UNITED STATES PATENT OFFICE.

CHARLES EDOUARD GUILLAUME, OF SEVRES, AND LOUIS CHARLES DUMAS, OF PARIS, FRANCE, ASSIGNORS TO THE SOCIÉTÉ ANONYME DE COMMENTRY-FOURCHAMBAULT, OF PARIS, FRANCE.

MANUFACTURE OF ALLOYS.

SPECIFICATION forming part of Letters Patent No. 626,609, dated June 6, 1899.

Application filed November 16, 1897. Serial No. 658,741. (Specimens.)

To all whom it may concern:

Be it known that we, CHARLES EDOUARD GUILLAUME, a citizen of the Republic of Switzerland, residing in Sevres, (Seine,) and LOUIS CHARLES DUMAS, a citizen of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in the Manufacture of Alloys of or Containing Iron and Nickel, (the same being the subject-matter of Letters Patent in France, No. 262,737, dated December 31, 1896,) of which the following is a specification.

This invention relates to alloys, and especially to alloys containing iron and nickel, and aims to provide an improved alloy which shall be non-expansible, and improvements whereby a predetermined degree of expansibility can be obtained by combining with such alloy other metals or alloys, and provides an improved process for the manufacture of alloys.

We have discovered that alloys of iron and nickel expand or contract under variations of heat in accordance with laws which are peculiar to such alloys and which are generally very different from the laws governing the expansion and contraction of iron or nickel separately.

We have found from numerous experiments that by varying the proportions of nickel and iron in the alloy products are obtained whose coefficients of expansion vary within considerable limits. When the proportion of nickel is less than about twenty per cent., the coefficient of expansion lies between that of iron and that of nickel; but this coefficient of expansion increases when the proportion of nickel is raised until with twenty-two to twenty-four per cent. of nickel it closely approximates that of brass, when it attains its maximum. The coefficient of expansion then progressively diminishes with further increase of nickel, and it is practically *nil* when the content of nickel reaches about thirty-seven per cent. Beyond this proportion the coefficient of expansion again increases and becomes approximately equal to that of platinum when the proportion of nickel reaches forty-five per cent. The coefficient of expansion of ferronickel alloys thus varies between a maximum and a minimum, the minimum being approximately zero and this minimum expansion being attained by alloying about thirty-seven per cent. of nickel with the iron. It is this practically non-expansible alloy obtained by alloying nickel and iron in the proportions specified which forms the subject of the present invention.

An alloy having any desired coefficient of expansion between the maximum and minimum may be obtained by introducing the corresponding quantity of nickel, either more or less than thirty-seven per cent., (which gives the minimum of expansibility.) Thus to obtain an alloy having the same coefficient of expansion as glass (which is slightly less than that of platinum) the proportion of nickel may be either twenty-nine per cent. or forty-four per cent.

The improved alloy may be produced in crucibles or Martin furnaces by any of the ordinary processes employed in the steel manufacture. The alloys produced in accordance with this invention may contain, besides iron and nickel, varying quantities of the metals and metalloids which ordinarily enter into the composition of steel, as carbon, silicon, and manganese, or, as impurities, traces of sulfur or of phosphorus. The addition of small quantities of chromium or tungsten does not noticeably affect the expansibility of our alloy.

The improved non-expansible alloy is particularly adapted for the construction of standard and geodetic rules, level-rulers, and all astronomical instruments, and in general for all exact instruments or tools for which it is desirable to avoid deformation. It will also be of great service in the construction of compensating pendulums and balances where it is desirable to maintain constant the distance between the point of suspension and the center of oscillation of the instrument. The alloy may also be employed with advantage for invariable springs for clockwork movements.

By employing this improved alloy for the tubes of steam-boilers or other apparatus or parts of apparatus exposed to a greater heat

than other parts the deterioration and excessive tension which result from too great expansion are avoided. Conversely, by making certain elements of apparatus of non-expansible alloy systematic tension or deformation may be produced which are much stronger than have been hitherto possible. As examples, there may be mentioned bimetallic thermometers, the expansion-plates of thermal variation galvanometers, fire-alarms, and compensators.

It will be understood that the non-expansible alloy may be mixed in suitable proportion with other metals or alloys for the production of alloys having the same expansion as other substances with which they are combined or connected—such as glass, crystal, &c.—and this will be of particular advantage for the manufacture of incandescent lamps, Crookes tubes and the like, spectacle-frames, mirrors, and optical instruments in general.

We claim—

1. As a new article of manufacture, an alloy containing iron and nickel in the relative proportions of approximately sixty-three per cent. of iron and about thirty-seven per cent. nickel.

2. As an article of manufacture, an alloy of nickel and iron in the proportions approximately of sixty-three per cent. iron and thirty-seven per cent. nickel, combined with another metal or alloy of known expansibility, whereby a product of predetermined expansibility is obtained, substantially as described.

In witness whereof we have hereunto signed our names in the presence of two subscribing witnesses.

CHARLES EDOUARD GUILLAUME.
LOUIS CHARLES DUMAS.

Witnesses:
JULES ARMENGAUD, Jeune,
PAUL F. PAQUES.