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[54] **SELF-LUBRICATING SLIDE ELEMENT**

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[52] **U.S. Cl.** **29/182.5;** 148/16.6; 148/126; 75/203; 75/205; 29/182.3; 29/182.7

[51] **Int. Cl.**.. **B22f 3/00**

[58] **Field of Search**............ 75/205, 203; 148/126, 75/16.6; 29/182.3, 187.5, 187.7

[56] **References Cited**

UNITED STATES PATENTS

2,448,369	8/1948	Heintz et al.	148/16.6
2,725,265	11/1955	Daniels et al.	75/205
2,906,007	9/1959	Bibbins	75/205
2,994,600	8/1961	Hansen	148/16.6
3,282,746	11/1966	Zlotek et al.	148/16.6
3,377,214	4/1968	Woodbridge et al.	148/16.6
3,741,733	6/1973	Kieffer	75/203

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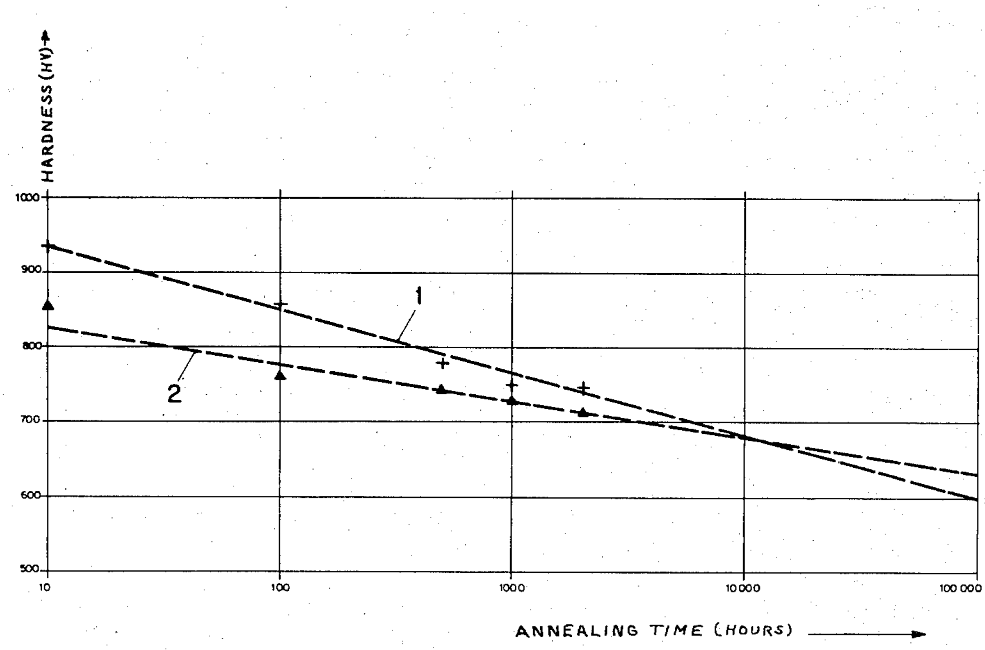
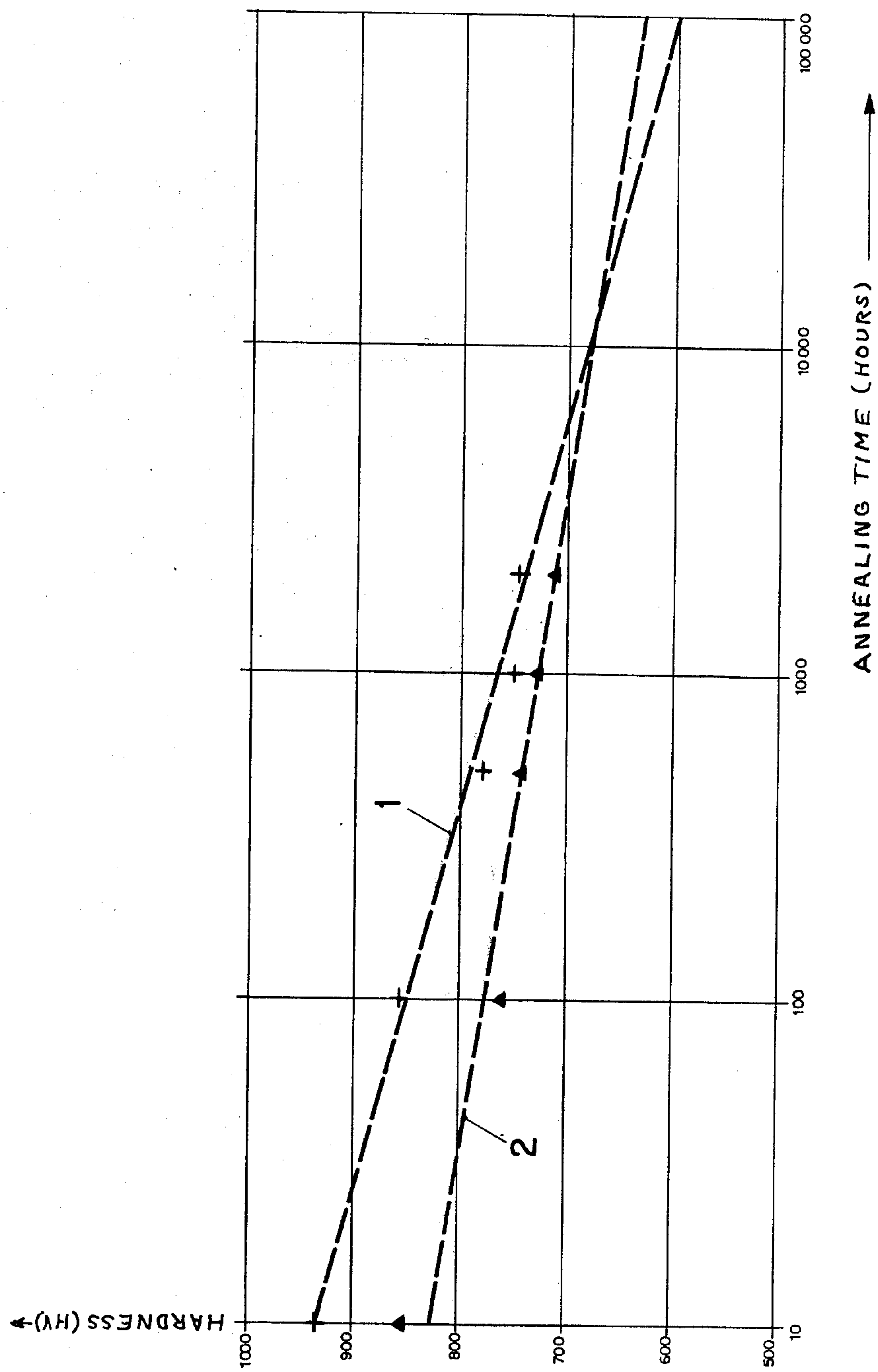
[57] **ABSTRACT**

A self-lubricating slide component is made from a sintered material which includes graphite in a metal phase. The metal phase consists of one or more nitride or carbo-nitride forming metal elements and which are located at least partially in the region of the surface of the slide component.

14 Claims, 1 Drawing Figure




HARDNESS (HV)
1000
900
800
700
600
500
10
100
1000
10 000
100 000
ANNEALING TIME (HOURS)
1
2

SELF-LUBRICATING SLIDE ELEMENT

The present invention relates to an improvement in the composition and structure of slide components of the self-lubricating type which consist of a sintered material that includes graphite in a metal phase.

Self-lubricating slide components are utilized for applications where it is not feasible to use a slide component which is accessible for conventional lubrication techniques. Their manufacture is usually accomplished by powder-metallurgical technique. The metal phase consists in most cases of iron, nickel, copper, tin, antimony, lead, zinc and tungsten. When these known slip components are subjected to stresses by sliding friction at temperatures above 250°C, the surface wear will be substantial. Furthermore, graphite bronzes have a tendency within this temperature range to grow.

The principal objective of the present invention is to provide an improved structure for these self-lubricating slide components so that the wear factor — resulting from sliding friction — will remain relatively low even at substantially increased temperatures.

This objective is attained in that the metal phase consists at least partially of one or more metal elements forming nitrides or carbo-nitrides, and that the metal elements within the region of the surface of the slip component take at least partially the form of nitrides or carbo-nitrides. The slide component may and preferably does contain from 10 to 90% by weight of said metal element or elements. The metal element may be and preferably is an iron alloy such as an iron-aluminum alloy, which may contain from 0.2 to 2.0% by weight of aluminum, or an iron-aluminum-chromium alloy.

The invention is described below in terms of three different samples and the attached drawing which consists of two curve plots related respectively to examples 2 and 3.

EXAMPLE 1

A slide component, made from a sintered material containing 8% by weight of graphite, in a metal phase consisting of 70% by weight of iron, with the remainder made up by nickel and copper, was nitrided for 10 hours at a temperature of 520°C, under a 30% NH_3 dissociation. The nitrogen atoms diffused during this process through the surface of the slide component whereby iron was nitrided, at least partially within a zone extending along the surface of the slide component. The surface of the slide component was found to have a hardness of 96.5 HV prior to nitriding, and a hardness of 146 HV after nitration.

EXAMPLE 2

A slide component, made from a sintered material containing 8% by weight of graphite, in a metal phase consisting of 60% by weight of an iron alloy, with the remainder made up by nickel and copper, was nitrided for 20 hours at a temperature of 520°C, under a 30% NH_3 dissociation. The iron alloy contained approximately 1% by weight of aluminum, 1.7% by weight of chromium, 0.2% by weight of molybdenum and 1% by weight of nickel. The hardness of the metal phase at the surface of the slide component was 1,020 HV after the nitriding. After annealing for 2,000 hours at 540°C, the hardness of the metal phase was still 740 HV. This is depicted by curve plot **1** of the drawing. Extrapolation of the line of curve plot **1** indicates that the hardness after 100,000 hours at this annealing temperature would still be approximately 600 HV.

EXAMPLE 3

A slide component, made from a sintered material containing 8% by weight of graphite, in a metal phase consisting of 60% by weight of an iron alloy, with the remainder made up by nickel and copper, was nitrided for 20 hours at a temperature of 560°C, under a 50% NH_3 dissociation. The iron alloy contained approximately 12% by weight of chromium, 0.5% by weight of nickel, 1.0% by weight of molybdenum, 0.3% by weight of vanadium, 0.3% by weight of tungsten and 0.1% by weight of niobium. The hardness of the metal phase at the surface of the slide component was 980 HV after the nitriding. The hardness was still 715 HV after an annealing time of 2,000 hours at a temperature of 540°C, as shown by curve plot **2.** Extrapolation of the curve plot **2** would indicate that the hardness after 100,000 hours of annealing at such temperature would still be approximately 640 HV.

At high temperatures, a high wear resistance of the slide component can be obtained if the metal phase contains iron, aluminum, chromium, molybdenum, vanadium, zirconium, tantalum or titanium. These elements can be contained in the metal phase individually, or in combination. Preferably, iron should be combined with one or more of the elements as listed. The elements aluminum, chromium, molybdenum, vanadium, zirconium, tantalum and titanium also promote formation of nitrides which are hard, temper-proof and partially corrosion-resistant so that these slide components will retain their good wear-resistance characteristic even at temperatures above 550°C.

While three specific examples have been given for the composition of the slide component, these are not to be construed as limitative since it is possible for the metal phase to consist of from 10 to 90% by weight of the nitride or carbo-nitride forming metal elements. Moreover, the iron alloys constituting the metal phase may also contain tin, lead, zinc and antimony.

The iron alloy may also be of the iron-chromium type containing between 0.2 and 2.0% by weight of aluminum.

The iron alloy may also be of the iron-aluminum-chromium type, containing approximately, by weight, 1% aluminum, 1.0 to 2.0% chromium, and also up to 0.6% molybdenum and up to 0.6% vanadium.

The iron alloy may also be of the iron-cnromium type containing between 1 and 30%, by weight, of chromium.

The iron alloy may also be of the iron-nickel-chromium type containing, by weight, 18% nickel and 8% chromium.

In addition to nitriding, the slide component can also be subjected simultaneously to carburization. As a result of this process, carbo-nitrides, with properties similar to the properties of the nitrides, will form within the region of the border zone. If the slide component is also simultaneously sulphurized, it will lead to a further improvement in its sliding properties.

I claim:

1. A self-lubricating slide component consisting essentially of a sintered material which includes graphite in a matrix consisting essentially of metal components, said metal components consisting at least partially of one or more nitride-or carbo-nitride-forming metal elements, and said metal elements in the surface zone of the slide component having at least partially the form of their nitrides or carbo-nitrides, said slide component being characterized by a hard and wear-resistant surface zone and a softer but still tough inner zone.

2. A self-lubricating slide component as defined in claim **1** wherein the metal components, in addition to the nitride- or carbo-nitride-forming metal elements contain a member of the group consisting of copper, nickel, tin, lead, zinc and antimony.

3. A self-lubricating slide component as defined in claim **1,** consisting of, by weight, 8% graphite, 60% iron alloy subjected to nitriding and the remainder nickel and copper, the iron alloy consisting essentially of by weight approximately 12% chromium, 0.5% nickel, 1.0% molybdenum, 0.3% vanadium, 0.3% tungsten and 0.1% niobium, balance iron.

4. A self-lubricating slide component as defined in claim **1** containing by weight 8% graphite, 60% iron alloy subjected to nitriding and the remainder nickel and copper, the iron alloy consisting essentially of by weight approximately, 1.0% aluminum, 1.7% chromium, 0.2% molybdenum and 1.0% nickel, balance iron.

5. A self-lubricating slide component as defined in claim **1** and which contains from 10 to 90% by weight of the nitride-or carbo-nitride-forming metal elements and wherein said metal elements are iron alloys.

6. A self-lubricating slide component as defined in claim **5** wherein the iron alloy is an iron-aluminum alloy.

7. A self-lubricating slide component as defined in claim **6** wherein the iron aluminum alloy contains between 0.2 and 2.0% by weight of aluminum.

8. A self-lubricating slide component as defined in claim **5** wherein the iron alloy is an iron-aluminum-chromium alloy.

9. A self-lubricating slide component as defined in claim **8** wherein the iron-aluminum-chromium alloy contains approximately, by weight, 1% of aluminum, 1.0 to 2.0% of chromium, up to 0.6% of molybdenum, and up to 0.6% of vanadium.

10. A self-lubricating slide component as defined in claim **5** wherein the iron alloy is an iron-chromium alloy.

11. A self-lubricating slide component as defined in claim **10** wherein the iron-chromium alloy contains between 1 and 30%, by weight, of chromium.

12. A self-lubricating slide component as defined in claim **5** wherein the iron alloy is an iron-nickel-chromium alloy.

13. A self-lubricating slide component as defined in claim **12** wherein the iron-nickel-chromium alloy contains, by weight, 18% of nickel and 8% of chromium.

14. A self-lubricating slide component as defined in claim **1** containing 8% by weight of graphite, 70% by weight, of iron subjected to nitriding and the remainder being nickel and copper.

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