May 27, 1930. C. F. LAUENSTEIN 1,760,241

METAL

Filed Oct. 15, 1928

Fig. 1

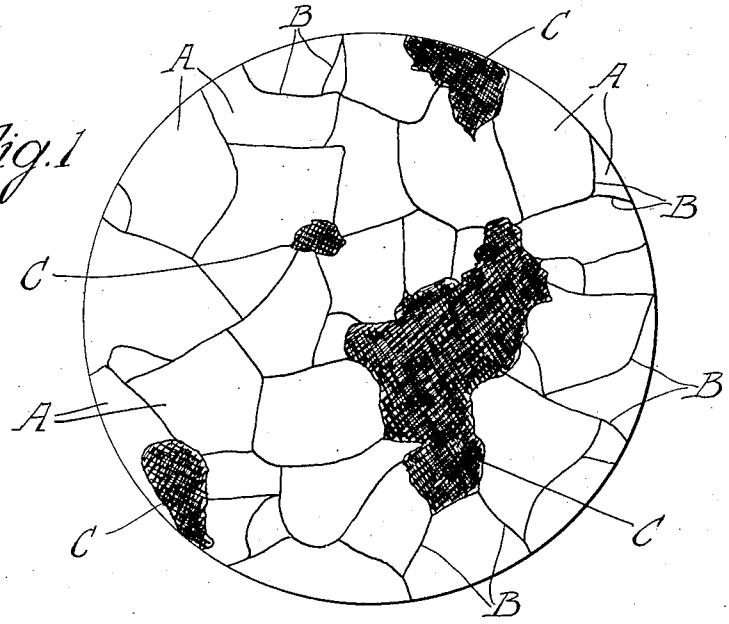
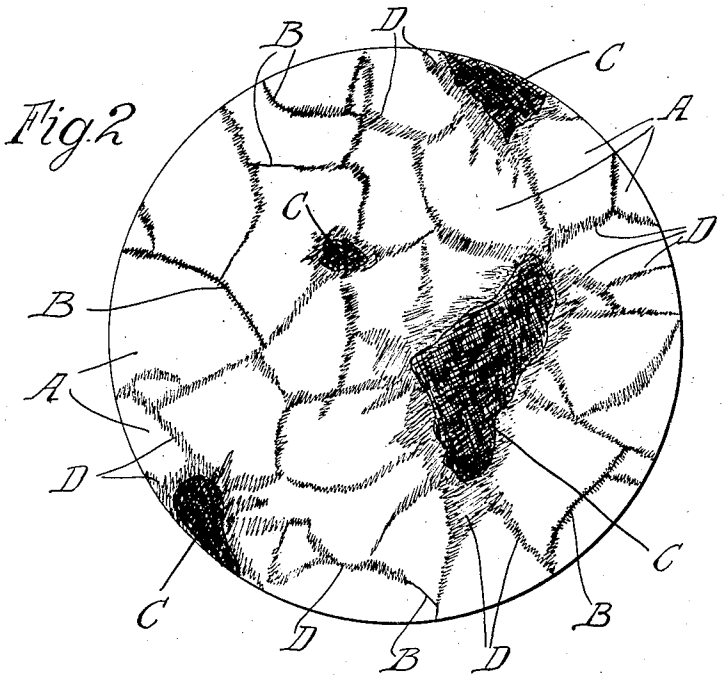


Fig. 2



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METAL

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This invention relates to a ferrous metal. One object of the invention is to produce a metal which has high physical properties and a high resistance to abrasive wear. Other objects will appear from time to time in the course of the specification and claims.

The metal of this invention is a ferrous metal and it may include the following ingredients:

1. Ferrite,—that is to say, carbonless iron. It may contain .70 to 1.30 per cent silicon and other impurities such as manganese sulphur or phosphorous in small amounts.

2. Graphitic carbon or free carbon. By this is meant carbon which is held mechanically in the metal, but is not in chemical combination with it or with the other ingredients.

3. Pearlite,—that is to say, the iron carbon eutectoid consisting of alternating masses of cementite and ferrite. Other substances may occur in varying quantities. Among these may be martensite and sorbite.

The accompanying drawing illustrates in Figure 1 the structural arrangement and constituents of a sample of malleableized cast iron and in Figure 2 a sample of the metal of my invention. The figures are diagrammatic showings based upon microphotographs of samples of metals. They suggest diagrammatically only typical forms of the metal. Other samples would show the same general characteristics, but would show detailed modifications.

In Figure 1 the metal is seen to be generally granular. It is composed of grains A, which are ferrite and separated from each other along boundaries B. The grains may be of irregular shapes and sizes. Interspersed through the mass of the metal are spots of free or graphitic carbon C.

Figure 2 is a diagram based upon a microphotograph of a section of a sample of the metal of this invention.

As illustrated in the drawing, the metal is generally granular, being formed of grains A. These grains are bounded or separated along boundaries B. The grains are in the form of ferrite. C represents a spot of graphitic or free carbon. In a larger sample of the metal a number of such spots of graphitic carbon would appear. Situated throughout the metal, surrounding the grains and the graphitic carbon and filling the great majority of the grain boundaries and to some degree penetrating within the ferrite grains themselves is pearlite. This material is indicated at D.

Figure 2 illustrates an important characteristic of the present invention, namely that there is distributed throughout the metal, along the grain boundaries and about such particles of graphitic carbon as are present an agent which tends to stiffen the grains and prevent their distortion under stress, thus strengthening the mass and preventing the separation or pulling apart of the grains. This agent is an iron carbide and in the form illustrated in Figure 2, is normally pearlite or sorbite. It is characteristic of the iron carbide, which in this case may be pearlite or sorbite, that it is strong and tough and it thus strengthens the grains against distortion, holding the grains together more strongly than in other cast iron where the ferrite is combined without the presence of any appreciable amounts of pearlite at the grain boundaries. It thus increases the tensile properties of the material.

It also makes the metal of the invention highly resistant to wear or abrasion. The harder and tougher pearlite or sorbite at the ferrite grain boundaries acts as a guard preventing the wearing or abrading away of the softer ferrite grains.

The metal of the present invention may be formed from cast iron, such as white cast iron. White cast iron has an average chemical composition as follows:

	Per cent
Combined carbon	2.30
Graphitic carbon	Nil
Silicon	.90
Manganese	.27
Sulphur	.060
Phosphorous	.16

Such cast iron is heat treated. The process involved is fully set out and explained in my pending application 231,789, filed Nov. 7, 1927. In brief this process includes the following steps—malleableized cast iron is heated to a temperating in the neighbor-

hood of 1475° F. This is only an approximation. The length of time that the material being treated must be held at this temperature varies with the size of the parts being treated. It is always necessary that the material be brought to a temperature above the critical or carbon combining temperature. After the heat has been carried on for a sufficient time, the material is quenched, that is to say it is cooled in air, oil, water or other medium. After it has been so quenched it is re-heated to a temperature not exceeding the critical or carbon combining temperature. The re-heating is usually carried out to the point sufficient to break down the martensite or troostite, which has been retained after the first heating, into the pearlite or sorbite. This change will normally be effected at a temperature range of 900° F. to 1200° F. These are not definite limits and are not to be so considered. They are cited merely as examples of a typical manufacturing practice. After the material has been treated, its chemical analysis may be as follows:

	Per cent
Combined carbon	.40
Graphitic carbon	1.50
Silicon	.90
Manganese	.27
Sulphur	.060
Phosphorous	.16

In the form of the cast iron, the metal is largely made up of cementite and pearlite, cementite being tri-ferrous carbide (Fe_3C). After the material has been processed and changed so as to produce the metal of the present invention, it consists, as above stated, of ferrite, pearlite and graphitic carbon. The arrangement of the constituents however, has taken the characteristic form shown in the drawing herewith and in this form, and instead of cementite, ferrite is the main constituent. Some free or graphitic carbon is present and a considerable quantity of combined carbon or pearlite is present, and this is spread about through the body of the metal and particularly within the grain boundaries so as to produce a toughening and strengthening of the entire body of the metal. Thus the relatively weak ferrite has associated with it the strong and tough pearlite or sorbite. This material by its presence in the mass of metal and particularly by its wide distribution along the grain boundaries greatly strengthens the resultant metal.

In making my metal where cast iron is used, this iron may be, and usually will be malleableized as one step of the process. It is one of the objects of my invention to produce a metal which is stronger and more resistent to wear than ordinary malleableized cast iron. For that reason I have illustrated malleableized cast iron in Figure 1 and in Figure 2 I have illustrated the metal of my invention. The contrast between these two drawings serves to bring out the characteristic features of my metal and to differentiate it clearly from malleableized cast iron.

In the metal of this invention, the main body of the metal is made up of a group of ferrite grains. The great majority of these grains is surrounded each with a harder shell of pearlite or sorbite, that is to say,—with a shell of an iron carbide which has such physical properties that it tends to strengthen the grain of ferrite. It prevents deformation of the grain and by this fact it resists distortion of the grain and resists breaking of the grain itself or separation of one grain from the other. This iron carbide in the body of the metal may be said to act like an iron reinforcement about a piece of wood. It prevents distortion and so prevents splitting and breaking. Thus in the metal of this invention there is built up throughout the body of the metal a reinforcing frame-work of the stronger iron carbide which has many cell-like compartments in it. These cells surround the weaker grains of the ferrite which are thus strengthened and the separation of these ferrite grains is resisted by this cell like structure of the carbide. In effect there is built up a structure which may be likened to a honey comb. This is formed of the iron carbide and within the cells of the honey comb are found the grains of ferrite. The honey comb thus serves to strengthen the individual grains and to resist deformation of them and further, to resist deformation of the mass as a whole and to prevent separation of the grains.

Where in the claim I use the expressions free ferrite or free cementite I mean ferrite or cementite not associated to form pearlite.

Where I use the term granular I am referring to the granular structure of the metal as distinguished from finely comminuted material such as grains of sand and the like.

Where I have used the expression alloy as referring to the metal which forms the subject matter of this invention I mean a combination composed mainly of iron with some carbon. Basicly the metal or alloy defined in the claims is malleableized cast iron which has been heat treated to produce a new and radically different type of metal. A typical analysis of the metal appears above.

I claim:

1. A granular ferrous metal including grains of free ferrite, graphitic carbon and iron carbide, the latter being distributed between the grains of ferrite and about the graphitic carbon.

2. A ferrous alloy of granular formation having a tough, strong constituent of the alloy distributed widely through the material along the grain boundaries whereby separation of the grains of the alloy is made more difficult, said strong substance being mostly an iron carbide.

3. A granular ferrous alloy characterized by the fact that there is formed within the body of the alloy, a strenghening and retaining structure lying within the grain boundaries and about the individual grains and that the material of said supporting structure is of greater strength than that of the grains of the main body of the alloy itself, the strengthening structure consisting mostly of an iron carbide.

4. A ferrous alloy having high abrasion resistant qualities and in which there is formed within the body of the alloy, a grain strengthening and retaining structure lying within the grain boundaries and about the individual grains, the material of this supporting structure having greater abrasion resistant qualities than the main body of the metal alloy itself, the strengthening structure consisting mostly of an iron carbide.

5. A ferrous alloy of granular formation including grains of free ferrite and having a tough strong constituent of the alloy distributed widely through the material along the grain boundaries whereby separation of the grains of the alloy is made more difficult, the tough strong constituent consisting mostly of an iron carbide.

Signed at Indianapolis, county of Marion and State of Indiana, this 4th day of Oct., 1928.

CARL F. LAUENSTEIN.