United States Patent

Lesher

[15] **3,683,876**

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[54] **SINTERED METAL TAPPET**

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[21] Appl. No.: **44,206**

[52] **U.S. Cl.** ....**123/90.51,** 123/90.33, 123/90.35, 123/90.55, 29/156.7 B

[51] **Int. Cl.**............**F01l 1/14,** F01l 1/24, F01m 9/10

[58] **Field of Search**..123/90.51, 90.55, 90.33, 90.35; 29/156.7 B

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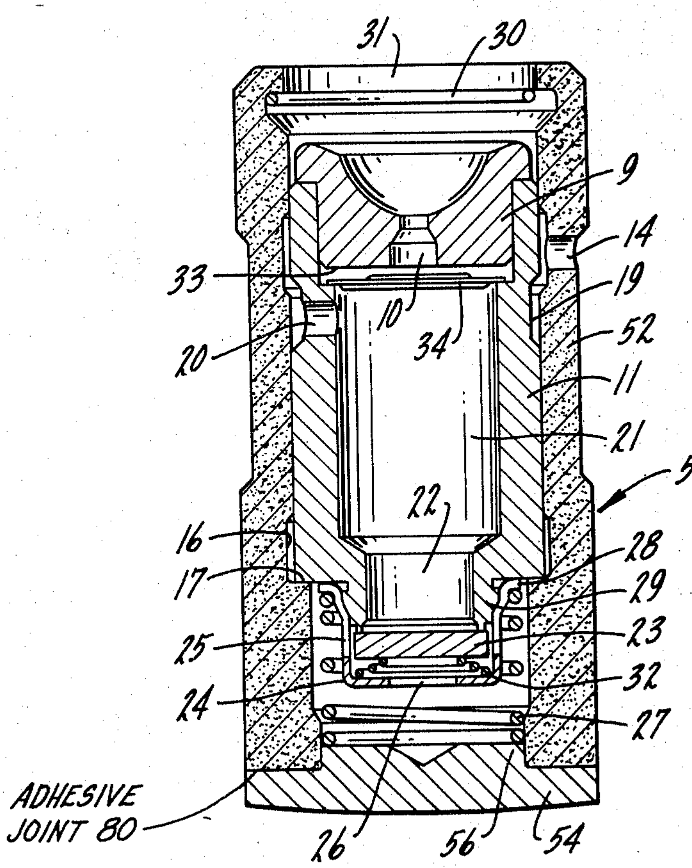
[57] **ABSTRACT**

A hydraulic tappet in which the barrel is formed of powdered metal, sintered and compacted to a density permitting fluid from within the barrel to pass to the barrel exterior to provide lubrication therefor. The cam face of the tappet barrel may be a sintered component infiltrated with a hardening agent, or it may be formed by a cast iron disc suitably attached to the barrel. The cam face may also be a separate sintered metal disc, again suitably attached to the tappet barrel.

15 Claims, 8 Drawing Figures



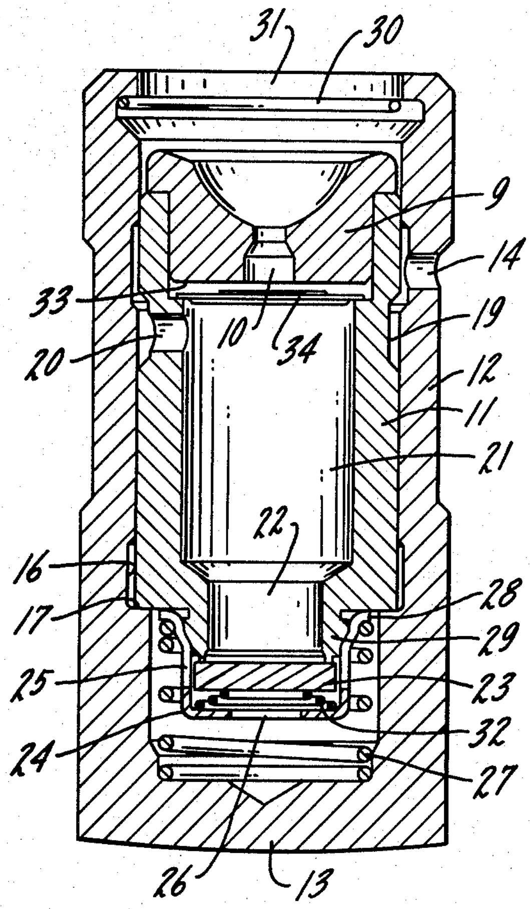


Fig.1.

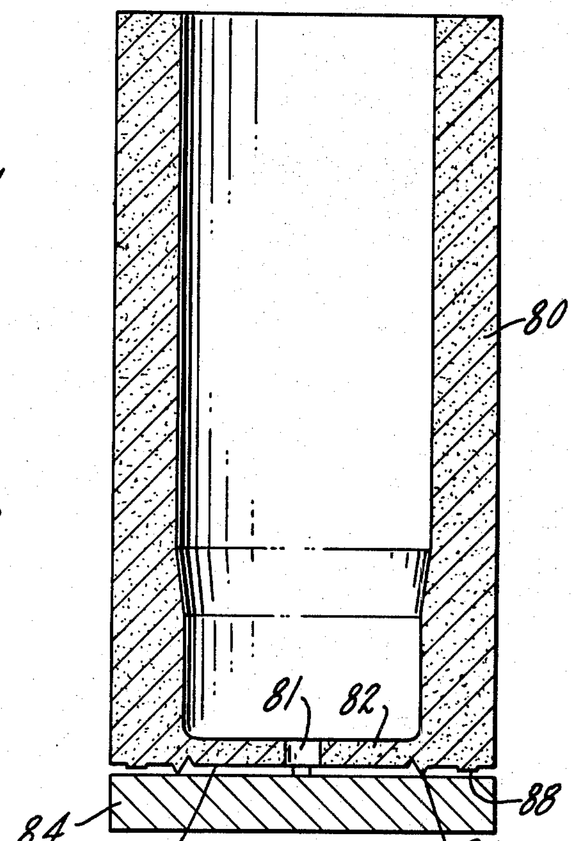


Fig.6.

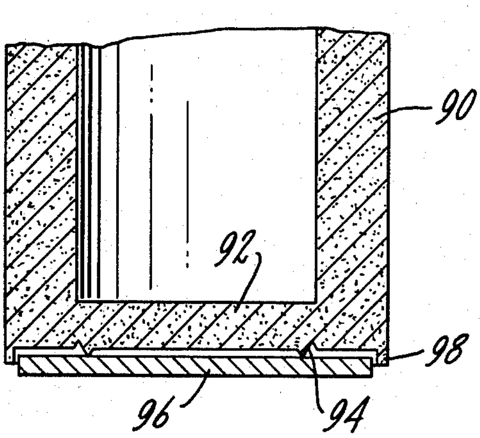


Fig.7.

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Fig. 2.

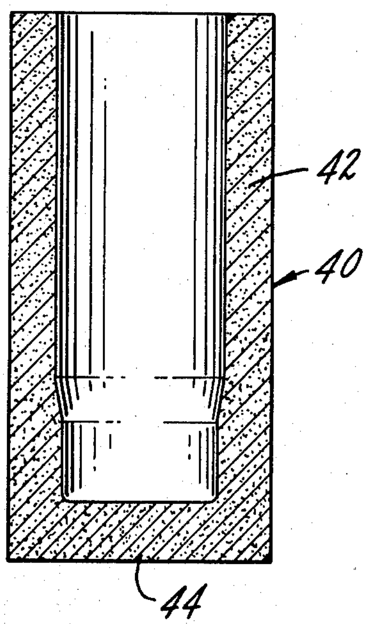


Fig. 3.

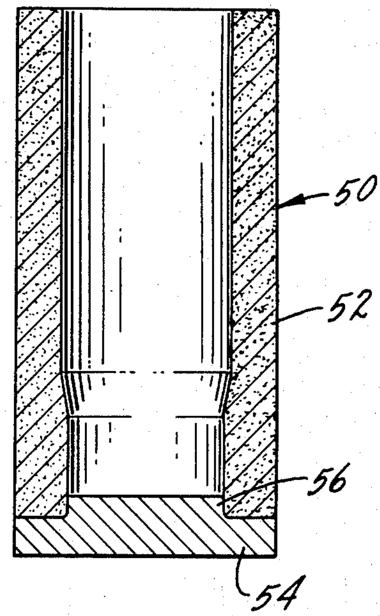


Fig. 4.

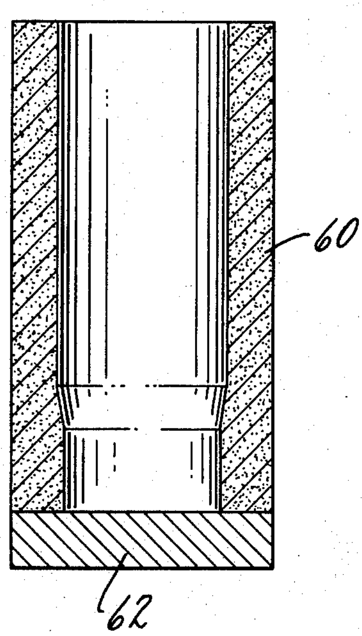
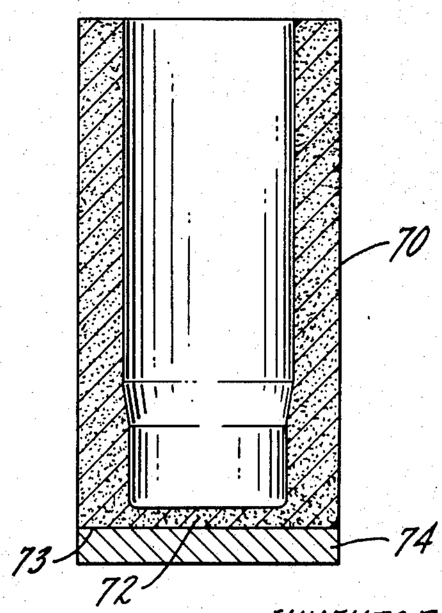


Fig. 5.



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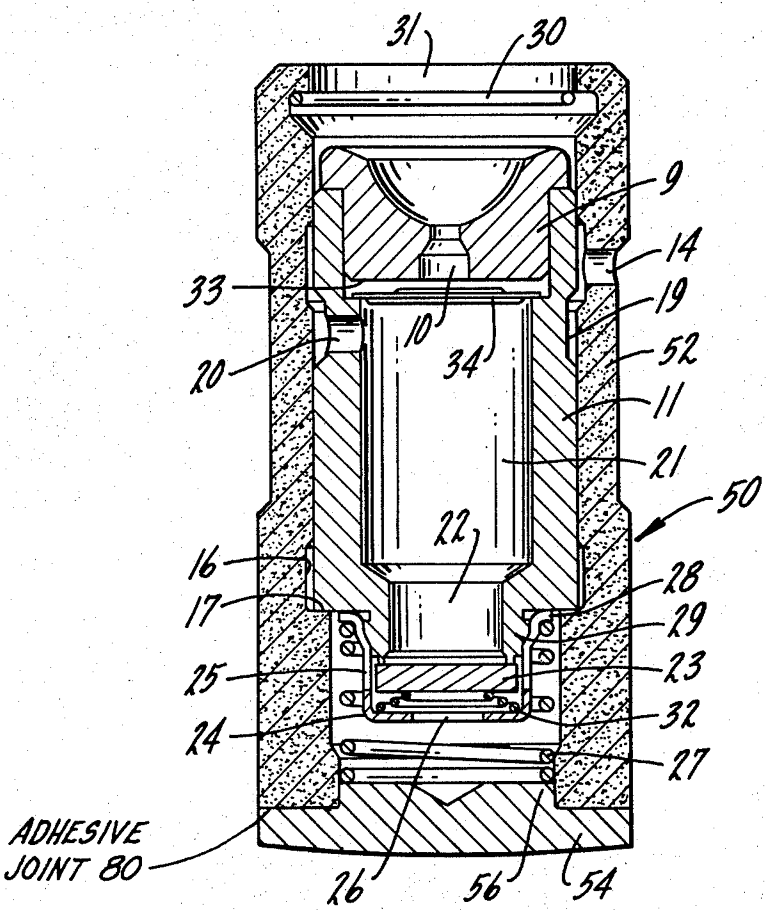
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Fig.8.

SINTERED METAL TAPPET

Summary of the Invention

This invention relates to hydraulic tappets and in particular to a tappet having a barrel formed of powdered metal.

A primary purpose of the invention is a tappet barrel formed of powdered metal having a controlled porosity so that fluid from within the barrel may pass to the exterior to provide lubrication therefor.

Another purpose is a hydraulic tappet having a sintered metal barrel and a sintered metal cam face, with the cam face being impregnated with a suitable hardening agent.

Another purpose is a hydraulic tappet having a sintered metal barrel and a cast iron cam face, with the cam face being attached to the barrel by an adhesive.

Another purpose is a hydraulic tappet having a sintered metal barrel and cast iron cam face, with the cam face being attached to the barrel by brazing.

Another purpose is a hydraulic tappet having a sintered metal barrel and a sintered metal cam face, with the cam face being formed as a separate disc and suitably attached to the barrel.

Other purposes will appear in the ensuing specification, drawings and claims.

Brief Description of the Drawings

The invention is illustrated diagrammatically in the following drawings wherein:

FIG. **1** is a section through a hydraulic tappet,

FIG. **2** is a section through a tappet barrel, prior to machining,

FIG. **3** is a section, similar to FIG. **2**, showing a modified form of tappet barrel,

FIG. **4** is a section, similar to FIGS. **2** and **3**, showing a further modified form of tappet barrel,

FIG. **5** is a section, similar to FIGS. **2**, **3** and **4**, showing an additional form of tappet barrel,

FIG. **6** is a section illustrating still a further form of tappet barrel,

FIG. **7** is a section illustrating a modified form of tappet barrel, and

FIG. **8** is a section through a hydraulic tappet, similar to FIG. **1**, showing the modified form of tappet barrel illustrated in FIG. **3**.

Description of the Preferred Embodiment

The invention will be described in connection with a particular tappet construction. Obviously, the invention should not be so limited as sintered metal barrels may be used on various hydraulic tappet configurations.

The tappet of FIG. **1** includes a hollow plunger **11** reciprocally mounted within a barrel **12** having a closed bottom or closed end **13**. The barrel **12** has an opening **14** to permit engine lubricant to enter into the tappet. The barrel is enlarged at **16** and has a shoulder **17**, with the shoulder forming a seat for the plunger.

The plunger may have a groove or channel **19** intermediate its ends, with an opening **20** connecting the groove **19** with the hollow interior **21** of the plunger.

A passage **22** in the inner end of the tappet plunger may be closed by a valve **23** held in position against the plunger end by a valve cage **24** having openings **25** in its sides. The valve cage has an open bottom **26**.

A coil spring **27**, positioned within the barrel **12** and beneath the plunger **11**, bears against a flange **28** of the valve cage **24** and is biased to move the plunger away from the closed bottom **13** of the barrel. Although the valve cage **24** is positioned about a reduced extension **29** of the plunger **11** with a press fit, should any looseness occur, it will be held in position by contact of the spring **27** with the flange **28**. A coil spring **32** may be positioned between the disc **23** and an adjacent portion of the valve cage **24**. The spring **32** is effective to move the valve **23** to the seating position of FIG. **1**.

A locking ring **30** is positioned in a suitable groove adjacent the open end **31** of the tappet barrel **12** and prevents accidental displacement of the plunger from the barrel.

A cap **9** is seated upon the open end of the plunger **11** and has an open upper end for contact by the engine push rod. A passage **10** in the cap **9** may be used to provide lubricant to the bottom end of the push rod. The push rod is hollow, providing a lubrication passage for the rocker arm and valve. The bottom of the cap **9** has a flat seat **33** against which the seating portion of a disc **34** is adapted to be positioned to provide a metering of fluid from within the plunger **11** to the bottom of the push rod seated in the open upper end of the cap **9**.

Further details and description of the operation of the above-described tappet can be found in my U. S. Pat. No. 3,439,660 issued Apr. 22, 1969.

The tappet barrels illustrated in FIGS. **2–7** are shown after their formation, but prior to machining. Hence, the opening **14**, the groove **16**, the shoulder **17** and other structural features of the finished tappet barrel are not illustrated.

In FIG. **2**, the tappet barrel **40** has a sleeve portion **42** and an end portion **44**. The sleeve portion is formed of powdered metal, sintered and compacted to a suitable density. One example of a suitable combination of materials for the sleeve **42** is to use powdered metal made up of 98 percent iron, 1.0 percent carbon and 1.0 percent copper. The powdered metal should be compacted and sintered until it has a density of approximately 6.8 grams per cubic centimeter. With such a density there may be a degree of porosity to the tappet sleeve such that fluid from within the barrel can seep through or pass through the sleeve until it reaches the exterior to provide lubrication for the exterior of the tappet barrel. Such lubrication is more effective when there is pressure on the fluid within the tappet barrel, or when the engine is in actual use; however, there will be some seepage of fluid when the engine is not operating. The porosity is not so great as to inhibit normal operation of the tappet because of excessive leakage from either the high pressure or low pressure chamber.

The end portion **44** of the barrel **40**, which provides the cam face for the tappet, is also formed of powdered metal and will be formed with the tappet barrel or in the same sintering process. A suitable hardening agent, for example a silicon boron material, placed preferentially in the area of the cam face and constituting approximately 10 percent of the total weight of all of the powdered metal used for the barrel, has been found to provide a satisfactory cam face. The cross-hatch lines near the bottom of FIG. **2** are closely spaced together to indicate a greater density in the area of the cam face as contrasted with the other portions of the tappet barrel.

In FIG. 3 a tappet barrel **50** may have a sleeve **52** and an end cap or end portion **54**. The cap **54** has a boss **56** which extends upwardly within the sleeve **52** for use in positioning the cap upon the sleeve.

In FIG. 4 a sleeve **60** may have its open end closed by a cap **62**.

In FIG. 5 a sleeve **70** may have a closed end **72**. A disc **74** is attached to surface **73** of closed end **72** to provide the cam face for the tappet barrel.

In FIGS. 3, 4 and 5, the sleeve may be formed of powdered metal of generally the same material components and proportions described in connection with the sleeve of FIG. 2. The caps **54**, **62**, and **74** are formed of cast iron having a preferential material component relationship of 92.2 percent iron, 3.5 percent carbon, 2.20 percent silicon, 1.10 percent chromium, 0.80 percent manganese, 0.50 percent nickel and 0.50 percent molybdenum.

In FIG. 6, a sleeve **80** may have a closed end **82**. A disc **84** is attached to surface **83** of closed end **82** to provide the cam face for the tappet barrel. The sleeve **80** and the closed end **82** may be sintered metal and of the same material components and proportions as described in connection with the other forms of sintered metal sleeves.

In FIG. 7 a sleeve **90** has a closed end **92** with weld abutments **94** projecting therefrom. A disc **96** is positioned on the abutments **94** and is partially enclosed by a shoulder **98** extending outwardly from the sleeve **90**. Sleeve **90** and its closed end **92** may be sintered metal and of the same composition described in connection with the other sleeves. The disc **96** may also be sintered metal, but formed separately from the sleeve. For example, a disc made up of 0.80 percent manganese, 3.0 percent carbon, 2.50 percent silicon, 1.0 percent chromium, 0.50 percent molybdenum and 0.50 percent nickel, and the balance iron, has been found to provide a satisfactory cam face. The powdered metal used for the disc **94** should be of a suitable screen analysis which, when compacted, will have a density of about 5.4 grams per cubic centimeter. The above analysis may be achieved by using either pure elements or by a suitable mixture of ferro-alloys.

The cast iron cap of FIG. 3 may be secured to the sintered metal sleeve in various ways. In one method, an adhesive is used to secure the cap to the sleeve. For example, a two-component epoxy-type adhesive has been found to be satisfactory. Also, single cure materials such as an anerobic material sold under the trademark "Loctite" have been found to be satisfactory.

FIG. **8** illustrates the tappet sleeve construction of FIG. **3** as applied to the particular tappet construction of FIG. **1**. Like parts have been identified by like numbers. The adhesive joined between the cast iron cap **54** and the sleeve **50** is illustrated at **80**.

In forming the structure of FIGS. **4**, **5** and **6**, a copper manganese sintered alloy, which gets slushy at approximately 2,050° F., the sintering temperature employed in forming the barrel, is used to control the porosity of the barrel. A small amount of this alloy is applied to the barrel end during the sintering operation so that during subsequent brazing using lower temperature melting alloys, there will be no tendency for the brazing material to flow into the barrel and thus prevent a firm bond between the barrel and disc.

Various brazing compounds and methods, for example either furnace or induction heating, may be used to join the cap to the barrel in FIGS. **4** and **5**. In one variation of the brazing method shown in FIG. **6** the disc **84** is placed against weld projections **86** on body **80** and the two members are welded together. During the welding operation, the cast disc will settle against weld abutments **88**, thereby leaving a space between the disc and the body. This space, preferably 0.001 to 0.004 inch thick, will serve as a suitable passageway to be filled with a braze material. The braze material is placed in the bottom of the closed cavity of body **80**, and melted by some suitable means to flow through hole **81** in the bottom of the cavity and out into the space between end **82** and disc **84**. The braze material should be powdered and made up of suitable combinations of iron, nickel, cobalt and phosphorous copper and the heating should be accomplished at a suitable temperature for **10** to **30** minutes. Heating at a temperature of 1,850° F. for 20 minutes has been found to be satisfactory.

In FIG. **7** the disc **96** will initially be placed so that it lies against the weld projections **94**. Heat will be locally applied to the weld projections to spot weld the disc to surface **92**. Subsequently, the disc **96** is melted onto the sleeve by induction heating, for example in an atmosphere of argon gas.

In the barrel construction of FIG. **2**, because the end portion **44** is also formed of powdered metal sintered to a desired degree of hardness, there will be some passage of oil from the barrel interior to the cam face. Such a passage of oil will provide cam face lubrication during engine operation.

In U. S. Pat. No. 3,124,869, issued to Robert C. Behnke, a low carbon steel tappet body has a powdered metal wearing disc applied to the cam face. However, such a construction does not provide lubrication along the sides of the tappet barrel or at the cam face. The steel sleeve and end section would prevent any passage of oil to the barrel exterior. Only by making the entire end of the barrel of sintered metal will the porosity of the barrel permit exterior lubrication.

Although certain percentages of ingredients have been described in connection with the powdered metal sleeve, as well as the discs forming the cam face for the tappet barrel, the invention should not be limited to the precise material compositions described.

Whereas the preferred form of the invention has been shown and described herein, it should be realized that there may be many modifications, alterations and substitutions thereto.

I claim:

1. In a hydraulic tappet, a barrel including a sleeve portion and an end portion, with the end portion forming a cam face for contact with a rotating cam shaft, means within the barrel for providing an operative connection between the cam shaft and an engine push rod, the sleeve portion of the barrel, throughout its length, having a density permitting fluid from within the barrel to pass through the sleeve to provide lubrication on the exterior thereof.

2. The structure of claim **1** further characterized in that the sleeve is formed of sintered metal.

3. The structure of claim **1** further characterized in that the density of the sleeve is in the area of 6.8 grams per cubic centimeter.

4. The structure of claim 1 further characterized in that said barrel end portion is formed of sintered metal infiltrated with a hardening agent.

5. The structure of claim 4 further characterized in that said barrel end portion is infiltrated with a silicon boron material, preferentially positioned adjacent the cam face.

6. The structure of claim 5 further characterized in that said silicon boron material constitutes approximately 10 percent of the weight of all material in the barrel.

7. The structure of claim 1 further characterized in that said barrel end portion is formed by a separate cast iron disc attached to the sleeve.

8. The structure of claim 7 further characterized in that said cast iron disc includes a major portion of iron and relatively minor portions of carbon, silicon, chromium, nickel and molybdenum.

9. The structure of claim 8 further characterized in that said cast iron disc includes approximately 92.2 percent iron, 3.5 percent carbon, 2.20 percent silicon, 1.10 percent chromium, 0.50 percent nickel and 0.50 percent molybdenum.

10. The structure of claim 7 further characterized in that said disc is brazed onto said sleeve.

11. The structure of claim 7 further characterized in that said disc is adhesively secured to said sleeve.

12. The structure of claim 1 further characterized in that said barrel end portion is formed by a separate disc of sintered metal, attached to the sleeve.

13. The structure of claim 12 further characterized in that said sintered metal disc includes a major portion of iron and minor portions of carbon, manganese, silicon, chromium, molybdenum and nickel.

14. The structure of claim 13 further characterized in that said sintered metal disc includes approximately 0.80 percent manganese, 3.0 percent carbon, 2.50 percent silicon, 1.0 percent chromium, 0.50 percent molybdenum and 0.50 percent nickel.

15. The structure of claim 14 further characterized in that the density of the sintered metal disc, after compaction, is in the area of 5.4 grams per cubic centimeter.

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