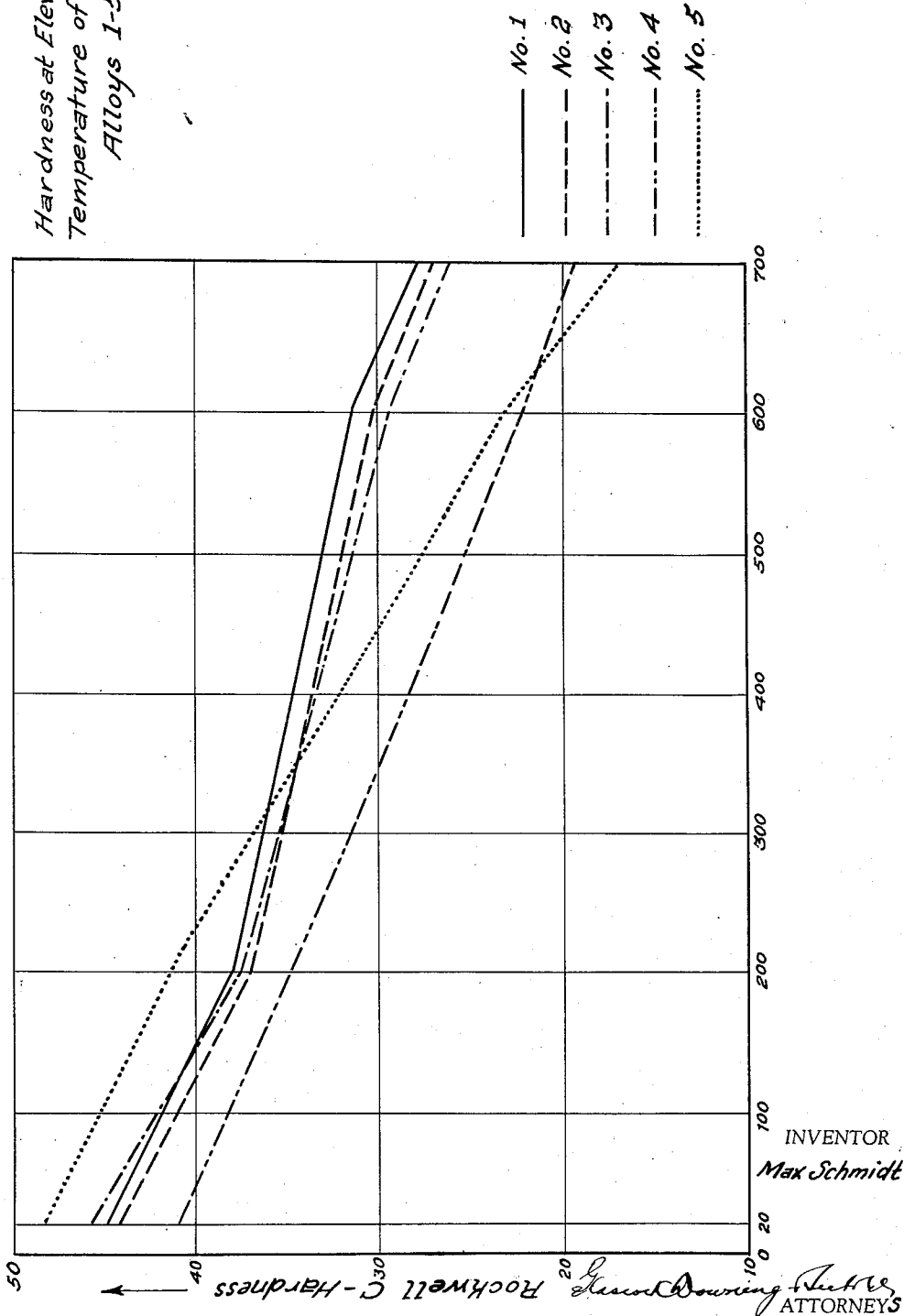


May 22, 1951

M. SCHMIDT
WELDABLE AND HIGH-TEMPERATURE RESISTING HARD
ALLOYS OF COBALT AND IRON BASE
Filed Feb. 27, 1948

2,553,609

Hardness at Elevated
Temperature of the
Alloys 1-5



UNITED STATES PATENT OFFICE

2,553,609

WELDABLE AND HIGH-TEMPERATURE RESISTING HARD ALLOYS OF COBALT AND IRON BASE

Max Schmidt, Kapfenberg, Austria

Application February 27, 1948, Serial No. 11,364
In Germany February 29, 1940

2 Claims. (Cl. 75-126)

1

Weldable hard metals as they are known under the trade names Celsit, Percit and Stellite, generally contain 0.8-3% carbon, 0.3 to 3.5% silicon, 23 to 32% chromium, 2 to 30% tungsten, up to about 2% of iron and the remainder of approximately 74 to 26% cobalt. The high cobalt content of these alloys in combination with the carbide forming elements chromium and tungsten endow them with an extraordinary hardness even at high temperatures and this is the reason why they are known as alloys with good high temperature (red hot) hardness. However, in view of their high cobalt content usually between 65 to 40%, they require considerable quantities of cobalt, and since cobalt may be difficult to obtain in times of war, it has been attempted to lower the cobalt content by introduction of a substitute metal. For this purpose, iron has been considered. In spite of the fact that the welding properties and hardness at room temperature are not influenced by a decrease of the cobalt content, alloys with greater quantities of iron exhibit a considerable decrease in hardness when heated. In iron-containing alloys in which the cobalt content is above 30%, the hardness at 600° C. is by 45-50% less than at room temperature, while in alloys practically free from iron the hardness at the same temperature is only about 28% lower than at room temperature. A further sharper decrease of the hardness when heated.

Such heat resisting weldable alloys of great hardness are however important for war, for they are, for example, necessary for armoring the valve cones of aircraft motors. Therefore it is desirable to make hard alloys which keep their properties when heated if their cobalt content is reduced to a large extent.

As a result of planned experiments it was first ascertained that by decreasing the cobalt content and increasing the iron content, even if substantial quantities of nickel which is closely related to cobalt is added, an improvement of the heat resisting properties cannot be achieved.

On the contrary, the addition of nickel which causes a stabilization of structure lessens the hardness while heated and an increase of the tungsten content does not solve the problem. It was found, however, that by the addition of certain quantities of molybdenum, alloys including iron could be obtained which, even with a substantial decrease of the cobalt content, exhibit the same properties in a heated state as alloys practically free from iron.

2

With these alloys, the limits of the various alloying elements lie within the following ranges:

0.8 to 3% carbon
0.3 to 3.5% silicon
23 to 32% chromium
2 to 30% tungsten
3 to 15% molybdenum

The balance up to 100% substantially all being iron and cobalt, of which the iron content amounts to at least 35% and does not exceed 80% of the total sum of the combined iron and cobalt contents.

The following is an example of a very economical alloy of proven high temperature hardness:

0.8 to 1.8% carbon
0.3 to 3.5% silicon
23 to 32% chromium
2.0 to 10% tungsten
3.0 to 8% molybdenum

The remainder to 100% is iron and cobalt of which the iron content is at least 50% and does not exceed 80% of the cobalt content.

The accompanying illustration shows the results of tests in a heated state of five alloys of the following composition:

	1. Alloy	2. Alloy	3. Alloy	4. Alloy	5. Alloy
	Per cent	Per cent	Per cent	Per cent	Per cent
C.....	1.42	1.43	1.46	1.38	1.60
Si.....	1.43	2.80	2.18	1.81	2.55
Mn.....	0.47	0.93	0.83	0.35	0.44
Cr.....	27.45	24.70	25.85	28.08	25.30
W.....	5.16	5.31	4.80	6.17	4.80
Mo.....	-----	4.68	4.68	-----	-----
Fe.....	1.07	27.16	41.80	28.91	47.33
Co.....	rest	rest	rest	rest	rest

From the illustration it appears that the addition of molybdenum maintains the hardness in a heated state of the alloys rich in iron and poor in cobalt at a value which corresponds with that of alloys free from iron and rich in cobalt.

It is also possible to substitute for the tungsten content the customary equivalent quantities of molybdenum, especially in the known ratio of 2:1.

With the knowledge thus gained that by the addition of molybdenum to hard alloys of iron but poor in cobalt, these alloys in a heated state may be endowed with the same properties which the hard alloys that are practically free of iron and of a high cobalt content exhibit, it becomes possible to get along with relatively small additions of cobalt and to satisfy the needs of wartime economy for such alloys.

The welding properties of the hard alloys ac-

3

cording to the invention alloyed with molybdenum and with addition of iron and decreased cobalt content do not exhibit a decline as compared with the alloys practically free from iron and rich in cobalt.

Having now fully described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. Weldable cobalt bearing hard alloys of high strength at elevated temperatures containing

0.8% to 3% carbon
0.3% to 3.5% silicon
23% to 32% chromium
2% to 30% tungsten
3% to 15% molybdenum

the balance up to 100% substantially all being cobalt and iron of which the iron content amounts to at least 35% and does not exceed 80% of the total sum of the combined iron and cobalt contents.

2. Weldable cobalt bearing hard alloys of high strength at elevated temperatures containing

0.8% to 1.8% carbon
0.3% to 3.5% silicon
23% to 32% chromium
2% to 10% tungsten
3% to 8% molybdenum

4

the balance up to 100% substantially being all cobalt and iron of which the iron content amounts to at least 50% and does not exceed 80% of the total sum of the combined iron and cobalt contents.

MAX SCHMIDT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,277,431	Kuehnrich	Sept. 3, 1918
1,376,056	Wandersee et al.	Apr. 26, 1921
2,309,372	Wissler	Jan. 26, 1943

OTHER REFERENCES

Stahl und Eisen, vol. 44, 1924, pages 1717 to 1720.

Chemical Abstracts, vol. No. 32, 1942, column 5756.

Engineering Alloys, second edition, page 170, alloy No. 1050-1. Edited by Woldman et al. Revised in 1945. Published by the American Society for Metals, Cleveland, Ohio.