C. A. MUDGE.

ELECTRICAL RESISTANCE.

APPLICATION FILED JULY 16, 1906.

1,044,562. Patented Nov. 19, 1912.

Fig. 1.

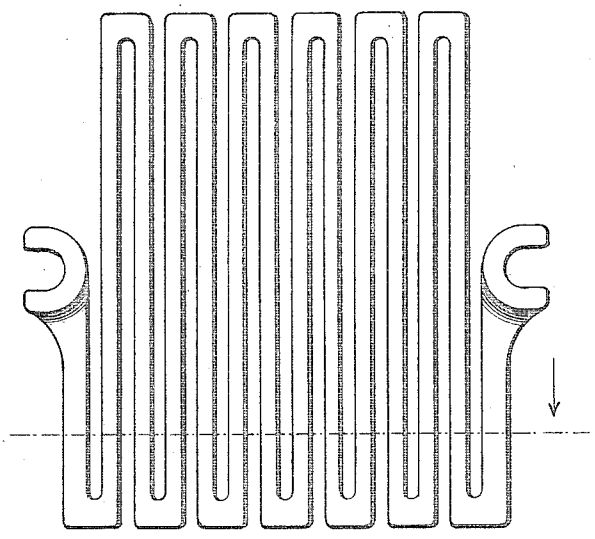

Fig. 2.

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ELECTRICAL RESISTANCE.

1,044,562. Specification of Letters Patent. Patented Nov. 19, 1912.

Application filed July 16, 1906. Serial No. 326,392.

To all whom it may concern.

Be it known that I, CHARLES A. MUDGE, a citizen of the United States, residing at New York, borough of Manhattan, in the county of New York and State of New York, have invented new and useful Improvements in Electrical Resistances, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to improvements in electric resistances and the process of making the same. It applies more particularly to that form of resistance which is known in the art as "grid" resistance. The accompanying drawing illustrates one form of "grid" resistance.

Figure 1, is an elevation, and Fig. 2, is cross-section on the line 2—2.

The "grid" resistance is especially adapted for commercial use because it may be produced at a low cost, because it may be readily made in such forms as are best suited to the conditions, and because it may be made of materials which are sufficiently rigid to permit it to be so formed and arranged as to expose a large portion of its surface for the radiation of heat.

The convolution of a grid must be of sufficient cross-section to be capable of being readily cast and to be able to withstand the mechanical shocks and strains received in use and during transportation. There is, therefore, a minimum cross-section less than which it is impracticable to make the convolutions, and, consequently, in practice a maximum resistance for a given material and space is established. Heretofore it has frequently been necessary to use resistance made of wire and ribbon of German silver and other alloys, where it would have been preferable to use grid resistance, if the specific resistance of the materials from which grids were made were higher.

The object of my invention is to produce a resistance material which will have a higher specific resistance than the materials now used in grid resistance and which will have sufficient mechanical strength to withstand the shocks and strains to which it will be subjected in practice.

Furthermore, it has for its object to produce a resistance material which will have a low temperature coefficient and which may be readily cast into grid form.

Heretofore the metal generally used to make grid resistance was ordinary gray cast iron of commerce, which consisted of 90% to 95% iron, the balance being made up of carbon, silicon, manganese, sulfur and phosphorus, carbon and silicon forming the greater part of the balance. The amount of carbon in cast iron determines its specific resistance more than any other element. Cast iron containing 4% of carbon will have approximately 10% higher specific resistance than cast iron having only 2% carbon, other elements remaining practically the same. Manganese and silicon also tend to increase the specific resistance of iron but not in the same proportion as carbon, but these elements harden and weaken the iron, thereby making it unfit for grid resistance. If cast iron contained a definite proportion of its constituent elements, it would have a higher specific resistance than is usually found in this metal. However, it is practically impossible to obtain the proper proportion of these elements from the foundries where grids are cast.

According to my invention I employ an alloy of iron and aluminum to make grid resistance. I find that the addition of a definite amount of aluminum to iron, no matter in what proportions the elements of the iron may be combined, results in an alloy the specific resistance of which is much greater than that of cast iron itself. The aluminum may be combined with the iron in various proportions. I have found, however, that if the alloy contains between 2% and 4% aluminum, it will have very desirable physical and electrical properties. In practicing my invention I have obtained very satisfactory results from such a composition as follows:

Carbon	4.2%
Aluminum	2.5%
Silicon	2.4%
Iron	90.9%
	100.0%

In this composition the iron contained traces of manganese, phosphorus, and sulfur, as is found in all foundry irons, but in

such small quantities that the exact per cent. was not determined. Grids made from an alloy of the above composition had 100% greater specific resistance than those made from ordinary cast iron. The smaller the cross-section of the convolutions of the grids, the better are the results, as it is a fact that the specific resistance of the alloy, when the alloy is cast in large cross-section, is somewhat lower than when the alloy is cast in small cross-section. Moreover, the specific resistance of the alloy is greater when the grids are cooled slowly.

If 2% aluminum be added to any specimen of cast iron, the resulting alloy will have at least 30% greater specific resistance than the cast iron itself.

I prefer that the alloy should have over 4% carbon or as much carbon as is possible. Of course, the various proportions of the elements in the alloy may be varied under different circumstances. It should be understood that I do not limit myself in any way to the proportions which I have specified as these proportions may be different and still produce the results which I seek.

My invention comprehends any composition of iron and aluminum which has a higher specific resistance than that of the iron itself. The iron may have its elements combined in various proportions.

In practising my invention, I prefer to melt the iron and aluminum separately, and then mix the same. If the iron be melted first and then the aluminum added thereto in solid form, or if the iron and aluminum be melted together, the aluminum will be subjected to heat so long that it will oxidize and pass off in fumes, and consequently it will be difficult to obtain the proper proportion of aluminum. The alloy should be poured into the mold for the grid soon after the melted iron and aluminum are mixed, in order to avoid oxidation of the aluminum. It is preferable to cast the grid in a heated mold, and then to cool it slowly so as to prevent the grid from becoming hard and brittle.

If grids be made according to the practice that I have set forth above, the same will have a very high specific resistance and considerable mechanical strength.

Although my invention concerns itself more particularly with "grid" resistance, it is applicable to other forms of resistance wherein the results which I obtain are desired.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. An electrical resistance formed from an alloy containing high carbon iron and aluminum.

2. An electrical resistance formed from an alloy containing aluminum, silicon and high carbon iron.

3. An electrical resistance containing high carbon cast iron and substantially 2.5% aluminum.

4. An electrical resistance formed from an alloy having substantially the following composition:

Carbon	4.2%
Aluminum	2.5%
Silicon	2.4%
Iron	90.9%

5. An electrical resistance formed from an alloy containing cast iron and aluminum, the cast iron containing over 3% of carbon.

6. A resistance formed from an alloy containing two or more per cent. of aluminum and iron containing over three per cent. of carbon.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

CHARLES A. MUDGE.

Witnesses:
A. B. JOHNSON,
H. C. LEIGH.