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[54] **SPONGE IRON FRICTION MATERIAL**

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[51] Int. Cl. **C08g 51/08**

[58] Field of Search 106/36, 290, 260/DIG. 39, 260/38

[56] **References Cited**

UNITED STATES PATENTS

2,861,964	[illegible]	[illegible]	[illegible]
3,168,487	2/1965	Spokes	106/36
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[57] **ABSTRACT**

A semi-metallic friction material for use in a vehicle brake as a friction lining or pad. The semi-metallic friction material utilizes the abrasive surface produced in coarse sponge iron to provide a high coefficient of friction and good wear resistance up to 250°F to compliment the coefficient of friction and wear resistance capable of being produced by the interaction of metallic and ceramic powders, steel fibers, rubber particles and graphite above 250°F.

7 Claims, 2 Drawing Figures

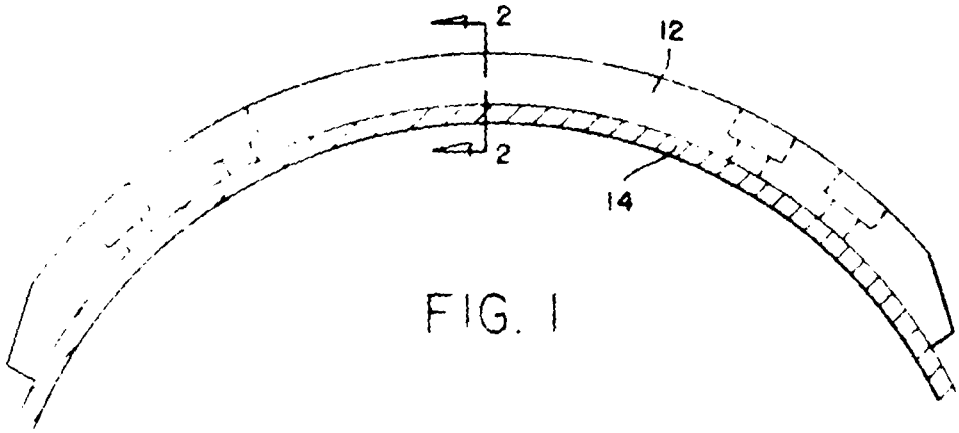


FIG. 1

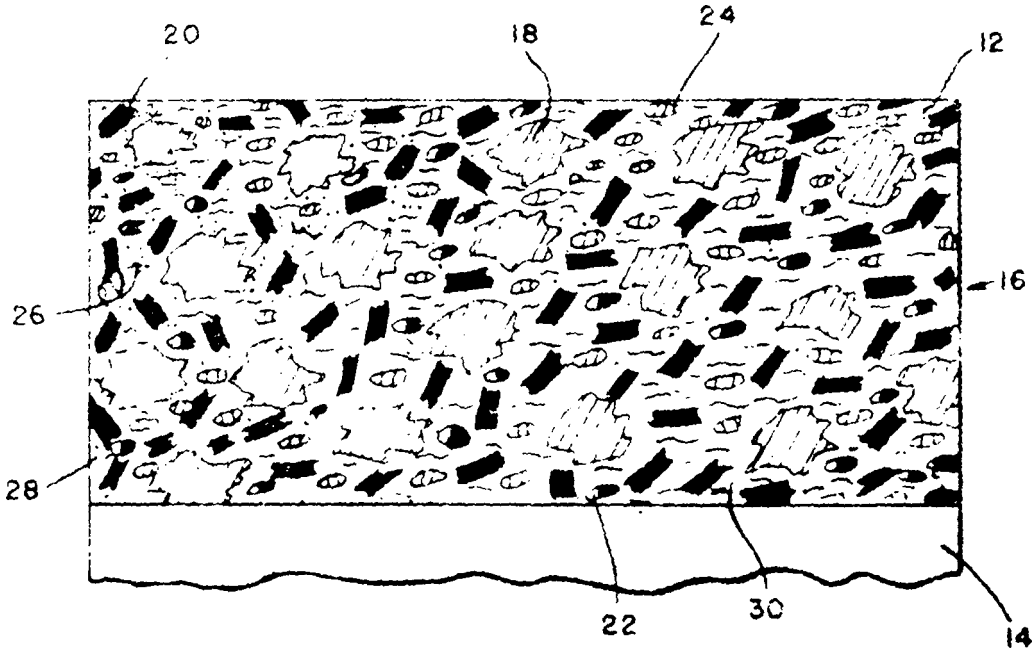


FIG. 2

SPONGE IRON FRICTION MATERIAL

BACKGROUND OF THE INVENTION

Friction materials consisting of graphite, metallic, ceramic and rubber powders held together by a thermosetting resin have been used as brake pads in braking systems to provide a uniform coefficient of friction without excessive fade. Such a brake lining material is fully described in U.S. Pat. No. 3,434,998 incorporated herein by reference.

The Department of Transportation of the U.S. Government has proposed that acceptable safe braking distances be reduced. It has been determined that if an organic friction material, such as that disclosed in U.S. application Ser. No. 309,011, incorporated herein by reference, could be modified to provide a high coefficient of friction immediately upon engagement of the wear pads with a mating brake surface, the proposed standards could be met. Frictional modifiers having higher coefficient of friction were tried, however, undesirable side effects such as noise, poor wear, fade, grooving in the mating surfaces and reduced structural strength resulted.

SUMMARY OF THE INVENTION

We have discovered a composition for a semi-metallic friction material wherein coarse sponge iron particles are utilized as a frictional modifier. The abrasive surface of the sponge iron will provide a brake lining with a high coefficient of friction upon initial engagement with a corresponding braking surface. Because the sponge iron particles are unannealed and coarse, initial burnish (low temperature wear) on the friction pad will be reduced. The irregular surface of the coarse sponge iron, which includes minute pin holes, will compliment the noise attenuating component in the semi-metallic friction material to essentially eliminate squeal associated during a frictional engagement. Since the sponge iron particles have a nominal size of between 20 to 80 mesh which tend to rupture under transverse loads, steel fibers in a proportioned relationship with the sponge iron particles are added to the semi-metallic friction material to provide structural unity for the brake lining.

It is, therefore, an object of this invention to provide a semi-metallic base material with a friction modifier consisting of coarse sponge iron particles to increase cold friction and reduce wear when used as a brake pad.

It is another object of this invention to provide a semi-metallic base material for a brake pad having coarse sponge iron particles as the principle component to compliment noise reducing ingredients therein in attenuating sounds created upon the brake pad engaging a corresponding brake member.

It is still a further object of this invention to provide a semi-metallic material having coarse sponge iron particles uniformly distributed therein to provide a high coefficient of friction at low temperatures and steel fibers therein to provide structural unity when the semi-metallic material is used as a brake pad.

It is still a further object of this invention to produce a semi-metallic friction material consisting of a mixture of metallic and ceramic powders, coarse sponge iron, graphite, rubber particles and steel fibers rigidly positioned in a resin matrix for use in a brake pad having a high coefficient of friction upon initial engagement with a corresponding brake member.

These and other objects will become apparent from reading this specification and viewing the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a friction pad for use in a brake assembly.

FIG. 2 is an enlarged view taken along line 2—2 of FIG. 1 illustrating the relationship of the compositional ingredients in the friction pad.

DETAILED DESCRIPTION OF THE PREFERRED COMPOSITION

Throughout this specification the terms metallic powder and ceramic powder are used to denote a material having a nominal size which will pass through a No. 80 mesh screen and consist of at least 85 percent of a base material with the balance being mainly oxides of the base material. Similarly the term "sponge iron" denotes a material having a nominal size, 85 percent of which will pass through a No. 20 mesh screen, yet will be retained on an 80 mesh screen, and consist of at least 90 percent metallic iron.

The brake pad **12** for a shoe **14** shown in FIG. 1 is constructed of a semi-metallic material whose principal ingredients are sponge iron, graphite and modifiers held together by a thermosetting phenolic resin which is then cured under heat and pressure to form a blended rigid mass **16**, as illustrated in FIG. 2. While disc brake pads are not illustrated, test results indicate the same advantages can be found when this material is used on disc brakes.

The sponge iron particles **18** are irregular in shape with a surface having pin hole voids therein. The sponge iron is produced by a method known as the Sicurin process. In this process, powdered magnetite iron ore, carbon, coke and lime are charged in layers into covered crucibles. These ingredients are heated in kilns until reduction is complete. After cooling, the iron produced which is removed will have a physical appearance of a round porous cake about 10 inches in diameter and 2–2½ inches thick. The reduced sponge cakes are then crushed and disintegrated into particles. Hoeganaes Sponge Iron Corporation, Riverton, N.J. produces sponge iron particles that are unannealed, designated M 20/80, having a nominal size which can vary from 20 mesh to 80 mesh have proven satisfactory for brake pads. These sponge iron particles have an abrasive surface sufficient to provide a high coefficient of friction upon initial engagement of the pad **12** with a corresponding braking surface, yet are large enough to resist abrasive wear at low operating temperatures, thereby reducing low temperature wear.

A typical composition for the semi-metallic brake pad **12** is as follows:

	Volume Percent	Volume Percent
Metallic powders (copper, iron & Zinc	[illegible]	0 to 30
Sponge Iron Particles	20	10 to 40
Ceramic Powders (sillimanite, mullite, magnesium oxide, barium sulfate, aluminum oxide and [illegible] silica, iron oxide)	[illegible]	2 to 15
Steel Fiber	[illegible]	0 to 20
Rubber [illegible]	[illegible]	[illegible]
Graphite	[illegible]	[illegible]

-Continued

	Volume Percent	Volume Percent
Phenolic resin binder	25	13 to 41
	100%	

The ingredients are mixed together and formed into a desired shape Then the mixture is placed in an oven where the resin is cured to hold the other ingredients in a fixed position with respect to each other. After curing the resin the material is shaped into a finished product such as the brake pad 12. The relationship of the various ingredients are illustrated in FIG 2 as follows. sponge iron particles 18, graphite particles 20, rubber particles 22, ceramic powders 24, steel fibers 26, iron powder 28 and resin 30.

Brake pads manufactured according to a formula as represented above were compared with brake pads of a conventional semi-metallic friction composition wherein the metallic powder constituted about 20% by volume of the total mixture with the following results

Material	Coefficient of Friction				Wear (in. × 10⁻³) for 300 Stops			
	250°F	325°F	475°F	550°F	250°F	325°F	475°F	550°F
Standard Semi-Metallic	0.32	0.34	0.33	0.32	25	15	5	10
Semi-Metallic Sponge Iron	0.38	0.36	0.35	0.32	10	8	4	10

The importance of providing an initially high coefficient for the brake pads can readily be realized from the following formula through which the effective braking distance on a level roadway may be approximated

$$d = V^2/30f$$

where

d = braking distance in feet

V = initial speed, miles per hour

f = coefficient of friction between friction members such as brake pad and drum

Assuming that the coefficient of friction will remain substantially uniform the period of time required to bring a vehicle to a stop will be proportionally reduced

As an example, assume identical vehicles wherein one has brake pads constructed of a standard semi-metallic material and the other of a semi-metallic material with sponge iron particles and both are traveling at 60 miles per hour, the effective braking distance will be as follows

$$d = 60^2/(30 \times 0.32) = 3600/9.6 = 375'$$

$$d/\text{sponge iron} = 60^2/(30 \times 0.38) = 3600/11.4 = 306'$$

Thus the vehicle with the brake pads having a semi-metallic material with sponge iron particles therein exhibits a shorter effective braking distance which will conform to the proposed stopping distance of the Department of Transportation

The wear resistance of conventional semi-metallics are equivalent to organic materials between 350° and 450°F and are superior to organics at temperatures above 450°F However, one of the major obstacles to the accpetance of semi-metallics as a friction material has been the poorer wear resistance of the semi-metallics (compared to organics) when operating at temperatures below 325°F. Average driving seldom results in temperatures above 325°F and is generally considered to generate brake temperatures of around 250°F. Thus, the wear rate of any potentially commercial friction material must be equivalent to organic materials at these lower operating temperatures The use of coarse sponge iron particles has shown a significant reduction in both the 250°F and 325°F wear levels, thereby improving the chances for commercial acceptance

As previously discussed, the proposed Department of Transportation reduction in acceptable safe brake stopping distances requires that the brake systems remain balanced throughout the test. This requires a friction material which will exhibit the same friction levels throughout the test. While conventional semi-metallic materials exhibit better friction stability than most organics throughout the test, one problem was found with conventional semi-metallic materials, that was low initial (pre-burnished) friction As a result, conventional semi-metallic materials were unable to meet the pre-burnished stopping distances proposed by the Department of Transportation The use of coarse sponge iron particles in semi-metallics have demonstrated significant improvement in initial (pre-burnished) friction, which will be required if semi-metallic materials are to be considered for commercial usage

Further, upon investigating the semi-metallic material, it was determined that the sponge iron will compliment the rubber particles therein to attenuate noise or squeal caused upon engagement of the brake pad with a corresponding member.

It is assumed that the voids in the sponge iron particles act as acoustical absorbers by breaking up the path through which sounds may travel.

The over-all transverse structural unity of the brake pads may be varied by the amount of steel fiber 26 used in the mixture. However, due to the disparity in price between steel fiber and sponge iron (about 6 times), for mass production a volumetric change in steel fiber content will usually be adjusted by a proportional change in the quantity of sponge iron particles.

Thus, we have developed a semi-metallic composition wherein the structural characteristics are enhanced by the use of sponge iron particles when used as a friction pad in a braking system.

We claim:

1. A semi-metallic base material for use in a vehicle brake as a friction lining, said material consisting of a mixture of.

metallic powder selected from a group consisting of iron, copper, zinc and mixtures thereof from 0 to 30 percent of the total mixture;

sponge iron particles from 10 to 40 percent by volume of the total mixture, said particles having a nominal size which can vary from 20 to 80 mesh,