

Patented June 19, 1923.

1,459,570

# UNITED STATES PATENT OFFICE.

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## FORGIBLE STEEL AS AN ARTICLE OF MANUFACTURE.

No Drawing. Continuation of application Serial No. 44,310, filed August 7, 1915. This application filed  
July 3, 1920. Serial No. 393,968.

*To all whom it may concern:*

Be it known that I, LINUS PORTER BURROWS, a citizen of the United States, and a resident of Erie, in the county of Erie and State of Pennsylvania, have invented certain new and useful Improvements in a Forgible Steel as an Article of Manufacture, of which the following is a specification.

In an application filed by me on the 4th day of May, 1920, No. 378,895, a continuation of an original application filed August 7, 1915, No. 44,310, now Patent No. 1,424,711, my Patent No. 1,424,710 I have described a process by which ore containing nickel is directly treated and refined and subsequently smelted, the resultant metalliferous product disintegrating on exposure to the air into a very fine powder, adapted for use with steel or iron scrap, and when thus used produces a very fine cast magnetic metal corresponding in microscopic structure to brass and other non-magnetic alloyed metals, but having finer crystals and having much greater rigidity and tensile strength. As described in an application filed by me January 20, 1920, No. 352,775, I take this powder which before it is treated again, imparts great tensile strength at a sacrifice of ductility, and subsequently treat it to make it suitable for use in the production of forging steel. This treatment consists of heating the first product to a low red heat without material oxidation which has the effect of reducing the weight of the previously recovered product, approximately 20 per cent, depending on what grade or strength of concentration I may require for the physical strengths wanted, and character of steel. The resultant product is remarkably effective in the production of forging steels, the steel made by the addition of said product its use constituting a new article of manufacture, having the rigidity of a .50 to .60 carbon steel, (though made as a medium and low carbon steel of .40 carbon and under and .20 carbon and under); of great density, high Brinell number, yet capable of bending, punching riveting and welding, having great ductility, having a difference in

color due to its density, superior in the uses to which soft low yield point steels are adapted, while at the same time this new steel is capable of being utilized in making a much better grade of tool steel than can be made with plain carbon steel. Different proportions of this powder may be used as desired, but I have found that one half to ten per cent gives good results. I may use from a half of one percent to two and one-half per cent of the powder depending upon the special character of steel desired.

A further distinctive feature of the steel is that its physical properties are not destroyed under high heat, having been actually heated as high as 2350° F. without injury; it can be heated almost to the point of melting and then water tempered into an efficient cutting tool. These qualities are all due to the use of the powder in connection with ordinary carbon scrap.

The steel made with the use of this powder (which I have named Burrowlite) described in application No. 352,775 and properly heat treated has the peculiar characteristic property of showing an extremely high Brinell number and rigidity and retains at the same time its malleability under impact without fracture and may be machined by ordinary methods. To determine the identity of steel coming within my invention a test may be made by:

Heating the steel to 2200° Fahrenheit to 2350° F. then quenching in water. If it is steel made within my invention it will be capable of being used as a cutting tool without further treatment and also of being riveted or machined, and these qualities are not found in any other known steel. From tests it has been found that the powder produces a very dense steel more free from gases of an exceptionally fine grain, exceedingly free from blow holes, ghost lines and other objectionable features and having a greater specific gravity than carbon steel. Tests have been made showing an increase of specific gravity from 7.4 for carbon steel to 7.8 or over for steel within my invention.

Owing to the density of the steel made



within my invention the Brinell hardness numbers have a different meaning and bear a different ratio to other steels, still it can be machined or worked cold; for instance, a .30 carbon steel cannot be hardened to give a 400 to 500 Brinell number, while a .30 carbon steel made according to my invention can be hardened to give these numbers and can still be machined, sawed, riveted, etc. This is not true of any other steels with Brinell numbers of 400 to 500, which numbers indicate a much higher carbon than .30 carbon steel, being a carbon of .40 and over, and .60 carbon and under.

I apply this powder as an addition to the molten metal, preferably in a manner to assure effective action without waste of the powder. The powder is usually placed in containers of sheet metal in quantities of about one hundred pounds and these containers are simply thrown into the bath, the weight causing them to sink in the mass beneath the slag where the powder is thoroughly distributed on the melting of the containers. I do not limit myself in this connection, however, as the powder may be applied in the crucible, open hearth or other furnace or ladle in any manner and as additions are now made to steel or it may be introduced into the crucible or open hearth simultaneously with the material to be melted.

The character of my new steel is remarkably distinguished from known steel in that I secure qualities not to be found heretofore in steel, even of the highest grade, and produce it at a cost slightly over that of straight carbon steel, and very much less than the cheapest of the present day alloy steels.

Tests have been made with steel made according to my invention, and partial results thereof are tabulated below:

Test A.

The following materials were charged into crucibles:

Melt No.	Steel punchings.	Cast iron.	Alloy.
A-1.....	67.5 lbs.....	7.5 lbs.....	0.75 lbs.
A-2.....	67.5 lbs.....	7.5 lbs.....	1.125 lbs.
A-3.....	67.5 lbs.....	7.5 lbs.....	1.50 lbs.

After solidification transferred to soaking furnace.

Test B.

B-1.....	90 lbs.....	10 lbs.....	1.0 lbs.
B-2.....	90 lbs.....	10 lbs.....	1.5 lbs.

Ingots transferred to soaking furnace for 14 hours at 1400° F. After soaking the temperature was raised to 1650° F. and ingots

forged under steam hammer into bars 1 1/4" square and cooled in air.

Analysis of specimens.

Specimen No.	Material.	C.	Mn.	Ni.	P.	Si.	S.
1414.....	A-1.....	1.05	0.26	0.11	0.088	0.19	0.080
1415.....	A-2.....	1.59*	0.28	0.15	0.091	0.17	0.081
1419.....	B-1.....	0.94	0.26	0.12	0.086	0.20	0.083
1422.....	B-2.....	1.09	0.25	0.15	0.086	0.16	0.083
1426.....	A-3.....	1.08	0.22	0.19	0.097	0.09	0.086

Combined 1.34. Graphite 0.25.

Tensile tests.

Specimens of Burrows steel are below compared with each other and with annealed samples of ship plate, Class A nickel steel with a Ni content of 3.92%, and armor plate.

Material.	Melt No.	Per cent alloy.	Yield point.	Tensile strength.
Ship plate.....			34,500	71,500
1414.....	A-1.....	1	80,500	143,600
1415.....	A-2.....	1 1/2	77,500	106,200
1419.....	B-1.....	1	56,400	132,200
1422.....	B-2.....	1 1/2	58,500	113,500
1426.....	A-3.....	2	122,500	193,600
Ni steel.....			53,900	81,300
Armor plate.....			58,400	88,200

Resistance test.

Metal.	Resistance.
B-1.....	3.8
B-2.....	3.7
A-3.....	3.6
Annealed armor plate.....	4.3
Class A nickel steel.....	4.3
Monel metal.....	4.4
Shop plate.....	4.3

The above tests were made in the physical laboratory, machinery division, navy yard, Philadelphia, Pennsylvania, and the report thereof may be found under the navy yard #205; 10-WPY.

I claim:

1. As a new article of manufacture a forging steel capable after being heated to 2200° F., and water tempered, of being used as a cutting tool and without further treatment of being forged, prepared by adding a purplish powder produced from nickel ore to a charge of metal scrap.

2. As a new article of manufacture, a forging steel prepared by adding from a half to 10% of a purplish powder produced from nickel ore to a charge of metal scrap.

In testimony whereof, I affix my signature.

LINUS PORTER BURROWS.

Witness:

ELLIS S. MIDDLETON.