P. A. WALLER.

METAL SHEET FOR ACOUSTIC PURPOSES AND METHOD OF MAKING SAME.

APPLICATION FILED OCT. 26, 1912.

1,204,096. Patented Nov. 7, 1916.

Fig: 1,

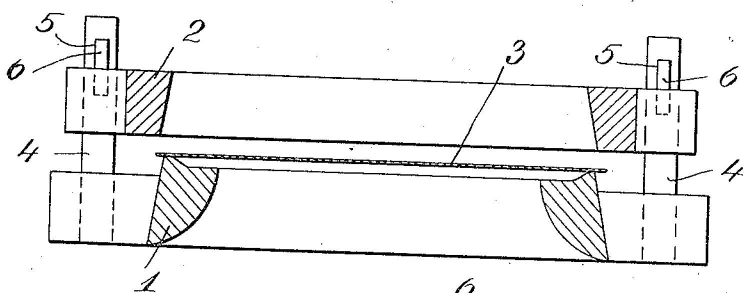


Fig: 2,

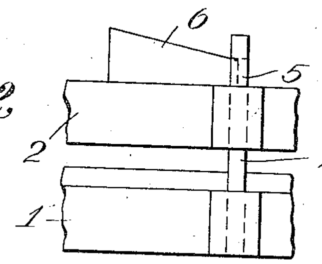
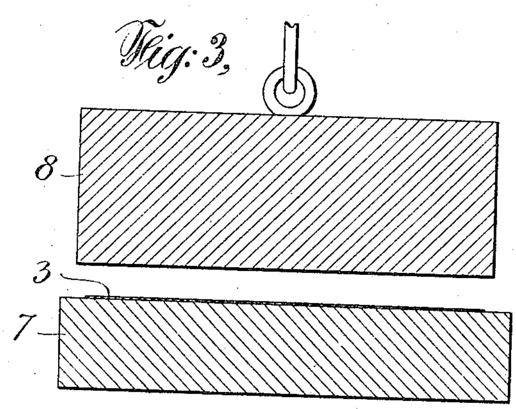


Fig: 3,



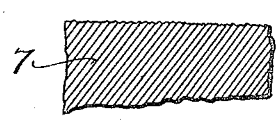


Fig. 4.

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METAL SHEET FOR ACOUSTIC PURPOSES AND METHOD OF MAKING SAME.

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To all whom it may concern:

Be it known that I, PER ARON WALLER, a subject of the King of Sweden, and a resident of Stockholm, Sweden, have invented certain new and useful Improvements in Metal Sheets for Acoustic Purposes and Methods of Making Same, of which the following is a specification.

My invention relates to improvements in methods of treating sheet steel to be used as sounding boards of pianos, as membranes or diaphragms of telephone microphones, and the like, and comprises the heating of a steel plate to a suitable temperature as hereinafter described, the clamping of such plate, while heated, in such manner that the plate is of necessity stretched during the ensuing cooling, and then the cooling of the plate and consequent stretching thereof beyond the elastic limit of the metal.

My invention further comprises the heating of steel or other metal or alloy to a temperature above the critical point of transformation of such metal or alloy, and the cooling of such metal while the metal is held against contraction. And my invention comprises as well the sounding boards for pianos, and the membranes or diaphragms of telephone microphones, and the like, resulting from such methods of treatment, said sounding boards and membranes, diaphragms, etc., having superior acoustic properties and being made of steel or other metal which has been stretched to beyond its elastic limit *e. g.* by the method indicated.

The object of my invention is to improve the acoustic properties of sheet steel and other metals designed to be used for the sounding boards of pianos and other musical instruments, or for the diaphragms or membranes of telephone microphones, and for other purposes.

In the accompanying drawings I illustrate more or less diagrammatically two forms of such apparatus which may be used in the stretching of steel plates in the carrying out of my process.

In said drawings: Figure 1 shows a transverse vertical section of one such form of apparatus, the view also showing a plate to be stretched in position in the apparatus. Fig. 2 shows a detail fragmentary side view of the two frames shown in Fig. 1, illustrating the use of wedges for holding the frames together. Fig. 3 shows a transverse vertical section of an alternative form of apparatus, this view also showing a plate to be stretched in position in the apparatus. Fig. 4 is a detail fragmentary sectional view of one of the blocks 7 and 8 of Fig. 3, illustrating on a greatly enlarged scale the roughening of the surface of such block.

Sheet metal which is to be used to amplify sound, as, for example, sheet metal which is to be used as the sounding board of a piano, or as a diaphragm or membrane of a telephone microphone, must be homogeneous, must have an absolutely flat surface, and must have high elasticity. Homogeneous metal is required, in order that sound waves may be amplified evenly, and in order that the sound may be clear, and that the tone may possess fullness and beauty. An absolute flat surface is necessary in order that the vibrations may be uniform, and in order that no additional means may be required to make the surface flat and true. A high elastic limit of the metal is necessary in order that this elastic limit may not be exceeded when the plate is put under the stress to which it is necessarily subject in use. Sheet steel possessing these qualities cannot be produced by ordinary rolling or forging processes, or by any other mechanical means known to me.

I have found that if a piece of sheet steel be heated, to a temperature such that, if the metal when so heated be held against contraction, the metal during cooling is stretched beyond its elastic limit; and if the metal so heated be secured against contraction and allowed to cool, so stretching it beyond its elastic limit, this steel sheet, when removed from the stretching apparatus, and when cold, retains the shape and the absolute flat surface acquired in such stretching apparatus, and the metal has been rendered homogeneous and has had its elastic limit raised. By this process of stretching, any internal stresses in the sheet are equalized, and therefore the metal is brought to a uniform condition, such that its vibrations due to sounds are uniform (whereas the vibrations in a sheet of steel not so treated are apt to be very irregular); and such a sheet of steel may then be used as a sounding board of a piano, or as the diaphragm or membrane of a telephone microphone, and when so used will produce true, full sounds, clear in tone and of a timbre superior to that produced by the aid of wooden and other sounding boards.

Referring to Fig. 1, showing one form of apparatus which may be employed in the stretching of the metal, numerals 1 and 2 designate two frames, frame 2 being so shaped that, when pressed against frame 1, the sheet of metal 3 between these frames is pinched at the edges and so is held against contraction. These frames 1 and 2 may be special stretching frames, or may together constitute the sounding board frame of a piano or other musical instrument. Various means may be employed for holding the two frames together. I have indicated for the purpose bolts 4, secured to the under frame 1 and passing through apertures in the upper frame 2, and provided above frame 2, with openings 5 adapted to receive wedges 6, (Fig. 2), which wedges, when driven into place, clamp the two frames together so tightly that contraction of the metal 3 is precluded.

In the alternative apparatus illustrated in Fig. 3, 7 designates an anvil block having a flat upper surface, and 8 designates an upper block having a flat lower surface. Block 8 may have such weight that when it is pressing the sheet metal 3 against the top of anvil block 7, contraction of the sheet 3 is precluded by the mere weight of block 8 and by the surface friction of the sheet 3 against the surfaces of the anvil block 7 and upper block 8; or, the surfaces of these two blocks 7 and 8 may be slightly roughened. In practice the roughening is very slight and may be only that produced by ordinary tools (a planer tool for example) in machining the surfaces of the two blocks. Such roughness is too slight to appear in the drawings without exaggeration, and accordingly in Fig. 4, an enlarged and exaggerated section is illustrated, but such slight roughness is nevertheless very effective in precluding contraction of the sheet metal held by the said blocks.

The rate of contraction of steel in cooling between definite temperature limits is well known, and therefore it is easy to calculate the temperature to which a sheet of steel must be heated in order that, after such steel has been so heated and is clamped in either the apparatus shown in Fig. 1 or in the apparatus shown in Fig. 3, it may be stretched beyond its elastic limit (the elastic limit of steels of different composition being well known, or, if not known, being easy to determine by well known methods) during the resulting cooling. In carrying out my process therefore, I take a sheet of steel 3, of suitable dimensions, and heat it to a temperature previously determined as such that, when the sheet cools, while held against contraction, it will be stretched beyond the elastic limit; and I then place such sheet of steel in either the apparatus shown in Fig. 1, or the apparatus shown in Fig. 3, and immediately clamp the sheet firmly and permit it to cool.

It will be seen that by the apparatus of Figs. 1 and 2 the metal will be stretched longitudinally, while by the apparatus of Fig. 3 it will be stretched both longitudinally and laterally.

In practice, I have attained excellent results with steel of from .35 to .40 per cent. carbon, and with thickness varying from .6 mm. to 1. mm. Such steel was ordinary good carbon steel, free from hardening substances, such as chrome; though I do not preclude the treatment by my process of the various alloy steels, such as tungsten steel, chrome steel, titanium steel, nickel steel, etc., but to the contrary contemplate the treatment of such steels by my process.

As a special feature of my process, though not in all cases a necessary feature, I include the heating of the steel and other metals and alloys, not only to a point such that the metal will be stretched beyond the elastic limit when cooled while held against contraction, but to a point beyond the critical point of transformation of the metal. It is well known that steel and other metals and alloys when heated beyond a certain temperature (this temperature varying with different grades of steel and other metals, but being well known or easily determined by well known methods, for each particular grade) undergoes a change of crystalline structure; and that when such steel or other metal, after being so heated, beyond the critical point of transformation, is cooled, it has acquired and retains permanently a new crystalline structure, characterized, usually, not only by greater hardness, but also by greater elasticity. I have found that this heat treatment of metal to be used for sounding boards, etc., viz:—the heating of the metal to beyond its critical point of transformation, before the metal is placed in the stretching apparatus, and then the cooling of the metal in the stretching apparatus while such metal is held against contraction, is particularly advantageous for metal to be used as sounding boards, microphone diaphragms, etc.

The apparatus shown in Fig. 3 has been found to be particularly suitable for use when treating steel which has been heated above the critical point of transformation; for the heated steel is cooled rapidly by its intimate contact with the two cool metal bodies 7 and 8, the mass of which is so great, relative to that of the steel sheet 3, that heat is absorbed from such steel sheet very much as heat would be absorbed if the sheet were dipped in water or other hardening liquid.

By this means the steel plate is hardened or tempered, and its elastic limit greatly raised.

As a particular illustration of the temperatures to which steel may be heated to advantage, when of from .35 to .40 per cent. carbon, for treatment according to my invention, I will state that where heating beyond the critical point of transformation is not desired, heating to from 350° to 400° centigrade has proved effective; and when heating beyond the critical point of transformation is desired, heating to from 800° to 900° centigrade will give good results. But it is to be understood that these temperatures are not constant for all grades of steel but may be varied according to the nature of the metal treated.

What I claim is:—

1. The herein described method of treating sheet steel to be used for sounding boards and the like, which comprises heating the steel sheet to a temperature such that, when cooled while held against contraction, it is stretched beyond its elastic limit, and then holding along its edges the steel sheet so heated and permitting it to cool, and thereby stretching the steel beyond its elastic limit.

2. The herein described method of treating sheet metal to be used for sounding boards and the like, which comprises heating the metal sheet to a temperature above its critical point of transformation, and then holding along its edges the metal sheet against contraction and permitting it to cool.

3. The herein described method of treating metal to be used for sounding boards and the like, which comprises heating the metal to a temperature above its critical point of transformation, and then clamping the metal between the surfaces of metal bodies having high heat absorption capacity, and permitting the heated metal to cool while so held.

4. The process of treating flat sheets of metal to remove unevennesses therefrom which comprises stretching said sheets longitudinally to beyond the elastic limit of the metal while in a heated condition.

5. The process of treating flat sheets of metal to remove unevennesses therefrom which comprises stretching said sheets both laterally and longitudinally to beyond the elastic limit of the metal while in a heated condition.

6. The process of treating flat sheets of metal to remove unevennesses therefrom which comprises stretching said sheets longitudinally to beyond the elastic limit of the metal by cooling said metal sheets from a heated condition without longitudinal contraction.

7. The process of treating flat sheets of metal to remove unevennesses therefrom which comprises stretching said sheets both laterally and longitudinally to beyond the elastic limit of the metal by cooling said metal sheets from a heated condition without lateral and longitudinal contraction.

8. As a new article of manufacture a metal sheet for acoustic purposes of metal stretched to beyond its elastic limit.

9. As a new article of manufacture a sounding board of steel stretched to beyond its elastic limit.

10. As a new article of manufacture a flat metal sheet for acoustic purposes of metal stretched to beyond its elastic limit, said sheet being homogeneous and of high elasticity, and having the characteristics of metal stretched to beyond its elastic limit by cooling without contraction.

11. As a new article of manufacture a sounding board of steel stretched to beyond its elastic limit, said sounding board being homogeneous and having flat surfaces and high elasticity, and having the characteristics of metal stretched to beyond its elastic limit by cooling without contraction.

12. As a new article of manufacture a metal sheet for acoustic purposes of metal stretched longitudinally to beyond its elastic limit.

13. As a new article of manufacture a metal sheet for acoustic purposes of metal stretched longitudinally and laterally to beyond its elastic limit.

14. As a new article of manufacture a sounding board of steel stretched longitudinally to beyond its elastic limit.

15. As a new article of manufacture a sounding board of steel stretched longitudinally and laterally to beyond its elastic limit.

16. As a new article of manufacture a metal sheet for acoustic purposes having a thickness of less than 1 mm. and made up of metal stretched to beyond its elastic limit.

17. As a new article of manufacture a sounding board having a thickness of about .6 mm. to 1. mm. and made up of steel stretched to beyond its elastic limit.

18. As a new article of manufacture a metal sheet for acoustic purposes having a thickness of less than 1 mm. and made up of metal stretched longitudinally and laterally beyond its elastic limit.

19. As a new article of manufacture a sounding board having a thickness of about .6 mm. to 1. mm. and made up of steel stretched longitudinally and laterally to beyond its elastic limit.

20. As a new article of manufacture a sounding board having a thickness of about .6 mm. to 1. mm. and made up of steel stretched to beyond its elastic limit, said sounding board being homogeneous and having flat surfaces and high elasticity, and

having the characteristics of metal stretched to beyond its elastic limit by cooling without contraction.

21. The process of producing metal sounding boards for pianos having superior acoustic properties which comprises clamping such metal sounding board, while in a highly heated condition, in the sounding board frame of such piano, and thereafter stretching the metal of such sounding board to beyond its elastic limit by cooling without contraction.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

PER ARON WALLER.

Witnesses:
GRETA PRIM,
FR. N. BLOMQUIST.