UNITED STATES PATENT OFFICE.

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ALLOY.

981,542. Specification of Letters Patent. Patented Jan. 10, 1911.

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To all whom it may concern:

Be it known that I, WILBUR B. DRIVER, a citizen of the United States, and a resident of East Orange, New Jersey, have invented new and useful Improvements in Alloys, which are fully set forth in the following specification.

My invention is a new alloy or a series of alloys, intended primarily for use as resistance-material in electrical work.

The object of the invention is to produce alloys having high, and even abnormally high, specific resistances; alloys which are also reliable and permanent in their physical properties (*i. e.*, ductile and not liable to deteriorate from rust upon exposure to atmosphere), and which are likewise reliable in their electric behavior. Although ductility is an exceedingly desirable property, yet where the alloy is to be employed in cases where it is not necessary to work it, or in other forms than drawn wire, some ductility may be sacrificed in obtaining increased specific resistance.

The specific resistance of ordinary copper is about 1⅔ microhms per cubic centimeter. Taking this resistance of copper as the unit, the resistance of the alloy "mangamin" as compared with that of copper is about 24 (or, about 40 microhms per cubic centimeter); of "eighteen-per-cent. German silver", about 18; of "thirty-per-cent. German silver", about 28; of "advance" or "constantan" about 28. And these are the highest figures of any satisfactory material now known which will not rust. There is a demand for alloys having much higher specific resistances,—resistances of about 80 or more microhms per cubic centimeter or fifty or more times that of copper. This amount of resistance is what I mean by "abnormally high" specific resistances. While it is true that a class of alloys has been produced with a very high specific resistance (about 83 microhms per cubic centimeter), yet it has proved unsatisfactory on account of certain inherent defects. The alloys of this class contain iron and nickel; but such alloys inevitably deteriorate more or less rapidly from rust, on account of the large quantity of iron.

It is well known that the addition of manganese to copper tends to raise the specific resistance; but if we increase the amount of manganese sufficiently to attain an abnormally-high or even a comparatively-high, specific resistance, the alloy becomes unreliable and unstable in its electric behavior. So that past experience has served to shut the door to manganese as a means for producing a commercially satisfactory alloy of very high resistance. Nickel is also known to increase the resistance of the alloys into which it enters,—but to a degree inferior to manganese. So that the addition of nickel will not produce the abnormally high specific resistance. Nickel and manganese have been used conjointly, with copper. But the nickel has been taken only in very small percentages.

I have discovered that nickel has the property, when entering into an alloy of copper and manganese, of "fixing" the electrical behavior of the alloy; when the percentage of manganese is increased, it is generally desirable to increase the amount of nickel; this increase, however, is not essential. An increase of nickel tends to harden the resultant alloy, which is sometimes an objection. When to copper is added a large percentage (ten per cent.—10%—or over) of manganese and also a large percentage (ten per cent.—10%—or over) of nickel, there is obtained a homogeneous alloy that is ductile and workable, one that does not rust, and above all that has a very high specific resistance and is reliable and constant in its electrical behavior. By this departure from the teachings of past experience, I obtain to a higher degree than heretofore deemed possible all the benefit of manganese but without the disadvantage, heretofore sup-

posed to be inseparable from the presence of a high percentage of manganese.

The following formulas give the proportions of the three ingredients and the specific resistance of each composition, stated in microhms per cubic centimeter:

Copper.	*Manganese.*	*Nickel.*	*Specific resistance.*
60	10	30	65
45	10	45	68
75	15	10	53
65	15	20	61
70	20	10	68
60	20	20	75
50	20	30	88
40	20	40	98
65	25	10	85
60	25	15	93
55	25	20	95
55	30	15	113
50	30	20	123
50	35	15	124
40	40	20	150

The proportions above indicated may of course be varied considerably without losing the effectiveness of the alloys, or departing from the spirit of my invention,—the result of such variations being to raise or lower the specific resistance, which in any case will be high. The spirit of my invention consists in using both manganese and nickel in proportions much larger than heretofore employed. My experiments, as illustrated by the formulas given, indicate that there must be ten per cent. (10%) or over of nickel, conjointly with ten per cent. (10%) or over of manganese.

Having thus described my invention, I claim:

1. A ductile and stable electrical conductor of non-rusting material, having an abnormally-high specific resistance, substantially as described.

2. An electrical resistance-element containing copper, with manganese and nickel, the two latter being present in large amounts, namely, at least ten per cent. (10%) of each substantially as described.

3. A composition of matter containing copper with over ten per cent. (10%) of manganese and over ten per cent (10%) of nickel.

4. An electrical resistance-element containing copper, with from ten to fifty per cent. (10–50%) of manganese and from ten to fifty per cent. (10–50%) of nickel.

5. An electrical resistance-element containing nickel and manganese with from thirty-five to sixty per cent. (35–60%) of copper.

6. An electrical resistance-element containing copper and manganese and at least ten per cent. (10%) of an ingredient for fixing the electrical behavior of the alloy.

7. An electrical resistance-element containing copper and a large amount of manganese with at least ten per cent. (10%) of an ingredient for fixing the electrical behavior of the alloy.

8. An electrical resistance-element containing copper, ten per cent. (10%) or more of nickel, and ten per cent. (10%) or more of manganese.

9. An electrical resistance-element containing copper, ten per cent. (10%) or more of nickel, and fifteen per cent. (15%) or more of manganese.

10. An electrical resistance-element containing copper, ten per cent. (10%) or more of nickel, and twenty per cent. (20%) or more of manganese.

11. A composition of matter containing copper, ten per cent. (10%) or more of nickel, and twenty-five per cent. (25%) or more of manganese.

12. A composition of matter containing copper, ten per cent. (10%) or more of nickel, and thirty per cent. (30%) or more of manganese.

13. A composition of matter containing copper, more than ten per cent. (10%) of manganese, and fifteen per cent. (15%) or more of nickel.

14. A composition of matter containing copper, more than ten per cent. (10%) of manganese, and twenty per cent. (20%) or more of nickel.

15. A composition of matter containing copper, more than ten per cent. (10%) of manganese, and twenty-five per cent. (25%) or more of nickel.

16. A composition of matter containing copper, more than ten per cent. (10%) of manganese, and thirty per cent. (30%) or more of nickel.

17. A composition of matter containing copper, with fifteen per cent. (15%) or more of nickel, and fifteen per cent. (15%) or more of manganese.

18. A composition of matter containing copper, with twenty per cent. (20%) or more of nickel, and twenty per cent. (20%) or more of manganese.

19. A composition of matter containing copper, with twenty per cent. (20%) or more of nickel, and thirty per cent. (30%) or more of manganese.

20. A composition of matter containing copper, with from twenty per cent. to forty per cent. (20%–40%) of manganese, and from ten per cent. to forty per cent. (10%–40%) of nickel.

21. An electrical resistance-element, con-

sisting of an alloy containing thirty per cent. (30%) or more of manganese, with more than one other ingredient.

22. An electrical resistance-element, consisting of an alloy containing copper, twenty per cent. (20%) or more of manganese, and at least one other ingredient.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

WILBUR B. DRIVER.

Witnesses:
C. A. L. MASSIE,
W. H. HARTING.