April 10, 1951 K. M. BARTLETT ET AL 2,548,092

COOLED HOLLOW ARTICLE

Filed Oct. 6, 1949

Fig. 1

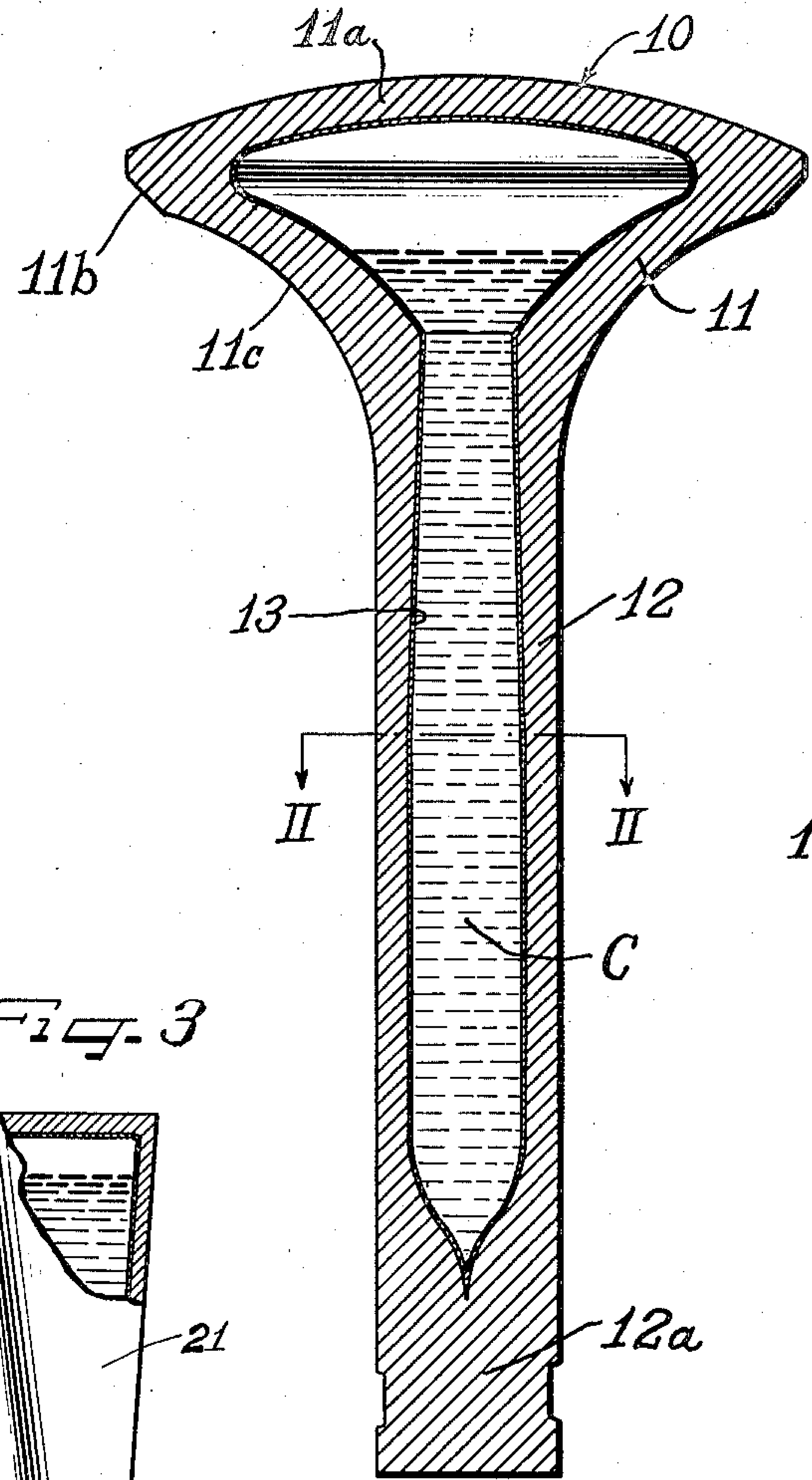


Fig. 2

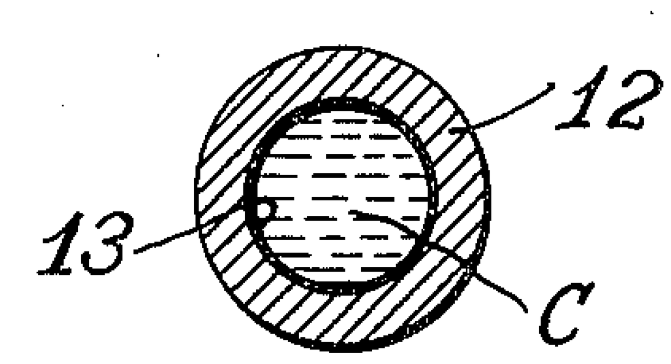
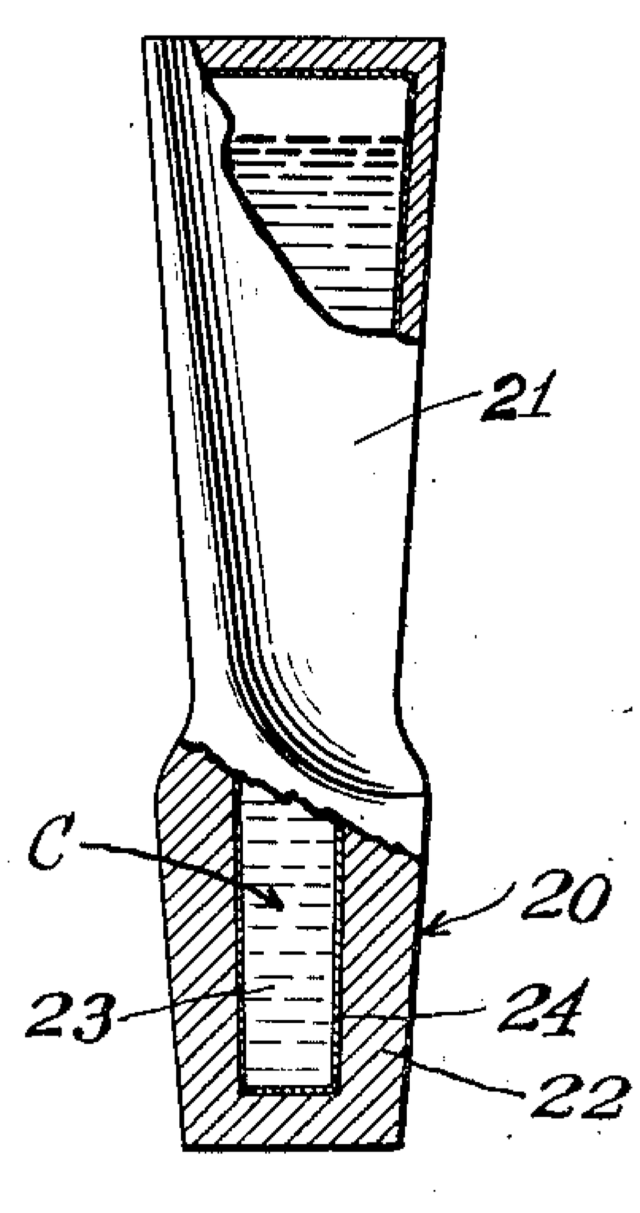


Fig. 3



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COOLED HOLLOW ARTICLE

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1

This invention relates to a coolant-filled hollow article, such as a poppet valve or turbine bucket, having an internal coating which increases the heat transfer rate between the body of the valve and the coolant.

Specifically, the invention deals with a sodium-cooled engine part, such as a poppet valve or turbine bucket, having a zinc-containing coating on the walls of the sodium chamber to increase the wettability of the sodium on the valve.

The invention will be hereinafter specifically described as embodied in a poppet valve, but is equally useful in coolant-filled hollow turbine buckets for gas turbine engines such as turbo-jet engines and the like engine parts.

Coolant-filled hollow poppet valves for internal combustion engines and the like are adapted to operate at high temperatures, because the coolant transfers heat from the valve head down through the valve stem, where it is dissipated to the valve guide and engine head or block. The efficiency of the coolant is greatly enhanced if it is capable of thoroughly wetting the valve.

We have now discovered that sodium, or a sodium-potassium eutectic, which are the most commonly used coolants in poppet valves, will not wet the valve body which is composed of a heat and corrosion-resistant steel.

The present invention now increases the cooling efficiency of sodium in a poppet valve by providing an interior valve surface which is thoroughly wet by the sodium during operation of the valve. This valve surface contains either zinc or silver, with zinc being preferred. The surface is applied as an electrodeposition, or by hot dipping, or by any other suitable coating process, and can be alloyed with other metals or the valve metal itself. Yellow brass is a suitable zinc-containing alloy. The sodium will wet the zinc or silver surface and, since this surface is integrally bonded to the valve body, the rate of heat transfer between the valve body and the sodium is materially enhanced.

We have further found that the corroding effect of sodium on the valve body is substantially minimized by the zinc or silver surface, thus increasing the life of the valve.

It is, therefore, an object of this invention to provide a sodium-filled metal article with an interior surface adapted to be wet by the sodium.

Another object of the invention is to improve the heat dissipation rate of sodium-filled engine parts by coating the interior of the parts with a metal that is easily wet by sodium.

A further object of the invention is to provide a sodium-filled engine part with an interior surface that is coated with zinc or silver.

A still further object of the invention is to provide a sodium-filled valve having a sodium

2

chamber coated with a thin layer of zinc in integrally bonded relation to the body of the valve.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheet of drawings which, by way of a preferred example only, illustrates one embodiment of the invention.

On the drawings:

Figure 1 is a longitudinal cross-sectional view of a sodium-filled poppet valve according to this invention.

Figure 2 is a transverse cross-sectional view of the valve of Figure 1 taken along the line II—II of Figure 1.

Figure 3 is an elevational view partly in longitudinal cross section, of a sodium-filled turbine bucket according to this invention.

As shown on the drawings:

The valve 10 of Figure 1 is composed of a hollow head portion 11 and a hollow stem portion 12. The head portion 11 has a dome 11*a*, a beveled seating face 11*b* around the periphery thereof, and a converging neck portion 11*c*. The stem portion merges into the neck portion and has a closed or solid tip end 12*a*.

As is customary in coolant-filled hollow poppet valves, the hollow interior of the valve is partially filled with a coolant C which is molten at the operating temperatures of the valve and effective to dissipate heat from the head portion down through the stem portion. The stem, being slidably mounted in a guide (not shown) will then dissipate the heat to the guide and to the engine block or head. Sodium is the preferred coolant.

In accordance with this invention, the hollow interior of the valve throughout both the head and stem portions is coated with a layer 13 of metal which will be wet by the coolant. Examples of such metals are zinc and silver. These two metals are wet by the molten sodium and the sodium will therefore more rapidly and thoroughly receive heat from the head and will more rapidly and more thoroughly dissipate this heat through the stem. The coating 13 is applied by electrodeposition, hot dipping, or any suitable method which will integrally bond the metal to the interior of the valve body.

We have discovered that the conventional valve steels, which are heat and corrosion resisting alloys, will not be wet by sodium at temperatures below 600° F. Since a valve stem should be maintained at temperatures below the decomposition temperature of the lubricating oil to prevent valve sticking and the like faulty valve operation, low temperature operation is highly desirable. However, if the heat transfer rate of the sodium valve wall interface is very low at these low temperatures, the sodium cooling effect is diminished.

Alloys having the following general formula are highly desirable for valve steels, because of their resistance to lead oxide corrosion:

	Per cent
Chromium	10 to 35
Columbium	0.1 to 5.0
Titanium	1.5 to 3.0
Aluminum	0.2 to 1.5
Iron	0.1 to 20.0
Silicon	.05 to 8.0
Carbon	0 to 0.25
Manganese	0.05 to 3.0
Nickel and/or cobalt	Balance

Other valve steels, less resistant to lead oxide corrosion, may have the following formula:

	Per cent
Nickel	14
Chromium	14
Tungsten	2.5
Carbon	0.35
Iron	Balance

We have further found that the provision of a good finish on the interior of the valve to prevent development of fatigue cracks, such as highly polished ground surfaces or electropolished surfaces are especially resistant to wetting by the sodium. Since the physical properties of these surfaces are essential to good valve design, it is, of course, highly important that the heat transfer rate between the sodium and valve body be increased.

Numerous surfaces have been tested for wettability by sodium below 600° F. The following surfaces are not wet by sodium below 600° F.:

(*a*) Electroplated nickel,
(*b*) Electroplated chromium,
(*c*) Electroplated tin,
(*d*) Electroplated cadmium,
(*e*) Electroplated lead,
(*f*) Electroplated cobalt,
(*g*) Electroplated copper,
(*h*) Nickel metal,
(*i*) Chromium metal,
(*j*) Aluminum,
(*k*) Magnesium,
(*l*) Titanium,
(*m*) Zirconium,
(*n*) Carbon.

It has been further found that electroplated zinc on valve steel will be wet 100% by sodium below 600° F. While some zinc may be dissolved by the sodium at elevated temperature, an effective zinc-containing surface was still intact after 72 hours at 1600° F.

The zinc coating can be a zinc containing material such as yellow brasses. A brass of the following general formula is useful:

	Per cent
Cu	69
Zn	30
Sn	1

Electroplated silver surfaces on valve steel are not quite as effective as zinc, but show a marked improvement in increasing the heat transfer rate between the valve body and the sodium. As in the case of zinc, the silver can be in the form of a silver alloy.

As indicated above, and as shown in Figure 3, the zinc or silver coatings are also useful in sodium cooled hollow turbine buckets. In Figure 3, the turbine bucket **20** has a hollow vane or blade portion **21** and a root portion **22** with a coolant

chamber **23** that communicates with the hollow interior of the vane. The root is anchored in a turbine wheel or a turbine stator ring (not shown) and is cooled by heat transfer to the mounting wheel or ring. The root in some installations may be exposed to a stream of cooling fluid such as air. The sodium coolant C partially fills the vane and root chambers to transfer heat from the vane to the root. The zinc or silver coating **24** covers the interior walls of the chambers.

From the above descriptions, it will be understood that this invention provides a poppet valve for internal combustion engines which has enhanced heat transfer capacity created by a coating of zinc or silver on the walls of the coolant chamber therein.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

We claim as our invention:

1. In a hollow sodium-filled article, the improvement which comprises a coating on the walls of the coolant chamber containing metal selected from the group consisting of zinc and silver and adapted to be wet by the sodium.

2. A coolant-filled hollow engine part of enhanced heat transfer capacity comprising a hollow metal body having a coolant chamber coated with zinc, and sodium sealed in the chamber adapted to wet the zinc.

3. A poppet valve comprising a valve body composed of heat and corrosion-resisting steel alloy and having a hollow head and a hollow stem portion defining a coolant chamber, the walls of said coolant-defining chamber having a film of zinc thereon, and sodium partially filling said chamber and adapted to wet the zinc.

4. A hollow turbine bucket comprising a metal turbine body having a vane portion with a coolant chamber and a root portion at one end of said vane having a coolant chamber communicating with said vane chamber, and a zinc containing lining in said chambers bonded to the turbine body.

5. The method of increasing the heat transfer rate of sodium-filled engine parts which comprises coating the sodium chamber of said parts with a metal selected from the group consisting of zinc and silver.

6. The method of increasing the heat dissipation capacity of a sodium-filled poppet valve which comprises electroplating a coating of metal selected from the group consisting of zinc and silver on the walls of the sodium chamber of said valve.

7. The method of increasing the heat dissipation capacity of a sodium-filled metal turbine bucket which comprises lining the coolant chamber wall thereof with zinc, and bonding the zinc to the turbine bucket metal.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,663,709	Kettering	Mar. 27, 1928
1,748,518	Midgley	Feb. 25, 1930
1,786,285	Bissell	Dec. 23, 1930
1,792,784	Trent	Feb. 17, 1931