United States Patent Office

3,495,957

Patented Feb. 17, 1970

3,495,957

LEAD-IMPREGNATED, IRON-BASE, SINTERED-ALLOY MATERIALS FOR CURRENT-COLLECTING SLIDER SHOES

Toshio Matoba and Akio Sakaba, Nigata-shi, Hachiro Sato, Tokyo-to, Tadashi Sato, Nigata-shi, and Tetsuro Yamaguchi and Yuichi Saito, Urawa-shi, Japan, assignors to Mitsubishi Kinzoku Kogyo Kabushiki Kaisha, Tokyo-to, Japan, a joint-stock company of Japan

No Drawing. Continuation-in-part of application Ser. No. 508,863, Nov. 16, 1965. This application Dec. 28, 1967, Ser. No. 694,033

Claims priority, application Japan, Mar. 15, 1965, 40/14,538; June 29, 1965, 40/38,475

Int. Cl. B22f 3/26

U.S. Cl. 29—182.1

14 Claims

ABSTRACT OF THE DISCLOSURE

Self-lubricating, wear-resistant current-collecting slider shoes obtained from a sintered alloy material composed of metal elements such as copper, molybdenum, nickel, chromium, or carbon, in a proper combination, and the remainder of iron. Lead of 15–30% by weight is further impregnated in the sintered porous skeleton of the alloy material.

This is a continuation-in-part of our copending patent application, Ser. No. 508,863, filed Nov. 16, 1965, entitled "Lead-Impregnated, Iron-Base, Sintered-Alloy Materials for Current-Collecting Slider Shoes," now abandoned.

This invention relates to current-collecting slider shoe materials, particularly lead-impregnated, iron-base sintered alloys. More specifically, the present invention concerns a new series of self-lubricating, wear-resistant alloy materials produced by impregnating, with lead, iron-base, sintered porous skeletons containing carbon and at least one metal selected from among copper, molybdenum, nickel, and chromium.

It is a general object of the present invention to provide alloys of the above stated character which are suitable for use as material for current-collecting slider shoes of high-speed electric trains.

In general, materials for current-collecting slider shoes of electric trains are required to have not only high electroconductivity and excellent mechanical properties, particularly high wear-resistance and high shock-resistance, but also the property of causing minimum wear of the copper trolley wire (or overhead wire) along which the slider shoes slide.

Heretofore, it has been known a wear-resistant alloy produced by impregnating a low temperature melting alloy in a sintered alloy. Such kind of alloy is disclosed, for example, in U.S. Patent 2,401,483 wherein ferrous metal or alloy is impregnated with low temperature melting metal, the alloy being for reducing friction on the surface of a shell body. In another U.S. Patent 2,409,307, an alloy whose surface is made soft by impregnating lead in a sintered body of iron, the alloy being for reducing resistance of a projectile. The wear-resistant alloys produced by these prior arts are, however, not usable as a current-collecting slider shoes as in the present invention, since the alloys are merely for a low resistance body. The materials for current-collecting slider shoes suitable for high speed electric train in recent days should have such composition and lead content as described hereinbelow.

According to the present invention there is provided a series of current-collecting slider shoe materials suitable for use in high-speed electric vehicles such as, for example, the electric vehicles running at speeds in excess of 200 kilometres per hour on the New Tokaido Line of

the Japan National Railways. These materials according to the invention are superior in mechanical properties to conventional materials of graphite, copper, and copper-base alloys and, moreover, have as their principal constituent iron which does not readily undergo fusion adhesion with copper trolley wire along which these materials slide. Furthermore, the materials provided by the invention are caused to have high resistance to wear and impact and, at the same time, to have suitable hardness by the addition thereto of various additive elements. In addition, the wear of these materials, themselves, and that of the trolley wire are reduced by the self-lubricating effect due to the impregnating lead which is dispersed uniformly within these materials.

The alloys according to the present invention are produced in each case by preparing an iron-base, sintered, porous skeleton by a powder metallurgical method whereby the alloy is pressed into a specified shape and then sintered in a non-oxidizing atmosphere such as an inert gas, a reducing atmosphere, or vacuum, said porous skeleton containing 0.1 to 0.2 percent or less of carbon and 0.5 to 5 percent of copper, molybdenum, nickel, chromium, or combination thereof and then by impregnating the porous skeleton so prepared with lead so that the lead content after impregnation becomes from 15 to 30 percent.

The kinds, added quantities, and effects of the additive elements added to the alloys of the present invention are set forth below.

(1) Copper: When copper of a quantity in the range of from 0.5 to 5 percent (by weight) is added to the iron-base materials for producing a sintered skeleton, it has the effect of promoting the formation of internal pores in the skeleton, of suppressing deformation of the skeleton during sintering, and of facilitating the impregnation with lead after sintering. Furthermore, copper also has the effect of increasing the hardness of the sintered skeleton.

When the quantity of added copper is 0.5 percent or less, these effects are not conspicuous, but amply good results in comparison with those of the ordinary case are still exhibited. When the added quantity exceeds 5 percent, not only is the pore formation effect lowered and the hardness of the sintered skeleton caused to become excessive, but the copper flocculates coarsely at the grain boundary of the iron after impregnation with lead, giving rise to the possibility of fusion adhesion with the trolley wire and acceleration of wear of the slider shoe material and the trolley wire.

(2) Molybdenum: Addition of between 0.5 and 5 percent (by weight) of molybdenum results in an increase in wear resistance and shock resistance without causing an appreciable increase in the hardness of the sintered skeleton. When the added quantity exceeds 5 percent, the effects of the addition of molybdenum are lowered. Also, at a quantity of less than 0.5 percent, the effect is extremely small.

(3) Nickel: Addition of nickel improves the hardness and shock resistance of the iron-base, sintered skeleton. By adding nickel together with molybdenum, the wear resistance is also increased. When the added quantity exceeds 5 percent, the hardness of the sintered skeleton becomes excessive, and there is a tendency for the wear of the trolley wire to be accelerated. The effect produced by the addition of less than 0.5 percent of nickel is extremely poor.

(4) Chromius: Addition of 5 percent or less of chromium increases the hardness and wear resistance of the iron-base, sintered skeleton. By adding chromium together with molybdenum, the wear resistance is remarkably increased. When the added quantity exceeds 5 percent, the hardness of the sintered skeleton becomes excessive,

whereby there is the possibility of excessive wear of the trolley wire, and, moreover, the shock resistance of the sintered skeleton is lowered. The effect produced by the addition of less than 0.5 percent of chromium is extremely poor.

between the skeleton and the molten lead, whereby their wetability is improved.

The properties of examples of lead-impregnated skeletons produced in the above described manner are indicated in the accompanying Table 1.

TABLE 1

	Sintered Skeleton			Impregnated Skeleton				
Sample Number	Composition (percent)	Density (g./cc.)	Porosity (percent)	Pb Quantity Impregnated (percent)	Density (g./cc.)	Hardness (HV)	Tensile Strength (kg./mm.²)	Charpy Impact Strength (kg-.cm-/cm.²)	Elect. Resistivity (μΩ-cm.)
1	Fe, 99; Cu, 1	6.45	18	18	7.9	64	23.8	197	16
2	Fe, 97; Cu, 3	6.35	20	24	8.2	76	26.6	183	14
3	Fe, 95; Cu, 5	6.35	20	25	8.3	80	27.3	177	13
4	Fe, 94.9; Cu, 5; C, 0.1	6.35	20	25	8.3	97	28.8	145	13
5	Fe, 94.5; Cu, 5; Sn, 0.5; C, 0.5	6.35	20	25	8.3	97	28.7	153	13
6	Fe, 97; Cu, 3	6.35	20	23	8.1	77	26.0	180	15

(5) Carbon: While an addition of 0.2 percent or less of carbon results in an increase in the hardness and wear resistance, when the added quantity exceeds 0.2 percent, the carbides increase rapidly, and not only does the hardness become excessive, but there is produced a heat hardened structure of very high hardness on the sliding surface due to repeated rapid heating and cooling thereby by arcs generated during high-speed, current-collecting sliding action, whereby the wear of the trolley wire is increased.

(6) Lead: The lead has a lubrication effect in the solid or liquid state during high-speed, current-collecting sliding operation and reduces wear loss of the slider shoe material and the trolley wire. It has been found that an iron-base, sintered skeleton of a specific gravity of from 5.9 to 7.00 can be impregnated with from 15 to 30 percent of lead. When the quantity of impregnated lead exceeds 30 percent, the mechanical properties of the iron-base sintered skeleton are greatly impaired. When this quantity is below 15 percent, the lubricating effect is diminished, and the wear of the slider shoe and the trolley wire increase.

In the process of causing the lead to melt and penetrate into the iron-base sintered alloy in the practice of the present invention, the lead is caused to so melt and penetrate in a reducing atmosphere containing hydrogen into which from 0.5 to 5.0 percent (by volume) of chlorine gas has been mixed, whereupon the melting and penetration of the lead is accomplished effectively.

For the hydrogen-containing reducing gas for carrying out this melting and penetration, a gas such as hydrogen gas or gases resulting from the cracking of ammonia can be effectively utilized. The chlorine gas introduced into this atmosphere ad hydrogen chloride gas formed by reaction of a portion of the chlorine gas with the hydrogen gas act upon and clean the skeleton metal particle surface and molten metal surface layer, whereby the wetability is improved, and it is possible to increase greatly the quantity of molten penetration lead. That is, from 15 to 30 percent of lead can be caused to undergo molten penetration without causing a lowering of the mechanical strength of the product.

In one example of practice, from 0.5 to 5.0 percent of copper powder (or, additionally, tin powder of a quantity corresponding to 15 percent of that of the copper powder) and from 0.1 to 0.2 percent of carbon powder are added to and mixed with iron powder, and the resulting mixture is press-formed and sintered to produce a skeleton. On the upper surface of this skeleton, a specified quantity of lead is placed, and these materials are then heated in a stream of hydrogen gas in which 3 percent of chlorine gas is mixed for 60 minutes at a temperature of 700 degrees C. to melt the lead and cause it to penetrate into the skeleton.

In this case, the chlorine gas within the hydrogen gas and the hydrogen chloride gas formed by the combination of a portion of the chlorine gas with the hydrogen gas have the effect of cleaning the respective surfaces

From Table 1, it is apparent that the products shown exhibit lead penetrations which are far superior to those of alloys known heretofore.

In order to test the lead-containing, iron-base sintered alloys of the instant example as material for slider shoes of electric trains, these alloys were used as test pieces, which were fixed, and, with hard copper wire used as the opposite rubbing material, friction wear tests were carried out, the wear in each case being measured under the test conditions of applied A-C voltage of 100 volts and current of 24 amperes, mechanical load of 1.7 kg./cm.², and sliding speed of approximately 75 km./hr. For the purpose of comparison, an iron-base sintered alloy which is presently being used by the Japan National Railways was also tested under the same conditions. The results of these tests are shown in the accompanying Table 2, from which the excellent wear resistance of the alloys according to the present invention can be observed.

TABLE 2

Sample Number	Composition (percent)	Wear in 30 min. (g.)
1	Fe, 83; Cu, 1; Pb, 16	0.512
2	Fe, 78.5; Cu, 2.5; Pb, 19	0.472
3	Fe, 76; Cu, 4; Pb, 20	0.457
4	Fe, 72.5; Cu, 3.5; Pb, 24	0.473
5	Fe, 75.9; Cu, 4; Pb, 20	0.440
6	Fe, 75.5; Cu, 4; Pb, 20	0.426
7	Fe, 79; Cu, 2.5; Pb, 18.5	0.495
	Iron-base sintered alloy presently used by the Japan National Railway.	2.38

In further tests on actual vehicles under the severe sliding condition of a sliding speed of 200 km./hr., the alloys of the present invention also exhibited excellent wear resistance, whereby the suitability of these alloys as material for current collector slider shoes of pantographs was verified.

In order to indicate still more fully the nature of the present invention, the following examples of typical procedure and result according to the invention are set forth, it being understood that these examples are presented as illustrative only, and that they are not intended to limit the scope of the invention.

EXAMPLE 1

Powders of 5 percent of copper, 0.1 percent of carbon, and the remainder of iron were mixed by the dry method and pressed under a pressure of 4 ton/cm.² into a skeleton of a density of 6.3 g./cm.³. The skeleton was then sintered at 1,150 degrees C. for one hour in hydrogen gas and then impregnated with 22 percent of lead in hydrogen gas.

EXAMPLE 2

Powders of 3 percent of copper, 3 percent of molybdenum, 0.5 percent of chromium, and the remainder of iron were mixed, and the resulting mixture was thereafter pressed, sintered, and impregnated under the same con-

ditions as those of Example 1. As a result, a lead impregnation quantity of 23 percent was obtained.

EXAMPLE 3

Powders of 3 percent of copper, 3 percent of molybdenum, 3 percent of nickel, and the remainder of iron were mixed, pressed, sintered, and impregnated with lead under the same conditions as those of Example 1. The skeleton was impregnated with 22 percent of lead.

The alloys produced by the foregoing Examples 1 through 8 were tested for their respective properties, wear-resistances being measured under the test conditions of a sliding speed of 90 km./hr., a sliding pressure of 2 kg./cm.^{2}, an applied A-C current of 25 amperes (at 100 volts)/cm.^{2}, and an opposite sliding material of hard copper. The test results are indicated in the accompanying Table 3 together with the results of comparison tests on a conventional copper-base alloy slider shoe used heretofore.

TABLE 3

Alloy	Composition (Wt. percent)	Mechanical Properties: Hardness (HV)	Charpy Impact Strength (kg.-m./cm.^{2})	Wear Resist. (min./g.)
Alloys of this invention:				
Example 1	5% Cu-0.1% C-Fe-base sintered alloy, impregnated with 22% Pb	105	1.5	50
Example 2	3% Cu-3% Mo-0.5% Cr-Fe-base sintered alloy, impregnated with 23% Pb.	85	2.6	55
Example 3	3% Cu-3% Mo-3% Ni-Fe-base sintered alloy, impregnated with 22% Pb.	115	2.2	75
Example 4	2% Cu-1% Mo-2% Ni-3% Cr-Fe-base sintered alloy, impregnated with 2% Pb.	110	1.4	85
Example 5	0.5% Cu-3% Mo-3% Ni-0.1% C-Fe-base sintered alloy, impregnated with 28% Pb.	85	2.5	80
Example 6	3% Cu-0.5% Mo-3% Ni-5% Cr-0.1% C-Fe-base sintered alloy, impregnated with 25% Pb.	110	1.8	90
Example 7	3% Cu-3% Mo-0.5% Ni-Fe-base sintered alloy, impregnated with 16% Pb.	90	2.2	85
Example 8	3% Cu-5% Ni-3% Cr-0.2% C-Fe-base sintered alloy, impregnated with 22% Pb.	108	1.6	85
Conventional alloy (for comparison)	12% Fe-9% Sn-3% Ni-4% C-Cu-base alloy	110	1.5	19

EXAMPLE 4

Powders of 2 percent of copper, 1 percent of molybdenum, iron-nickel alloy of a quantity corresponding to 2 percent of nickel, iron-chromium alloy of a quantity corresponding to 3 percent chromium, and the remainder of iron were mixed and pressed in the same manner as in Example 1, presintered at 500 degrees C., for one hour in hydrogen gas, and then sintered at 1,170 degrees C. for one hour in a vacuum. The resulting skeleton was impregnated with 20 percent of lead.

EXAMPLE 5

Powders of 0.5 percent of copper, 3 percent of molybdenum, 3 percent of nickel, 0.1 percent of carbon, and the remainder of iron were mixed by the dry method and pressed under a pressure of 4 ton/cm.^{2} into a skeleton of a density of 6.3 g./cm.^{3}. The skeleton was then sintered at 1,100° C. for one hour in nitrogen gas (N_2) and then impregnated with 28 percent of lead in the nitrogen gas.

EXAMPLE 6

Powders of 3 percent of copper, 0.5 percent of molybdenum, 3 percent of nickel, 5 percent of chromium, 0.1 percent of carbon, and the remainder of iron were mixed by the dry method and pressed under a pressure of 4 ton/cm.^{2} into a skeleton of a density of 6.3 g./cm.^{3}. The skeleton was then sintered at 1,500° C. for one hour in vacuum of 10^{-3} Hg and then impregnated with 25 percent of lead.

EXAMPLE 7

Powders of 3 percent of copper, 3 percent of molybdenum, 0.5 percent of nickel and the remainder of iron were mixed by the dry method and pressed under a pressure of 4 ton/cm.^{2} into a skeleton of a density of 6.3 g./cm.^{3}. The skeleton was then sintered at 1,200° C. for 30 minutes in hydrogen gas and then impregnated with 16 percent of lead in hydrogen gas.

EXAMPLE 8

Powders of 3 percent of copper, 5 percent of nickel, 3% of chromium, and 0.2 percent of carbon and the remainder of iron were mixed in dry method and pressed under a pressure of 4 ton/cm.^{2} into a skeleton of a density of 6.3 g./cm.^{3}. The skeleton was then sintered at 1,150° C. for one hour in hydrogen gas and then impregnated with 22 percent of lead in hydrogen gas.

The results of comparative tests on the alloy of the present invention as indicated in Example 1 and a conventional alloy, which tests were carried out on actual operational vehicles, are indicated in the accompanying Table 4 and Table 5.

TABLE 4

Alloy	Alloy of this invention, Example 1	Conventional alloy (for comparison)
Composition	5% Cu-0.1% C-Fe-base, sintered alloy, impregnated with 22% Pb	12% Fe-9% Sn-3% Ni-4% C-Cu alloy
Wear (mm./1,000 km.):		
Specimen No. 1	0.98	4.36
Specimen No. 2	1.30	7.05
Specimen No. 3	0.65	2.53
Specimen No. 4	0.78	2.03
Specimen No. 5	0.94	2.49
Specimen No. 6	0.57	2.87
Specimen No. 7	0.58	4.07
Average	0.81	3.63

NOTE 1.—The above results were obtained from actual tests carried out on vehicles running on the New Tokaido Line of the Japan National Railways. The test conditions were as follows:

Sliding speed	250 km./hr. (max.).
Sliding load	5.5 kg.
Collector current	120 amp. (A-C 25 kv.).
Slider shoe width and height	27 x 10 mm.

NOTE 2.—Wear values are expressed in terms of loss of slider shoe height (mm.) after a sliding run of 1,000 km.

TABLE 5

Alloy	Alloy of this invention, Example 1	Conventional alloy (for comparison)
Composition	5% Cu-0.1% C-Fe-base, sintered alloy, impregnated with 22% Pb	5% Fe-10% Sn-4% C-Cu alloy
Total Sliding Test Distance (km.)	21,681.4	21,681.4
Rate of Weight Loss of Slider Shoe (g./1,000 km.)	3.10	4.07
Rate of Height Loss of Slider Shoe (mm./1,000 km.)	0.057	0.083
Max. Height Loss after 21,681.4-km. Test (mm.)	1.38	3.60

NOTE.—The above results were obtained from actual tests carried out on vehicles run on the Han-Wa Line of the Japan National Railways.

EXAMPLE 9

To metal powder of the composition of 3 percent of copper, 3 percent of molybdenum, and the remainder of iron, 0.5 percent of chromium and 1 percent of zinc stearate were added and mixed by the dry method. The resulting mixture was then pressed under a pressure of 4 ton/cm.^{2} to produce a moulded structure of a moulded density of 6.3 g./cc., which was sintered at 1,150 degrees C. for one hour in a hydrogen furnace. Then, in a hydrogen atmosphere, 23 percent of lead was caused to penetrate into the pores of the sintered skeleton in an atmosphere of hydrogen gas to produce an alloy for slider shoes.

EXAMPLE 10

A sintered skeleton of 3 percent of copper, 3 percent of molybdenum, 3 percent of nickel, and the remainder of iron was produced by the same procedure as set forth in Example 9 and impregnated with 22 percent of lead.

EXAMPLE 11

Powders of 2 percent of copper, 1 percent of molybdenum, 2 percent of nickel and 3 percent of chromium in the form of alloy powders, and the remainder of iron were mixed and moulded according to the procedure set forth in Example 9. The moulded material was then presintered at 500 degrees C. for one hour and thereafter sintered at 1,170 degrees C. for one hour in a vacuum. The resulting sintered skeleton was then impregnated with 20 percent of lead in molten salt to produce an alloy for slider shoes.

The alloys produced in accordance with the foregoing Examples 9, 10, and 11 were tested for their respective properties including wear resistance, and results as indicated in the accompanying Table 6 were obtained. The wear tests were carried out in each case under the test conditions of a sliding speed of 90 km./h., a sliding pressure of 2 kg./cm.^{2}, an applied A-C current of 25 amperes (at 100 volts)/cm.^{2}, and an opposite sliding member of hard copper. Wear resistance is indicated as the time (in minutes) in which each alloy was reduced in weight by 1 gram. For comparative reference, the results of the same tests on a lead-impregnated alloy of the iron-copper-carbon series in operational use at present are also shown in Table 6.

amples of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention as set forth in the appended claims.

What we claim is:

1. A lead-impregnated, iron-base, sintered alloy material having self-lubricating and wear-resisting properties for current-collecting slider shoes in the form of a sintered skeleton consisting of at least one substance selected from the group consisting of copper, molybdenum, nickel, chromium, all of these substances being in the range of 0.5–5% by weight, and carbon in the range of 0.1 to 0.2% by weight, the remainder being iron, and lead in the range of 15 to 30% by weight as impregnated in said sintered skeleton

2. The alloy material of claim 1 consisting essentially of 5% by weight copper, 0.1% by weight carbon, the remainder being iron, and 22% by weight lead impregnated in the sintered skeleton.

3. The alloy material of claim 1 consisting essentially of 3% by weight copper, 3% by weight molybdenum, 0.5% by weight chromium, the remainder being iron, and 23% by weight lead impregnated in the sintered skeleton.

4. The alloy material of claim 1 consisting essentially of 3% by weight copper, 3% by weight molybdenum, 3% by weight nickel the remainder being iron, and 22% by weight lead impregnated in the sintered skeleton.

5. The alloy material of claim 1 consisting essentially of 2% by weight copper, 1% by weight molybdenum, 2% by weight of nickel, 3% by weight chromium, the remainder being iron, and 20% by weight lead impregnated in the sintered skeleton.

6. The alloy material of claim 1, consisting essentially of 0.5% by weight copper, 3% by weight molybdenum, 3% by weight nickel, 0.1% by weight carbon, the remainder being iron, and 28% by weight lead impregnated in the sintered skeleton.

7. The alloy material of claim 1, consisting essentially of 3% by weight copper, 0.5% by weight molybdenum, 3% by weight nickel, 5% by weight of chromium, 0.1% by weight carbon, the remainder being iron, and 25% by weight lead impregnated in the sintered skeleton.

8. The alloy material of claim 1, consisting essentially of 3% by weight copper, 3% by weight molybdenum, 0.5% by weight nickel, the remainder being iron, and 16% by weight lead impregnated in the sintered skeleton.

9. The alloy material of claim 1, consisting essentially of 3% by weight copper, 5% by weight nickel, 3% by weight chromium, 0.2% by weight carbon, the remainder being iron, and 22% by weight lead impregnated in the sintered skeleton.

10. The alloy material of claim 1 consisting essentially of 2% by weight copper, 1% by weight molybdenum, 2% by weight nickel, 3% by weight chromium, the remainder being iron, and 20% by weight lead impregnated in said sintered skeleton.

11. The alloy material of claim 5 wherein iron-nickel alloy and iron-chromium alloy are respectively used in place of nickel and chromium in a quantity correspond-

TABLE 6

Alloy (skeleton) (Weight Percent)	Lead Impregnated (Percent)	Charpy Impact Strength (kg.-m./cm.^{2})	Elect. Resistivity ($\mu\Omega$-cm.)	Hardness (HV)	Wear Resist. (min./g.)
Alloys of This Invention:					
Example 9—3 Cu, 3 Mo, 0.5 Cr, remainder Fe	23	2.6	23	85	55
Example 10—3 Cu, 3 Mo, 3 Ni, remainder Fe	22	2.2	30	115	75
Example 11—2 Cu, 3 Mo, 3 Ni, 4 Cr, remainder Fe	20	1.4	35	110	85
Alloy Presently Used: 4 Cu, 0.1 C, 0.1 Sn, remainder Fe	22	1.5	15	105	50

As is apparent from the foregoing disclosure, the present invention provides a series of lead-impregnated, iron-base sintered alloys which, for use as materials for current collector slider shoes, is superior to such materials known heretofore, and which, moreover, are highly suitable for current collector slider shoes of high-speed electric vehicles with operational speeds of 200 km./hr. and higher speeds. Furthermore, the alloys of the invention can be produced by relatively simple and low-cost processes from relatively inexpensive materials.

It should be understood, of course, that the foregoing disclosure relates to only preferred embodiments of the invention and particular examples of detail and that it is intended to cover all changes and modifications of the ex-

ing to the specific content of said respective metal elements.

References Cited

UNITED STATES PATENTS

2,192,792	3/1940	Kuntz	29—182.1
2,409,307	10/1946	Patch	29—182.1
2,456,779	12/1948	Goatzal	29—182.1
2,561,579	7/1951	Lanal	29—182.1 X
2,758,229	8/1956	Perry	29—182.1 X
3,142,559	7/1964	Ruf	75—208

CARL D. QUARFORTH, Primary Examiner

A. J. STEINER, Assistant Examiner

U.S. Cl. X.R.

29—182.5; 75—208