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H. F. PRASSE ET AL
CAST VALVE SEAT INSERT
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2,742,356

Fig. 1

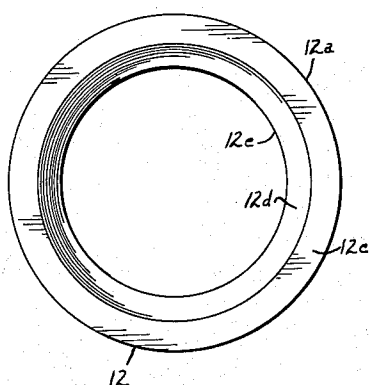


Fig. 3

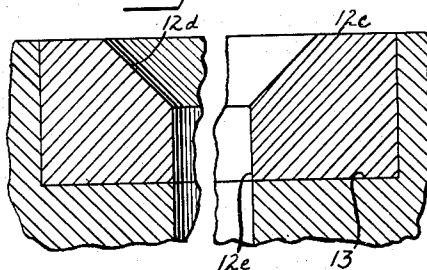


Fig. 4

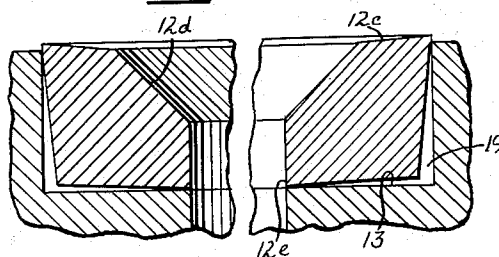


Fig. 2

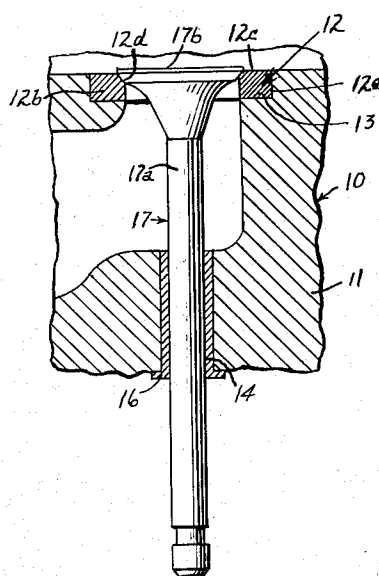
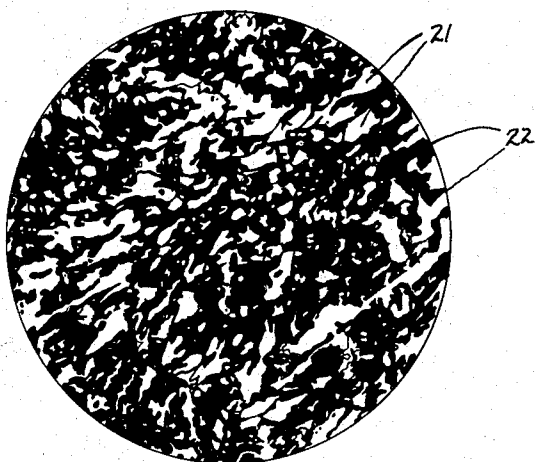


Fig. 5



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CAST VALVE SEAT INSERT

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4 Claims. (Cl. 75—171)

The present invention relates to valve seat inserts of the type employed in internal combustion engines.

While the valve seat insert is a relatively simple structure from a mechanical point of view, the metallurgical problems presented in attempting to provide a completely suitable valve seat insert for modern engines employing leaded gasolines are very substantial.

One of the primary problems of the selection of a suitable metal or alloy for use in valve seat inserts arises from what is known as "collapse" resistance.

It is known that when metals or alloys are heated to very high temperatures for extended periods of time, they will congeal or set in an expanded state and will not contract to their original dimensions when cooled. Since engine valve seat inserts are normally press-fitted in recesses in engine cylinder heads or blocks, the valve seat inserts become heated in the operation of the engine and may expand to a point where further expansion is restricted by the cylinder metal itself. When this point is reached, continued expansion due to increased temperatures will cause the insert to bow inwardly away from the restraining shoulder or wall of the engine head or block. If the bowed inserts reach the setting temperature and are then cooled from this temperature, the insert metal shrinks away from the insert recess and the insert becomes loose in the engine. The bowed and set inserts are known as "collapsed" inserts and the temperature at which such inserts take a permanent set is known as the "collapse" temperature.

In the past, valve seat inserts for the most part have been produced by expensive forging, machining, and heat treating procedures. The best of these prior known inserts had to be annealed, hardened, quenched, tempered, and drawn to a Rockwell hardness of about 35 on the C scale. The micro-structure of these inserts generally exhibited an aggregate of carbides with some martensite oriented in an interdendritic pattern and having some of the carbides in the grain boundaries and scattered throughout the matrix. This structure, however, did not provide adequate collapse resistance at temperatures above about 800° F. Since modern, high speed, high compression internal combustion engines frequently operate at temperatures which would cause the temperature of valve seat inserts to rise to above 800° F., collapsed inserts have presented a serious engine problem.

Another problem which manifests itself particularly in engines employing gasolines having a relatively high percentage of tetraethyl lead is that of surface resistance. A good insert must have a smooth face which resists deposit build up, corrosion, erosion, pitting, or excessive wear. Otherwise, an unsatisfactory seal will result between the valve seating face and the valve seat insert ring.

A characteristic possessed by a good valve insert ring is that of lack of affinity for the carbonaceous materials and lead deposits present in the combustion chamber. These materials tend to become deposited on valve seat insert rings and act as effective heat dams, thereby increasing the valve head temperatures.

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In line with the above, a good valve seat insert should also maintain its hot hardness properties, i. e., it should retain a substantial amount of its hardness even at the elevated temperatures at which the engine is operating. This ability to maintain its hardness governs to a large extent the degree of contact which can be maintained between the valve face and the valve seat insert at the operating temperatures of the engine.

The characteristics of the valve seat insert also have a pronounced effect upon the valve lash changes evident during operation of the engine. These changes accumulate in the valve train due to wear and the pounding down of the valve seat insert during use. It is desirable that the valve seat insert have characteristics which minimize these changes, as it is undesirable to make frequent adjustments on the valve lash during operation of the engine.

All of the above factors indicate that the problem of selecting a suitable alloy for valve seat insert rings is quite substantial.

In view of the foregoing, the need still remains in the art for a more satisfactory valve seat insert ring, and the satisfaction of that need is the primary object of the present invention.

Another object of the present invention is to provide an improved valve seat insert ring which is less expensive and more convenient to manufacture than the type of valve seat insert rings being presently employed in many types of internal combustion engines.

Other and further objects of this invention will be apparent to those skilled in the art in the foregoing detail description of the annexed sheet of drawings which, by way of example only, illustrates a valve seat insert of this invention.

On the drawings:

Figure 1 is a plan view of the valve seat insert ring of the present invention;

Figure 2 is a fragmentary view, with parts in elevation, of the valve port area of an internal combustion engine, showing the valve seat insert in its normal condition;

Figure 3 is a greatly enlarged fragmentary view of the valve port area, illustrating the insert ring in its normal condition;

Figure 4 is a view similar to Figure 3, but illustrating the ring in its "collapsed" condition;

Figure 5 is a graphic reproduction of a micro-structure of the alloy constituting the insert, at a magnification of about 500 times.

As shown on the drawings:

From Figures 1 to 4, it will be seen that the engine valve port assembly 10 may include an engine block or cylinder head 11 normally composed of cast iron, and a cast valve seat insert 12 press fitted into a recess 13 of the engine block or cylinder head 11. A bore 14 concentric with the recess 13 is provided to receive a valve stem guide 16 in the usual manner. A valve 17 is shown in seated relation in the valve seat insert ring 12 (Fig. 2), the valve 17 having a stem 17a slidably received within the valve stem guide 16.

The valve seat insert ring 12 may consist of a ring having a cylindrical outer peripheral wall 12a, a flat bottom 12b, a flat top 12c and a tapered seating face 12d converging from the flat top 12c to a cylindrical inner peripheral wall 12e.

The peripheral wall 12a is in snug fitting relation with the vertical wall of the recess 13 and is preferably press fitted or shrink fitted into the recess 13 with the flat bottom 12b of the insert being seated upon the bottom of the recess 13. As evident from Figure 2, the tapered seating face 12d is arranged to receive the tapered stem 17b on the valve 17.

In normal operation, the valve seat insert ring 12 main-

tains its tight fit in the recess 13 and expands to substantially the same degree as the metal in which the recess 13 is formed. However, when the valve seat insert 12 is heated to a point where it can expand no further due to the restraining effect of the walls of the recess, it may become bowed as illustrated in Figure 4. This bowing may create a gap illustrated at 19 in an exaggerated form in Figure 4. If the insert 12 is "collapsed" in the condition shown in Figure 4, then the gap 19 will remain void under lower operating temperatures. As a result, the insert 12 will remain loose in the recess 13.

We have now found that the "collapse" temperature of valve seat inserts can be increased, and other desirable properties of the inserts enhanced by employing a cast valve seat insert having the following composition:

	Percent
Carbon	2.25 to 2.75
Nickel	37 to 43
Chromium	18 to 22
Cobalt	10 to 14
Tungsten, molybdenum or mixtures thereof....	5 to 7
Iron.....	Substantially the balance

A particularly preferred composition for valve insert rings has the following analysis:

	Percent
Carbon	2.5
Nickel	40
Chromium	20
Cobalt	12
Tungsten	6
Iron.....	Substantially the balance

For the purposes of this invention, molybdenum and tungsten are substantially interchangeable. Where the hardness of the insert is of prime importance, tungsten alone may be employed as in the above preferred composition. Where toughness is the objective, molybdenum alone may be used. If desired, a mixture of the two metals may be used to secure the benefit of each, as in the following composition:

	Percent
Carbon	2.5
Nickel	40
Chromium	20
Cobalt	12
Tungsten	3
Molybdenum	3
Iron.....	Substantially the balance

The alloys of the above compositions may be melted and cast in suitable molds for producing the insert ring 12. The casting process employed may include conventional sand casting, shell molding, investment casting, or other casting techniques capable of producing smooth, accurate castings free from cracks, blow holes, shrinks and the like.

The cast insert rings need no special heat treatment, making them considerably easier and less expensive to manufacture than commonly used insert rings which frequently require hardening and drawing steps incident to their manufacture.

The micro-structure of the finished valve seat insert rings is illustrated in Figure 5 of the drawings. It will be observed that the structure may include dendrites 21 surrounded by a solid solution 22 consisting of an eutectic matrix.

A convenient "collapse" test for the rings consists in inserting the ring under test in cast iron cup receiving a high frequency induction coil in the hollow interior of the ring. The cast iron cup is surrounded by a water ring. The insert is then intermittently heated by the induction coil and cooled by a water spray on the cast cup.

The insert is heated first to about 300° F. for several hundred cycles of operation. It is then cooled and checked for looseness. The temperature is then increased in 25° increments and the heating is repeated for several hundred cycles. The procedure is continued until the insert under test loosens in the cast iron cup. The final temperature is then recorded as the loosening temperature or "collapse" temperature. The "collapse" resistance of four insert rings having compositions within the ranges given previously was measured with the following results:

Initial Interference	Decrease Insert, O. D.	Decrease Insert, I. D.	Increase Fixture, I. D.	Cycles to Loosen	Final Temp. ° F.
.0030	.0031	.0023	.0001	4,200	1,075
.0030	.0048	.0034	.0001	4,500	1,100
.0039	.0060	.0030	.0003	5,400	1,175
.0036	.0067	.0030	.0002	4,500	1,100

The resistance of the insert rings to corrosion by lead oxide was determined in a standard test in which the samples are packed in lead oxide and maintained at a temperature of 1675° F. for one hour in an oxidizing atmosphere. The decrease in weight after the test, expressed in grams per square decimeter, is taken as the lead oxide corrosion loss. When tested under the conditions given, valve seat insert rings having compositions within the ranges indicated above showed an average loss of only 3.5 grams per square decimeter. In contrast, samples of various commercial valve seat inserts of compositions different from that of the present inventions lost up to several hundred grams per square decimeter under the identical test conditions.

In addition to the foregoing, valve seat inserts made in accordance with the present invention did not accumulate a significant amount of combustion chamber deposits on their faces and evidenced no measurable loss in hardness at the operating temperature of the engine. This, again, was in marked contrast to several commercial valve seat inserts which had a substantial affinity for the combustion chamber deposits and lost a substantial amount of their strength at the operating temperature of the engine.

A very significant advantage of the present invention arises from the valve lash properties observed when valve seat inserts of the present invention are employed in operating engines. In one such test, a heavy duty truck engine was provided with several valve seat insert rings produced according to the present invention in several of its cylinders. The accumulated lash change in the cylinders after 400 hours of operation was an increase of 0.004 inch. In other cylinders, high nickel alloy insert rings containing 58.7% nickel, 26% chromium, about 4% iron, and about 2.0% carbon were employed. The accumulated valve lash change for these inserts, in the same test, was in excess of 0.010 inch.

From the foregoing, it will be appreciated that the valve seat inserts of the present invention have exceptional resistance to collapse, resistance to lash loss, and excellent corrosion resistance. The additional properties of good hot strength and resistance to deposits make the alloys of the present invention considerably more satisfactory for the intended use than heretofore known more expensive inserts.

While the alloy of the present invention has properties making it particularly suitable in the manufacture of valve seat inserts, it will be appreciated that the alloy will have more general applicability for articles requiring wear and corrosion resistance properties.

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

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We claim as our invention:

1. A cast valve seat insert comprising a ring having the following composition:

	Percent	
Carbon	2.25 to 2.75	5
Nickel	37 to 43	
Chromium	18 to 22	
Cobalt	10 to 14	
Metal selected from the group consisting of tungsten, molybdenum, and mixtures thereof..		
Iron.....	5 to 7	10
	Substantially the balance	

2. A cast valve seat insert comprising a ring having the following composition:

	Percent	
Carbon	2.5	15
Nickel	40	
Chromium	20	
Cobalt	12	
Tungsten	6	20
Iron.....	Substantially the balance	

3. The method of making a valve seat insert having enhanced wear resisting and corrosion resisting properties which comprises forming a molten mixture of the following composition:

	Percent	
Carbon	2.25 to 2.75	
Nickel	37 to 43	
Chromium	18 to 22	
Cobalt	10 to 14	30

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Metal selected from the group consisting of tungsten, molybdenum, and mixtures thereof.. 5 to 7
Iron..... Substantially the balance

and casting said mixture into the shape of a ring.

4. A method of making a valve seat insert having enhanced wear resisting and corrosion resisting properties which comprises forming a molten mixture of the following composition:

	Percent	
Carbon	2.5	
Nickel	40	
Chromium	20	
Cobalt	12	
Tungsten	6	
Iron.....	Substantially the balance	

and casting said mixture into the shape of a ring.

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