TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

No. 314

ALLOYS SIMILAR TO DURALUMIN MADE IN OTHER COUNTRIES THAN GERMANY.

By K. L. Meissner.

From "Zeitschrift für Metallkunde," 1925.

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ALLOYS SIMILAR TO DURALUMIN MADE IN OTHER COUNTRIES THAN GERMANY.*

By K. L. Meissner.

Dr. R. Beck has published an exhaustive article on duralumin in "Zeitschrift für Metallkunde" (See N.A.C.A. Technical Memorandum No. 284). Duralumin is aluminum alloyed with 3.5-4.5% of copper, 0.5% magnesium and 0.25-1% manganese. In Germany it is protected by patent No. 244554 of March 20, 1909. The name "duralumin" was copyrighted in October, 1909, before the right of manufacture had been sold to any firm outside of Germany. It seems strange, therefore, that the English periodical "The Engineer" of December 7, 1923, should say, in connection with a report on the construction of the Zeppelin airship ZL 126, that the alloy designated in Germany as "duralumin" differs decidedly from the duralumin employed in England and that, consequently, the German alloy would have to be designated simply as "an aluminum alloy." Entirely aside from this perversion of the facts, due either to ignorance or intentional misrepresentation on the part of the English author, the statement is false that the duralumin made in other countries differs in composition from that made in Germany.

* From "Zeitschrift für Metallkunde," 1925, p. 64.

It is evident that the discovery of duralumin, whose very great technical importance was soon recognized, has led also in other countries to further work in this field. In spite of all our efforts and our increased scientific knowledge of the refining process, we have not yet succeeded in finding any alloy superior to duralumin. On the other hand, many patents have been issued in other countries on alloys closely resembling duralumin in every way. From these patents we have culled the following examples.

1. The French patent 560992 of December 30, 1921 (English patent 190996) of Geyer in Paris, concerns an alloy of aluminum with 4.25% Cu, 0.79% Mg, 0.8% Mn, and 0.24% Pb + C. It also covers an aluminum alloy, to which a further 0.24% Pb + C has been added. According to the patent, this alloy has a tensile strength of 43.5 kg/mm^2 (61872 lb./sq.in.) and an elongability of 20.3%, after treatment. The remarkable thing is that these properties, which correspond to those of duralumin, are supposed to be attained without quenching and indeed without any thermal treatment whatever. I doubt, however, whether anyone, who has had much to do with aluminum alloys, will forthwith give credence to this claim.

2. The English patent 195893 of June 7, 1922, of the Baush Machine Tool Company, is for an alloy containing 94% Al, 0.5% Mg+Cr and 5.5 Cu+Mn. This alloy is heated, like duralumin (whose

composition it closely approximates), to 500-525°C (932-977°F), quenched and then seasoned for five days.

The following patented alloys, which infringe more or less on the duralumin patent, differ from duralumin in the fact that the five days' seasoning, after the quenching, is replaced by a brief treatment at a somewhat higher temperature. This treatment is defined as "seasoning at a high temperature" or "artificial seasoning." This method of seasoning is, indeed, not specifically mentioned in the duralumin patent, but the inventor of duralumin, Mr. Wilm, stated, in the magazine "Metallurgie" (Vol. 8, 1911, pp. 225-227), that, after heating and quenching, the strength of the alloy could be more quickly increased by leaving it for some time in boiling water. He renounced the technical utilization of this method, however, because he obtained greater strength by seasoning at the temperature of the room than at 100°C (212°F). Attention is, however, expressly called to the fact that the idea of seasoning artificially at a higher temperature was also of German origin. It was not till some years later (1919) that the Americans, Merica, Waltenberg and Scott (Bureau of Standards, Scientific Papers, No. 347), undertook systematic experiments on the effect of artificial seasoning.

3. The American patent 1394535 of November 30, 1917, of Earl Blough is indeed on aluminum-copper alloys containing less than 10% of copper, though other substances may be added, express mention being made of magnesium. The composition of duralumin would accordingly bring it within the scope of this patent. The

alloys are heated to 400-600°C (752-1112°F), usually 520°C (968°F quenched in boiling water and seasoned from 2 to 24 hours at 100-200°C (212-392°F).

4. The English patent 159852 of August 24, 1920, of Alberta de Lavandeyra was, like the one just mentioned, on aluminum-copper alloys, which could likewise contain other metals, including magnesium. As an example, an alloy containing 95.8% Al, 3% Cu, 0.5% Mg, and 0.7% Cr was mentioned. Its composition is therefore very similar to that of duralumin, in which the manganese is replaced by chromium. In the German patent, however, several metals with high melting points are mentioned as possible admixtures, without specifying the percentages. The composition of the example therefore comes under the duralumin patent. The thermal treatment consists of heating the alloy 10 to 15°C (18 to 27°F) above the temperature at which the copper enters into solution in aluminum. The alloy is then quenched in oil and, after remaining a short time in oil, is seasoned in hot water for about an hour and a half.

5. The French patent 540383 of January 25, 1921, of the French Aluminum Company, is on the thermal treatment of aluminum alloys containing 1-2% Mg and 0.75-2% Si. The alloy may also contain admixtures of copper, preferably in the proportion of 3-4%. Its composition, therefore, approximates that of duralumin. Only the content in magnesium and silicon has been simultaneously raised, obviously for the purpose of introducing larger

quantities of Mg_2Si into the alloy. It is refined by heating at high temperatures, quenching in water and seasoning either at the room temperature or at an increased temperature not exceeding 300°C (572°F). This alloy attains a strength of over 40 kg/mm² (56894 lb./sq.in.), but does not appear to be superior to duralumin, notwithstanding its greater Mg_2Si content. This may be due to the fact that, according to the researches of Gaylor (Inst. of Met., Vol. 28, 1922, pp. 214-244), the solubility of Mg_2Si in aluminum is lowered in the presence of copper. The solubility then corresponds approximately to the amount of Mg_2Si contained in the duralumin, namely, about 0.8%, composed of 0.5% Mg and 0.3% Si. An excess of Mg_2Si does not, therefore, have any refining effect, but only a general hardening effect, somewhat like manganese.

6. The American patent 1472740 of December 29, 1921, of Archer and Jeffries, covers the thermal treatment of aluminum alloys with copper and magnesium with or without the admixture of other metals, such as manganese, chromium, nickel and molybdenum. Another important stipulation regarding this alloy is that it shall contain at least 0.5% silicon. An alloy, containing 4.5% Cu, 0.5% Mg, 0.75% Si and 0.5% Mn, is mentioned as an especially fine example. Its composition is extraordinarily similar to that of duralumin, only that the quantity of silicon must reach a certain percentage. Regarding this point the same may be said in regard to the preceding patent. Duralumin always contains the

quantity of silicon required for the formation of $Mg_2 Si$. Since silicon alone has no particular refining effect, any increase in its amount over that required for the formation of $Mg_2 Si$ is of no special use. The refining is accomplished by heating to 500-550°C (932-1022°F), quenching and seasoning at 100-150°C (212-302°F). After seasoning for 70 hours at 120°C (248°F), a tensile strength of 46.8 kg/mm² (66566 lb./sq.in) with 20.5% elongation is claimed. Likewise, a strength of 52.7 kg/mm² (74958 lb./sq.in.), with an elongation of 13%, is claimed after 20 hours' seasoning at 150°C (302°F).

7. Another American patent (1472739) of Archer and Jeffries of December 20, 1921, resembles the preceding, excepting that the alloys contain no copper. This patent also closely resembles the duralumin patent, in that the alloys contain magnesium. The thermal treatment is similar to that in the foregoing patent.

8. Also the alloy "Y" containing 4% Cu, 1.5% Mg, and 2% Ni, much used in England both for casting and for structural purposes, falls within the scope of the duralumin patent. It is obvious from the composition that this alloy can also be refined by thermal treatment. In comparison with duralumin, however, it has the disadvantage of being difficult to roll. It must therefore be assumed that the alloy "Y" yields a very large amount of waste in being rolled.

All the above-mentioned alloys closely resemble duralumin,

without its being possible to establish that they represent any improvement on it. Moreover, people in other countries should understand that all the endeavors to produce new good aluminum alloys are based on the purely German discovery of duralumin. It would, however, appear from the article in "The Engineer" as though this fact had already been forgotten.

Translation by Dwight M. Miner,
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