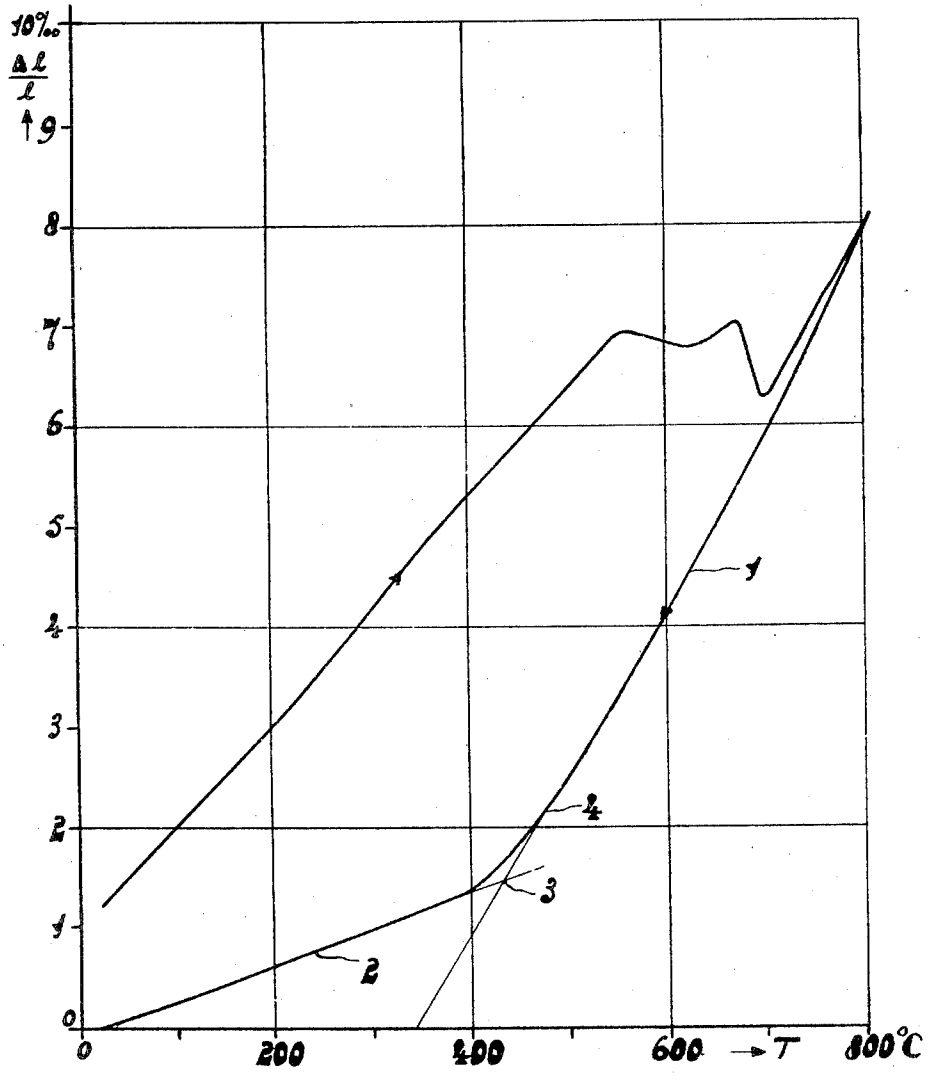
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ALLOY FOR GLASS TO METAL SEAL

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ALLOY FOR GLASS TO METAL SEAL

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Alloys consisting of iron, nickel and cobalt, of which the coefficient of expansion, at least in the metastable γ-phase, is smaller than 70.10^{-7} are often used in engineering for seals i. e. in the present case articles comprising glass and metal parts which are sealed together, these alloys being more particularly used for seals, of which the glass part consists of a specimen of glass having a low coefficient of expansion.

In establishing such seals the linear thermal expansion of glass and metal are required to be substantially equal at all temperatures at which the strains cannot compensate each other within a reasonable time, that is to say that the characteristic curves establishing the relation between temperature and linear thermal expansion are required to coincide substantially for both materials.

In using alloys consisting of iron, nickel and cobalt the circumstance emerges that they may occur in two phases, the so-called α-phase and γ-phase in which the curves of thermal expansion are widely different. For seals the γ-phase should be used, since it exhibits a particularly low coefficient of expansion below a definite temperature. This temperature lies at a point, the so-called Curie temperature, at which the material loses its ferro-magnetic properties.

A difficulty experienced in this case consists in that the material in the γ-phase, which arises on heating at high temperatures, for instance in excess of 700° C., becomes metastable at temperatures of less than approximately 400° C. i. e. that at a given temperature it tends to pass over into the α-phase which is stable at these temperatures. Since the thermal coefficient of expansion of the material in the last-mentioned phase is much higher than that of the material in the γ-phase below the Curie-temperature, this involves volume variations and the occurrence of severe strains and fracture in the seal. By increasing the nickel content it is feasible, and has already been proposed, to reduce the temperature at which the material passes over from the γ-phase into the α-phase. At the same time this yields the advantage that the Curie point is higher; however the coefficient of expansion is also increased, due to which the field of application of the alloy is limited again.

The invention concerns a method of manufacturing alloys containing iron, nickel and cobalt, with which this disadvantage occurs to a lesser degree.

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According to the invention the alloy contains 0.25 to 5% copper. It has been found that due to the presence of copper in this quantity the transition of the material from the γ-phase to the α-phase is shifted to such a low temperature range that in practice no trouble is experienced from this transition. Moreover, the Curie-temperature is increased, as a result of which the material becomes useful for sealing species of glass having a higher softening point.

In the present case the lower limit of 0.25% is chosen in connection with the possibility that in the conventional alloys copper occurs as impurity. The upper limit of 5% is determined by the coefficient of expansion which increases too much with a high copper content.

In order that the invention may be more clearly understood and readily carried into effect it will now be described more fully by giving a few examples and a corresponding curve.

This curve indicates the relation existing between the relative expansion of the material and the temperature in °C.

From the curve it appears that the material, for which in the present case use is made of an alloy containing 26.5% Ni, 17.5% Co, 1% Cu, 0.5% Mn and remainder Fe, when it is in the α-phase, transforms into the γ-phase at about 700° on heating. In this phase the material exhibits in the downward branch 1 a fairly high coefficient of expansion between 800° C. and 420° C. At 420° C. lies the buckling point of the curve, which is defined by extrapolation of the branch 1 and the following flatter branch 2. From the curve this buckling point 3 can be exactly determined more easily than the Curie point 4 which lies at a point at which the downward branch 1 passes over into the flatter branch 2. In this branch 2 from 420° C. to 20° C. the material exhibits the low coefficient of expansion which renders it so suitable for seals. At 20° C. begins the transition to the γ-phase. This transition cannot further be sharply defined, since it depends quantitatively upon several factors, for instance the rate of cooling and the size of grain. Otherwise this further form of the curve is of no importance for the aforesaid use in engineer-

ing, since practically any transition to the α-phase should be avoided.

The influence exerted by the addition of copper to these alloys clearly appears from the following table:

No.	Ni	Co	Cu	Mn	Fe λ	20-350°	Buckling point	(γ—α) transformation
							°C.	°C.
1	26.7	17.2		0.5	remainder	27.10 $^{-7}$	390	+100
2	28.9	17.3		0.5	do	55.10 $^{-7}$	430	−30
3	29.6	17.5		0.5	do	61.10 $^{-7}$	460	<−183
4	26.5	17.5	1	0.5	do	35.10 $^{-7}$	420	+20
5	26.5	17.5	2	0.5	do	48.10 $^{-7}$	450	−80
6	26.5	17.5	3	0.5	do	59.10 $^{-7}$	480	<−183

From numbers 1, 2 and 3 of this table it appears that an increase in nickel content by 2% and 3% respectively raises the buckling point and lowers the temperature at which the (γ—α) transformation occurs, and that at the same time the coefficient of expansion increases. However, an admixture of 2% copper raises the buckling point by 20° C. more than an increase in nickel content by 2%, viz. to 450° C. instead of 430° C., and lowers the temperature, at which the γ—α transformation occurs, by 50° C. more viz. down to —80° C. This has the great advantage that the coefficient of expansion has less increased viz. only to 48.10^{-7} instead of 55.10^{-7}. From comparison of numbers 3 and 6 it appears that an admixture of 3% copper yields advantages particularly with respect to the rise of the buckling point, and in addition a small advantage with respect to the coefficient of expansion. With the two alloys the (γ—α) transformation is lower than —183° C.; the exact temperature at which this occurs is of no importance in practice.

What I claim is:

1. A low expansion alloy for use in glass to metal seals, comprising approximately 26.5 to 29.6% nickel, approximately 17.5% cobalt, approximately .5% manganese, approximately .25% to 5% of copper and the balance iron and incidental impurities, said alloy having a temperature coefficient of expansion of about 20×10^{-7} to 70×10^{-7}.

2. A low expansion alloy for use in glass to metal seals comprising approximately 26.5% nickel, 17.5% cobalt, 1% copper, 0.5% manganese and the balance iron and incidental impurities, said alloy having a temperature coefficient of expansion of approximately 35×10^{-7}.

JAN JACOBUS WENT.

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