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CAST PIANO PLATE

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Fig. 2

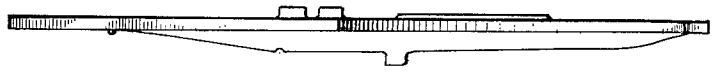
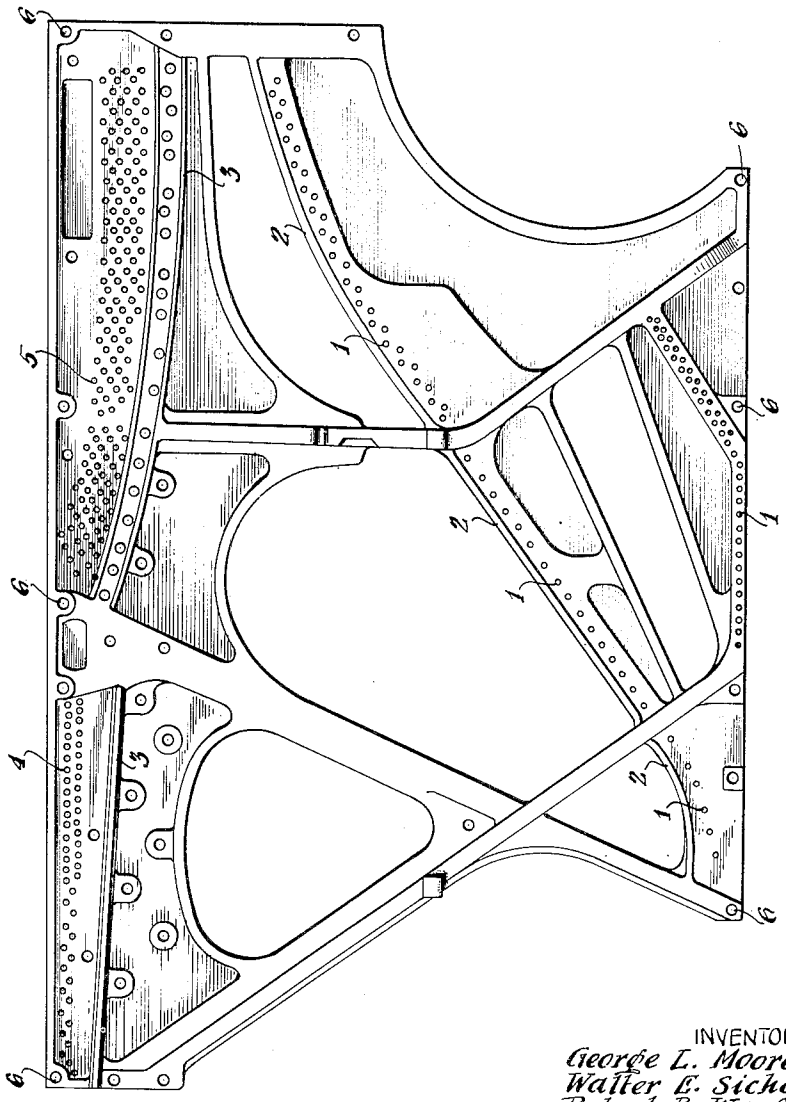


Fig. 1



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CAST PIANO PLATE

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This invention relates to aluminum alloy piano plates.

The string plate of the modern piano forms the anchor for one end of the strings which are secured thereto by hitch pins rigidly seated in the plate. The strings are fastened at the other end to the tuning pins seated in the tuning pin plank which, though usually not an integral part of the string plate, is, together with the plate, secured to the frame so that the three comprise a unitary assembly in the piano. The present day string plates are almost universally made of cast iron which, in replacing the use of wood a century or so ago, made it possible to increase greatly the tension on the strings. The disadvantages and limitations attendant on the use of heavy cast iron piano plates have long been recognized, and several attempts have been made in the past to substitute a light weight metal for the cast iron. Unfortunately, previous efforts have failed to result in a plate having substantially less weight than the cast iron plate, together with the requisite mechanical properties. Previous attempts to use aluminum alloys have been unsuccessful because these plates would yield under the tension of the strings. The tension required on the tuned strings was found to cause creep in these earlier light metal plates, with the result that the piano failed to remain in tune as long as those in which cast iron plates were used The term creep as used herein refers to the tendency of metal to become permanently deformed when stressed for long periods even though the stresses are below the normal yield strength of the metal.

It is an object of the present invention to provide a light weight piano plate which will maintain the strings in tune as well as or better than a cast iron plate. A further object is to provide an aluminum alloy piano plate which will be substantially lighter than the present cast iron piano plates of comparable size, and which will be substantially free from creep under the tension of the tuned piano strings.

For a clear understanding of the present invention, a conventional piano plate is shown in the accompanying drawings in which Fig. 1 is a plan view of such a plate and Fig. 2 is an end view.

In the figures 1 designates holes for receiving the hitch pins to which the lower ends of the piano strings are secured; 2 and 3 are bridges for the strings, while 4 and 5 are, respectively, apertures for the tuning pins of the bass and treble strings seated in the tuning pin plank (not

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shown) located behind the plate. The tuning pin plank is either secured to the piano frame and comprises a part thereof, or is secured directly to the plate which in turn is secured to the frame of the piano, but with either modification the piano plate is essentially the same in construction and design. The plate in either modification is rigidly mounted on the frame by screws or stud bolts inserted in holes 6.

In use the plate must withstand a total string load on the order of 15 to 20 tons without creeping, for it is apparent that the strings would not remain tuned if the plate were to plastically deform during or after tuning. In order to serve satisfactorily the aluminum alloy piano plates should have a yield strength of at least 25,000 P. S. I., a ratio of yield strength to tensile strength of less than 0.95, an elongation of between 0.5 and 2.5 per cent, and a Brinell hardness between 80 and 100. The hardness requirement is of special significance in the application of aluminum alloys to piano plates in that it is indicative of the brittleness of the metal and also the capacity of the metal to support the string load. The plate must be sufficiently resistant to creep to support the string load of the tuned piano yet not too brittle to withstand shock and the normal abuses of service. The plates should be substantially free from creep; i. e., any creep of magnitude which adversely affects retaining the tuned condition of the piano strings. This is achieved in the production of aluminum base alloy plates by the use of a particular alloy in combination with a suitable thermal treatment which will be fully described and illustrated hereinafter

In accordance with the present invention, the piano plate is cast from an aluminum base alloy containing silicon and copper as the principal added alloying constituents, together with a small amount of magnesium; however, small amounts of other elements such as zinc, manganese, iron, nickel, and titanium may also be present. The ranges for the constituents of this alloy in respect to its use in piano plates are as follows: silicon 3 to 7 per cent, copper 2.5 to 4.5 per cent, magnesium 0.02 to 0.4 per cent, and not more than about one per cent each of zinc, manganese, iron, and nickel, nor more than about 0.2 per cent titanium. It is preferred that the magnesium content come within the range of 0.08 to 0.2 per cent since with smaller amounts undesirably long aging periods may be required to develop the minimum properties and with larger amounts than 0.2 per cent the increase

in properties is not pronounced. A preferred composition consists of the following: 6.5 per cent silicon, 3.5 to 4 per cent copper, 0.10 to 0.15 per cent magnesium, and the balance substantially aluminum. The phrase, "balance substantially aluminum," as used here and elsewhere in the specification and claims, is not intended to exclude the optional elements mentioned above within the ranges given. It should be pointed out that the limitation given for the magnesium content is especially significant in producing heat treated plates having sufficient resistance to creep without being unduly brittle; consequently, in view of the importance of these two properties in the production of satisfactory plates, the limitations on the use of small amounts of magnesium, as well as those on the predominant elements of silicon and copper, should be closely adhered to. Plates can be satisfactorily cast from these alloys by standard practices in either sand molds or in permanent metal molds.

In order to develop the desired mechanical properties and resistance to creep in the cast aluminum base alloy plates, it is necessary to subject them to a suitable thermal treatment which is essentially an artificial aging treatment for precipitating the alloying constituents held in a supersaturated solid solution following either heat treating and quenching or rapid cooling in a metal mold. After artificial aging, the internal structure of the alloy plate resulting from rapid cooling in a metal mold is substantially the same as the structure of the solution heat treated and artificially aged alloy plate. The cast piano plates which are to receive a solution heat treatment, for example those made in sand molds, are heated at a temperature and for a time sufficient to obtain substantially complete solution of the added alloying constituents. The plates are then quenched, preferably in an air blast, and artificially aged for a time sufficiently long to render the mechanical properties substantially stable for the life of the plates and to eliminate any tendency of the plates to creep under the stresses applied by the tuned piano strings. More specifically, the cast plates are preferably heated at a temperature between 920° and 1000° F. for a period of six to sixteen hours, cooled from this temperature in an air blast and thereafter artificially aged at a temperature within the range of 300° to 450° F. for a period of two to twelve hours. While a more rapid quenching medium such as cold or hot water could be employed in quenching the plates from the solution heat treating temperature and satisfactory mechanical properties still be obtained, the plates are less likely to be distorted by quenching in an air blast than in cold water. The manner in which the plates are cooled from the artificial aging temperature is not important. Permitting them to cool in air to room temperature will give them satisfactory properties. When the plates are cast in permanent metal molds, the solution heat treatment described above may be omitted because the rapid chilling of the metal in the mold to temperatures appreciably below the normal solution heat treating temperature range retains a substantial proportion of the soluble constituents in supersaturated solution. The artificial aging treatment for the plates cast in metal molds that have received no solution heat treatment is essentially the same as that given the sand cast plates.

To serve satisfactorily, the artificially aged piano plates should have a minimum yield strength of 25,000 p. s. i., a tensile strength of at least 28,000 p. s. i., an elongation of 0.5 to 2.5 per cent, and a Brinell hardness of between 80 and 100 with a yield strength to tensile strength ratio of not more than 0.95. With these mechanical properties our solution heat treated and artificially aged piano plates perform as well as or better than cast iron plates, and do not have any significant tendency to creep under the stresses of the tuned piano strings.

As a specific example, a plate for a spinet piano was cast in a green sand mold from an aluminum base alloy containing 6.5 per cent silicon, 4.0 per cent copper, 0.10 per cent magnesium, 0.4 per cent iron, 0.5 per cent manganese, 0.4 per cent zinc, 0.05 per cent nickel, and 0.03 per cent titanium. After the plate was trimmed to remove the risers and sprues and to smooth rough edges, it was solution heat treated at approximately 960° F. for six hours, then removed from the furnace and cooled in an air blast. The plate was then given an artificial aging treatment consisting of about 2 hours at 380° F. In order to determine whether the plate had sufficient resistance to creep under the tension of the tuned strings, a stress analysis was made on the plate by the use of strain gauges, but these tests failed to reveal any evidence of creep in the plate. Tensile test bars which were machined from sections of the plate and then tested were found to have an average tensile strength of 32,700 p. s. i., yield strength of 29,200 p. s. i., a Brinell hardness of 94, elongation of 0.8%, and a yield strength to tensile strength ratio of 0.89. These properties readily meet the specified mechanical properties for the piano plate referred to herein.

It will be understood that this invention is not limited to any specific piano plate design, but may be used in the fabrication of grand, upright, and spinet pianos or in any modification thereof.

We claim:

1. A cast piano plate composed of an aluminum base alloy consisting of 3 to 7 per cent silicon, 2.5 to 4.5 per cent copper, and 0.02 to 0.4 per cent magnesium as the principal added alloy constituents, and balance substantially aluminum, said plate having an internal structure produced by artificial aging and characterized by substantial freedom from creep under the stress imposed by tuned strings and a yield strength exceeding 25,000 p. s. i.

2. A cast piano plate composed of an aluminum base alloy consisting of 3 to 7 per cent silicon, 2.5 to 4.5 per cent copper, and 0.08 to 0.2 per cent magnesium as the principal added alloy constituents, and balance substantially aluminum, said plate having an internal structure produced by artificial aging and characterized by the properties of substantial freedom from creep under the stress imposed by tuned strings, a yield strength exceeding 25,000 p. s. i., and a Brinell hardness of between 80 and 100.

3. A cast piano plate composed of an aluminum base alloy consisting of 3 to 7 per cent silicon, 2.5 to 4.5 per cent copper, and 0.02 to 0.4 per cent magnesium as the principal added alloy constituents, and balance substantially aluminum, said plate having an internal structure produced by solution heat treatment and artificial aging and characterized by the properties of substantial freedom from creep under the stress

imposed by tuned strings, and a yield strength exceeding 25,000 p. s. i.

4. A cast piano plate composed of an aluminum base alloy consisting of 3 to 7 per cent silicon, 2.5 to 4.5 per cent copper and 0.08 to 0.2 per cent magnesium as the principal added alloy constituents, and balance substantially aluminum, said plate having an internal structure produced by a solution heat treatment at a temperature of between 920 and 1000 F., a quench, and aging at a temperature of between 300 and 450° F., and characterized by the properties of substantial freedom from creep under the stress imposed by tuned strings, a yield strength exceeding 25,000 p. s. i., a ratio of yield to tensile strength of less than 0.95 and a Brinell hardness of between 80 and 100.

5. A sand cast piano plate composed of an aluminum base alloy consisting of 3 to 7 per cent silicon, 2.5 to 4.5 per cent copper, and 0.02 to 0.4 per cent magnesium as the principal added alloy constituents, and balance substantially aluminum, said plate having an internal structure resulting from heating it at a temperature of between 920° and 1000° F. for six to sixteen hours, quenching in an air blast, and aging at a temperature of between 300° and 450° F. for two to twelve hours, and characterized by the properties of substantial freedom from creep under the stress imposed by tuned strings, a yield strength exceeding 25,000 p. s. i., a ratio of yield to tensile strength of less than 0.95 and a Brinell hardness of between 80 and 100.

6. A permanent mold cast piano plate composed of an aluminum base alloy consisting of 3 to 7 per cent silicon, 2.5 to 4.5 per cent copper, and 0.02 to 0.2 per cent magnesium as the principal added alloy constituents, and balance substantially aluminum, said plate having an internal structure resulting from aging it at a temperature of between 300° and 450° F. and characterized by the properties of substantial freedom from creep under the stress imposed by tuned strings, a yield strength exceeding 25,000 p. s. i., and a ratio of yield to tensile strength of less than 0.95.

7. A sand cast piano plate composed of an aluminum base alloy which consists of approximately 6.5 per cent silicon, 3.5 to 4 per cent copper, and 0.10 to 0.15 per cent magnesium as the principal added alloy constituents, and balance substantially aluminum, having an internal structure resulting from being solution heat treated at a temperature of between 920° and 1000° F. for six to sixteen hours, quenched in an air blast, and aged at a temperature of between 300° and 450° F. for two to twelve hours, and characterized by the properties of substantial freedom from creep under the stress imposed by tuned strings, a yield strength exceeding 25,000 p. s. i., a ratio of yield to tensile strength of less than 0.95, and a Brinell hardness of between 80 and 100.

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