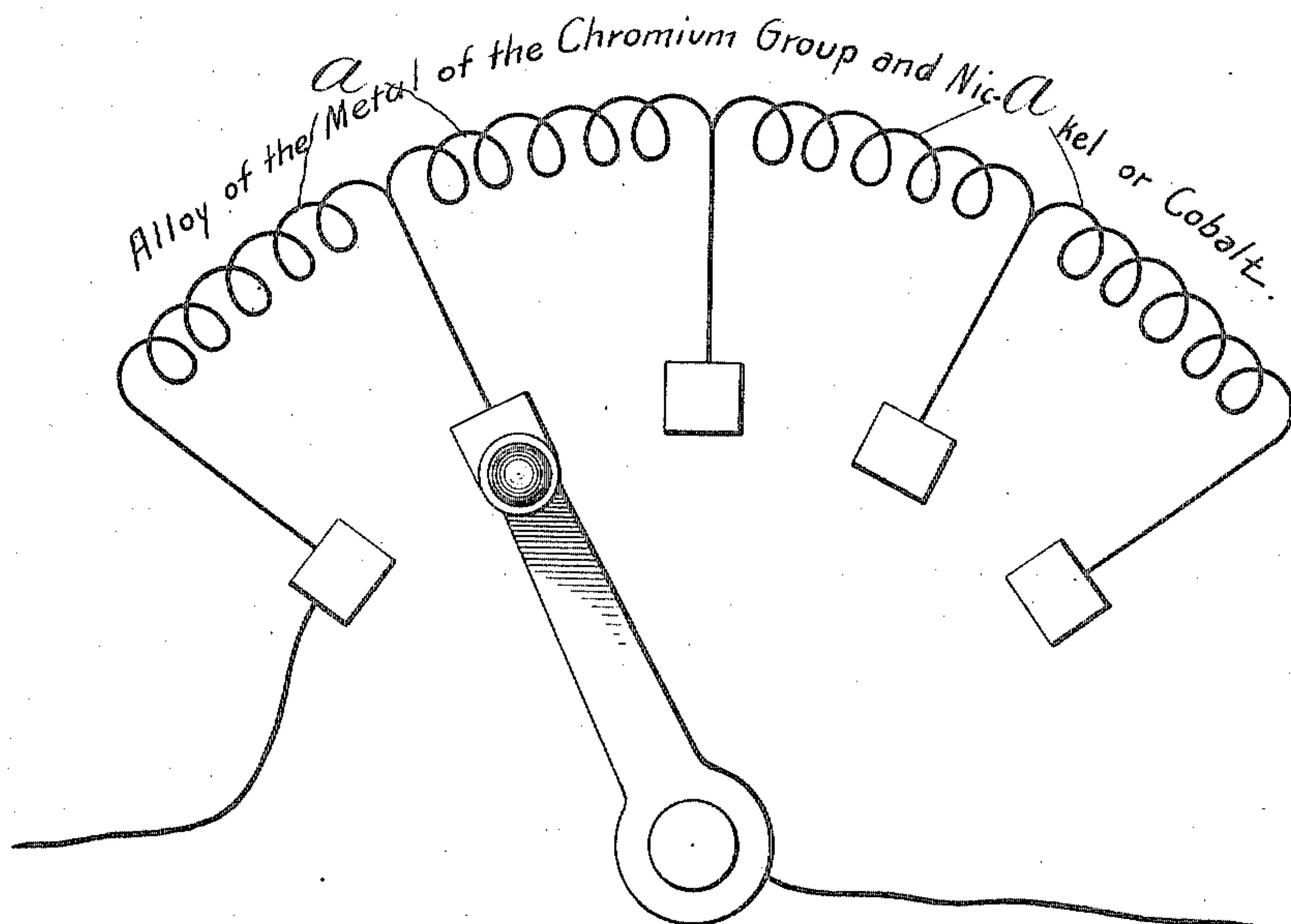


No. 811,859.

PATENTED FEB. 6, 1906.

A. L. MARSH.
ELECTRIC RESISTANCE ELEMENT.

APPLICATION FILED MAR 15, 1905.



Witnesses:

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UNITED STATES PATENT OFFICE.

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ELECTRIC RESISTANCE ELEMENT.

No. 811,859.

Specification of Letters Patent.

Patented Feb. 6, 1906.

Application filed March 15, 1905. Serial No. 250,309.

To all whom it may concern:

Be it known that I, ALBERT L. MARSH, a citizen of the United States, residing at Lake Bluff, in the county of Lake and State of Illinois, have invented a new and useful Improvement in Electric Resistance Elements, of which the following is a specification.

My object is to provide, as an improved electric resistance material, a metal which has the property of being particularly low in electric conductivity, has a melting-point exceeding that of pure copper, and may be drawn or otherwise shaped to form particularly durable, efficient, and desirable strips, strands, or filaments suitable for use in the various connections where electric resistances are desirable.

I have discovered that the metals of what is termed the "chromium group," particularly when mixed with nickel, form an alloy having the properties of being very low in electric conductivity, very infusible, non-oxidizable to a very high degree, tough and sufficiently ductile to permit drawing or shaping it into wire or strip form to render it convenient for use as an electric resistance element. The chromium group herein referred to, as defined, for example, in Watt's *Dictionary of Chemistry*, consists of the metallic elements of group No. VI, (indicated by the even numbered series,) according to what is generally designated as Mendeléeff's table. (See page 212, Remsen's *Chemistry*, fifth edition, Henry Holt & Co., New York, 1898.) These metals are chromium, molybdenum, tungsten, and uranium. Any one of these metals is suitable for my purpose, though for various reasons I prefer to employ chromium. Uranium at the present time is so rare and expensive as to render its general use for my purpose commercially prohibitive. As the above metals possess characteristics in common which adapt them to my purpose, any one of them may be employed, though when alloyed with nickel or cobalt, for example, proportions may vary to produce the best electric resistances, taking into consideration the necessary toughness and degree of ductility desirable for the particular purpose in hand. I have found, for example, that an alloy consisting of ninety per cent. nickel and ten per cent. commercially pure chromium may be drawn into a fine wire and annealed, producing a tough metal having a melting-

point exceeding that of pure copper and with an electric resistance approximating fifty times that of pure copper. Its temperature coefficient is particularly low, it does not become crystalline and brittle under heating and cooling, it resists oxidation to a remarkable degree under very high temperature, and likewise keeps a polish under all atmospheric conditions, even where corrosive fumes are present.

Any metal of the chromium group possesses desirable qualities for electric resistance material whether employed alone or alloyed with nickel or cobalt. At the present time I am of opinion that the most practical and desirable electric resistance material may be formed of an alloy of nickel and chromium in suitable proportion drawn into strips, strands, or filaments and annealed. In its broadest sense, however, my invention is not to be limited to an alloy of the last-named metals.

The accompanying drawing shows a rheostat of a well-known type in which the coiled wires *a* are resistance elements formed of a metal alloy, consisting of less than fifty per cent. of a metal of the chromium group and more than fifty per cent. of nickel or cobalt, or both. In practice I prefer, mainly for commercial reasons, to form the alloy of preferably less than twenty-five per cent. chromium and more than seventy-five per cent. nickel. Variations in the relative proportions of the metals would affect more or less the variations in strength, durability, and resistivity of the alloy. It may be stated, for example, that a metal alloy consisting of fifteen per cent. chromium and eighty-five per cent. nickel drawn into a wire sixteen one-thousandths of an inch in diameter has a resistance approximating 2.3 ohms per foot.

As stated before, either nickel or cobalt is suitable for my purpose when alloyed with a metal of the chromium group in a proportion of more than fifty per cent. nickel or cobalt, or both, and less than fifty per cent. chromium or the like. Nickel and cobalt alloy readily with metals of the chromium group and resist oxidation to a high degree. Iron, on the other hand, is readily oxidizable and will not answer my purpose when alloyed with a metal of the chromium group. Where I mention in the claims a metal having the properties of nickel or cobalt, I wish to

designate only the metals nickel and cobalt, which have properties that are the same for my purpose, but which cannot both be classed under any single term of which I am aware.

5 What I claim as new, and desire to secure by Letters Patent, is—

1. An electric resistance element composed of a metal alloy consisting of one of the metals of the chromium group, in the proportion of
10 less than fifty per cent. of the element, and more than fifty per cent. of metal having the properties of nickel and cobalt.

2. An electric resistance element comprising a strip, strand or filament formed of an
15 alloy of nickel and one of the metals of the chromium group.

3. An electric resistance element comprising an annealed strip, strand or filament formed of an alloy of nickel and one of the metals of the chromium group.

4. An electric resistance element formed of a metal alloy consisting of nickel and chromium.

5. An electric resistance element formed of a metal alloy consisting of chromium in the proportion of less than fifty per cent. of the element and nickel in the proportion of more than fifty per cent. of the element.

ALBERT L. MARSH.

In presence of—

J. H. LANDES,

J. H. LEE.