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GRAY IRON ALLOY

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This invention relates to gray iron alloys and more especially to nickel bearing iron alloys. The invention relates more particularly to gray iron nickel bearing compositions adapted for wearing parts, such as dies, cams, gears, cylinders, and like parts subject to wear and requiring strength and hardness coupled in some cases, with mechinability.

We provide a composition which is tough and strong. Moreover, the hardness may be varied to suit the purpose for which the composition is used. The composition may be varied within certain ranges to obtain certain definite properties, notably strength, hardness and toughness, along with a desirable degree of machinability.

Our improved composition is rendered particularly adapted for wearing parts by reason of its susceptibility to ready lubrication. The presence of flakes of graphite in the composition affords a source of lubrication in themselves, and these flakes absorb and retain oil.

In practice we have obtained good results with compositions within the following ranges:

	Per cent
Carbon	2– 4
Silicon	.25– 3
Manganese	.25– 2
Nickel	1.5–12
Chromium	up to 3

The elements usually present in cast iron in small amounts, such for example, as sulphur and phosphorus, may be present within the usual ranges.

The composition may be varied somewhat if desired by the addition of other alloy materials such as copper, aluminum, molybdenum, tungsten, etc.

Compositions lying within the above ranges may be had with hardness up to 350 Brinell in sand casting. The properties however, vary somewhat from thin to thicker sections, and a range of compositions is therefore desirable to adjust the hardness and chilling tendency of the iron to the section which is to be poured. The tendency of the iron to chill may be readily controlled by suitably adjusting the nickel and chromium contents together with the silicon and carbon contents, and the sulphur present. We have found that the chilling tendency is increased by an increase of the chromium or sulphur content, but an increase in the silicon, carbon and nickel tends to decrease the chilling tendency. Roughly speaking, the relative effectiveness of the elements is about as follows:

1 part of carbon equals 3 parts of silicon
1 part of silicon equals 2 parts of nickel
2½ parts of nickel equals 1 part of chromium
1 part of sulphur equals 10 parts of silicon

Sulphur and phosphorus may be present within the usual ranges found in cast iron. In order to attain the desired results, the nickel must be in a ratio of from about 2 and upwards of nickel to 1 of chromium.

For a strong tough iron having a hardness of 250–350 Brinell as cast in green and dry sand, we prefer the following ranges:

	Per cent
Carbon	2.75–3.5
Silicon	.5 –1.5
Manganese	.5 – .8
Nickel	4 –8
Chromium	up to 2

This composition gives an extremely hard iron which will probably have to be ground to shape, since it cannot be machined readily. This composition has the distinguished feature of a martensitic structure. Martensite is often associated with austenite, and hence by the word "martensite" we intend to include either or both in association. Within these limits the composition may require some adjustment to secure the maximum hardness for different sections of casting. If good ma-

chinability is required, recourse may be had to the slightly different range of composition given below which gives a hard, tough iron readily machinable:

	Per cent
Carbon	2.75–3.5
Silicon	.5 –1.5
Manganese	.5 – .8
Nickel	1 –5
Chromium	up to 2

Sulphur and phosphorus may be present within the usual ranges found in cast iron.

The iron obtainable by this composition is characterized by its hardness and resistance to wear; it has very little shrinkage; and it may be readily handled in ordinary foundries. The hardness of the iron obtained by this composition may be varied from about 200 to 300 Brinell as desired. Even with the higher degree of hardness, however, the iron is readily machinable.

All of the compositions contemplated by this invention are subject to heat treatment. Various characteristics, such as hardness and toughness may be modified by heat treating if desired.

As indicated above, the properties of our improved alloy vary somewhat from thin to thicker sections and the range of composition given provides for adjustment of the hardness and chilling tendency of the iron to the section which is to be poured. We have found that the thinner sections require a relatively smaller amount of chromium to impart the hardness mentioned, whereas heavier sections require relatively larger amounts of chromium within the ranges set out.

By using nickel in the higher part of the range an austenitic structure may be secured which is very tough, although not quite so hard as the martensitic iron obtained with lower nickel content.

Straight nickel additions to cast iron increase the hardness up to a certain point, after which the hardness begins to decrease. The center of the martensitic stage for the cooling rate encountered in one and one quarter inch test bars may be found in the neighborhood of ten per cent of nickel. (With heavier sections, however, a higher percentage of nickel may be required to bring out the maximum hardness.)

Another important asset of our improved alloy is a marked resistance to deformation. This characteristic renders the alloy particularly suited to die work, and like uses, where it is desirable that the forming parts remain a predetermined size under load and impact.

We are aware that nickel has been proposed as an addition material to reduce the chilling effect in iron alloys and that chromium has been proposed as a hardener. We have found, however, that a proper proportion should be maintained with respect to the other elements present to secure the maximum hardness and strength, and yet adequate machinability. The machinability of iron wearing parts is an important consideration which is intimately related to the chilling tendency of the iron. We provide for suitable adjustment of the composition to obtain the desired physical qualities of the iron and also obtain machinability of the degree required for the particular use to which the composition is to be put.

We further provide a gray iron alloy having improved qualities rendering it adapted for wearing parts, such as hardness, resistance to wear, resistance to deformation, and susceptibility to lubrication.

We claim:

1. A gray iron casting containing about 1.0% to about 12.0% nickel, up to about 2.0% of chromium, and about 2.0% to about 4.0% of carbon, the nickel being in excess of the chromium in the ratio of from about 2 and upwards of nickel to 1 of chromium, said casting as cast in a mold without heat treatment consisting practically wholly of graphite and martensite or troostite and to a minor degree of free iron carbide and having a Brinell hardness in excess of about 200.

2. A gray iron casting containing about 1.0% to about 12.0% of nickel, up to about 2.0% of chromium, and about 2.0% to about 4.0% of carbon, the nickel being in excess of the chromium in the ratio of from about 2 and upwards of nickel to 1 of chromium, said casting as cast in a mold without heat treatment consisting practically wholly of graphite and martensite or troostite and to a minor degree of free iron carbide and having a Brinell hardness in excess of about 200 and lower than about 400.

3. A hard gray iron casting containing about 2.5% to about 3.7% of carbon, about 0.30% to about 3.0% silicon, about 1.0% to about 10.0% nickel, and about 0.15% to about 2.0% chromium in the ratio of from about 2 and upwards of nickel to 1 of chromium, said nickel being present in excess of chromium, said casting as cast in a mold without heat treatment consisting practically wholly of graphite and martensite or troostite, and to a minor degree of free iron carbide and having a Brinell hardness in excess of about 200.

4. A gray iron casting containing about 1.0%to about 5.0% of nickel, up to about 3% of chromium, and about 2.0% to about 4.0% of carbon, the nickel being in excess of the chromium in the ratio of from about 2 and upwards of nickel to 1 of chromium, said casting as cast in a mold without heat treatment consisting practically wholly of graphite and martensite or troostite, and to a minor degree of free iron carbide and having a Brinell hardness in excess of about 200.

5. A machinable gray iron casting contain-

ing from about 1.0% to about 4.0% of nickel, up to about 1.50% chromium, and about 2.0% to about 4.0% of carbon, the nickel being in excess of the chromium in the ratio of from about 2 and upwards of nickel to 1 of chromium, said casting as cast in the mold without heat treatment consisting practically wholly of graphite and martensite or troostite, and to a minor degree of free iron carbide, and having a Brinell hardness of over about 200 and less than about 300.

In testimony whereof we have hereunto set our hands.

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