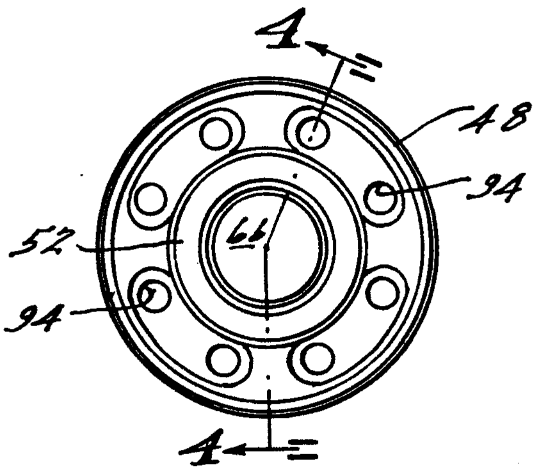

Fig. 3.

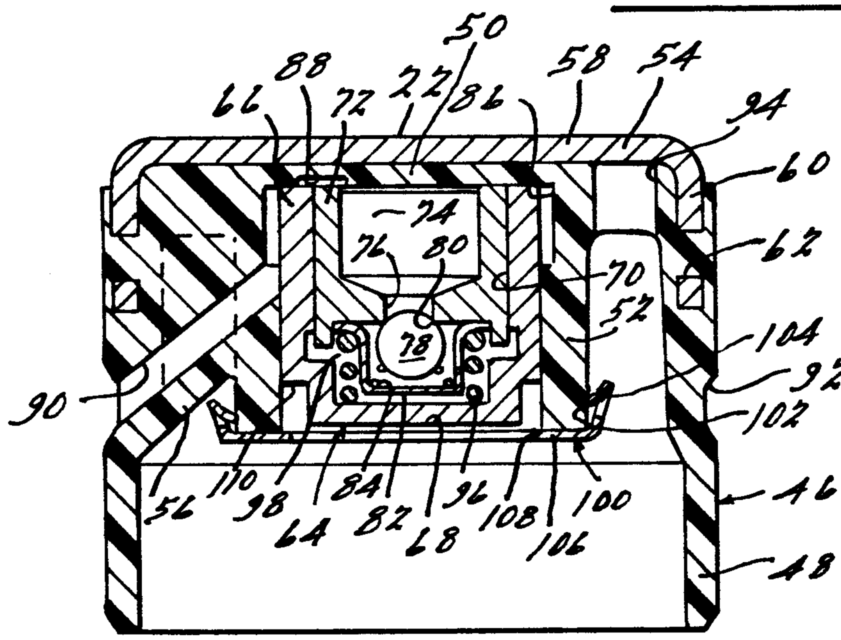

Fig. 4.

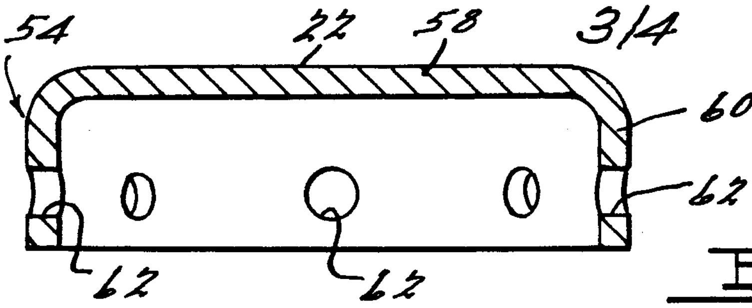

Fig.5.

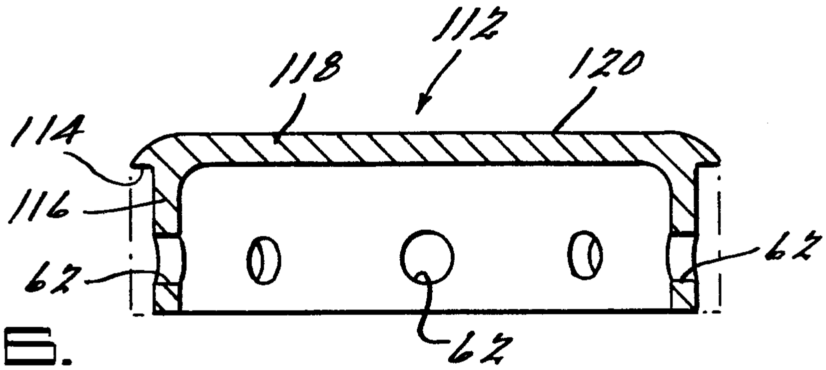

Fig.6.

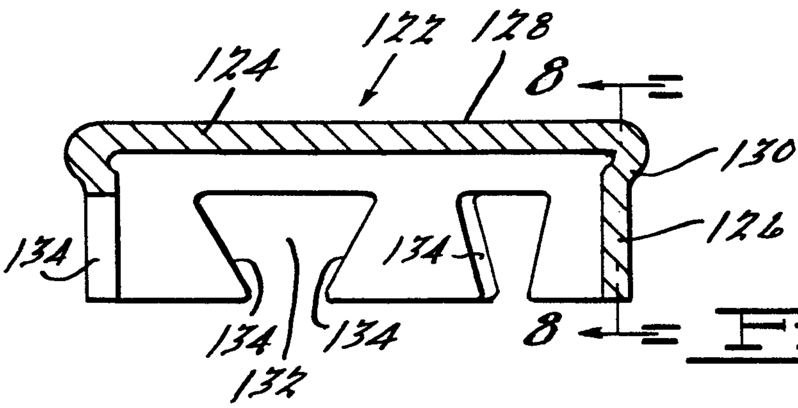

Fig.7.

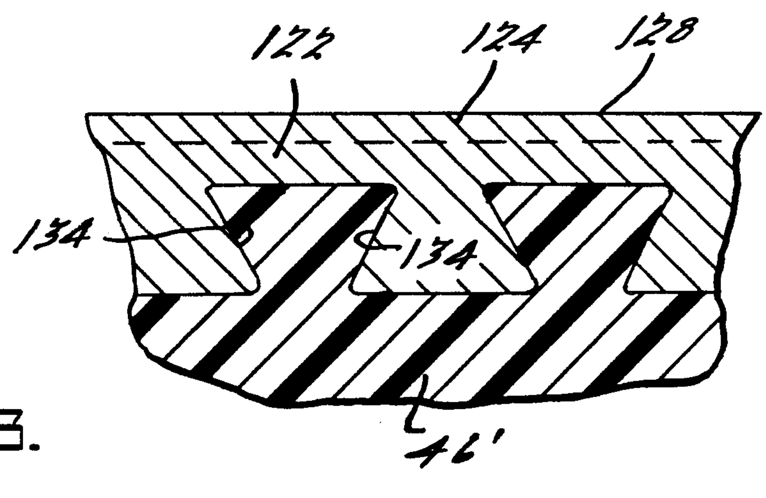

Fig.8.

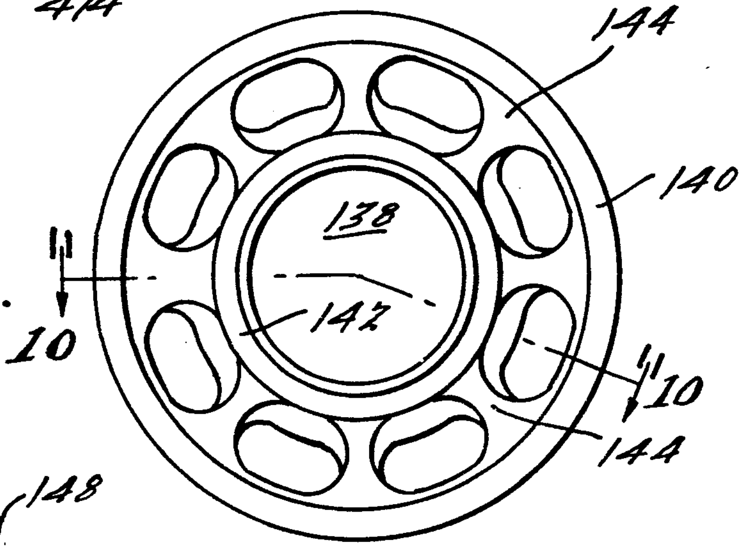

FIG. 9.

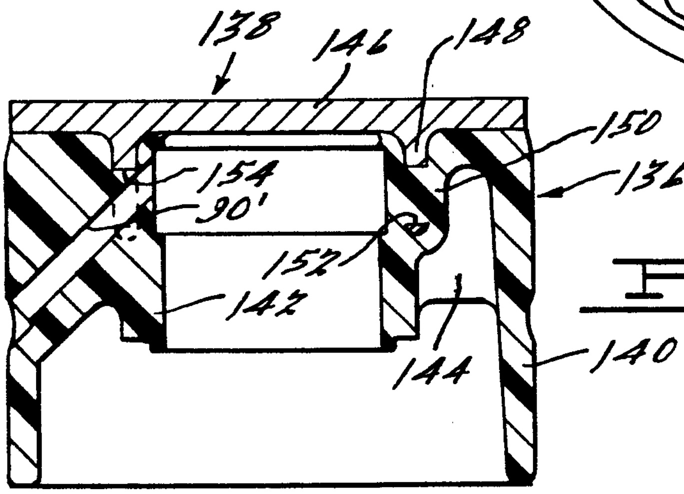

FIG. 10.

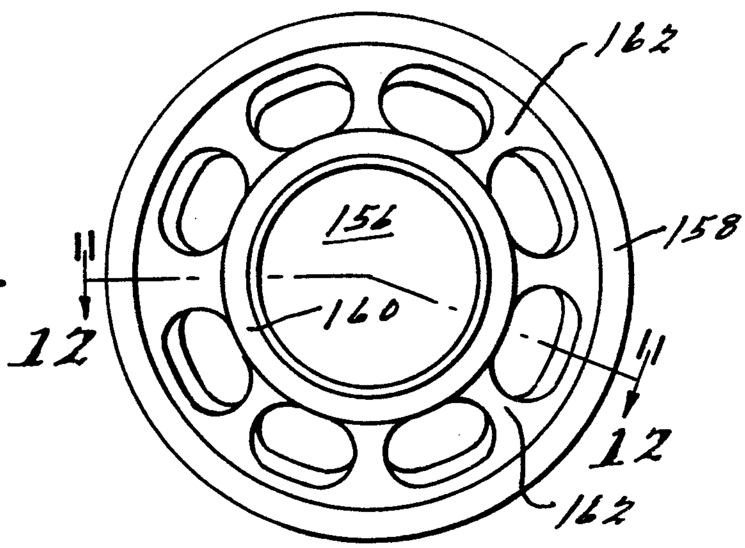

FIG. 11.

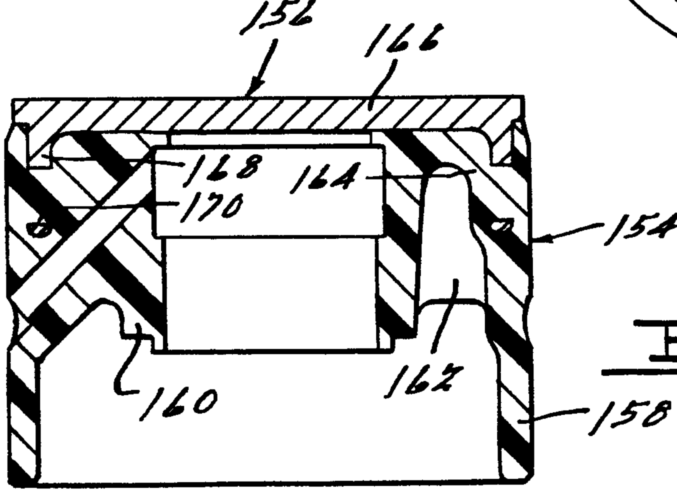

FIG. 12.