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PROCESS FOR MAKING ORTHODONTIC BRACKETS

Filed June 26, 1969

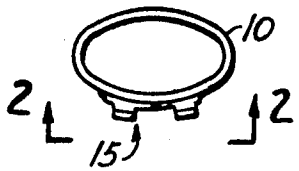


FIG. 1

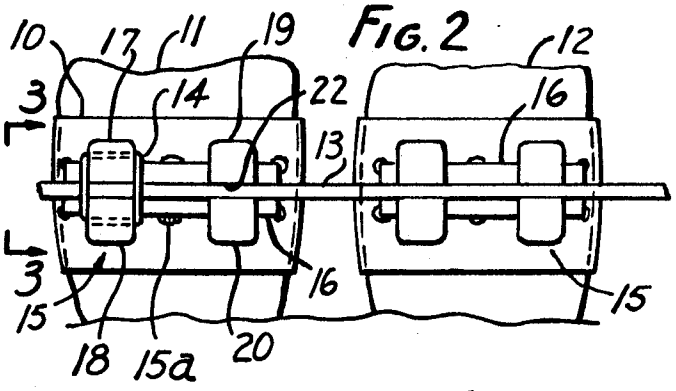


FIG. 2

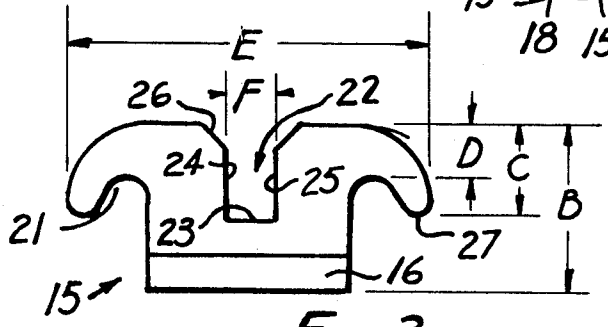


FIG. 3

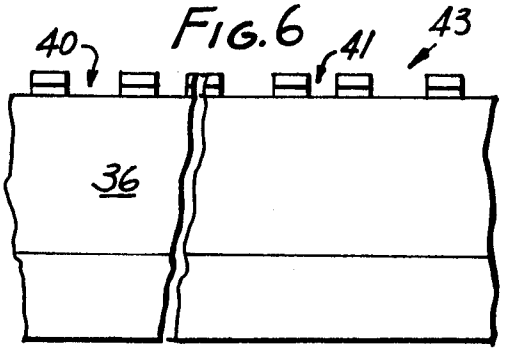


FIG. 6

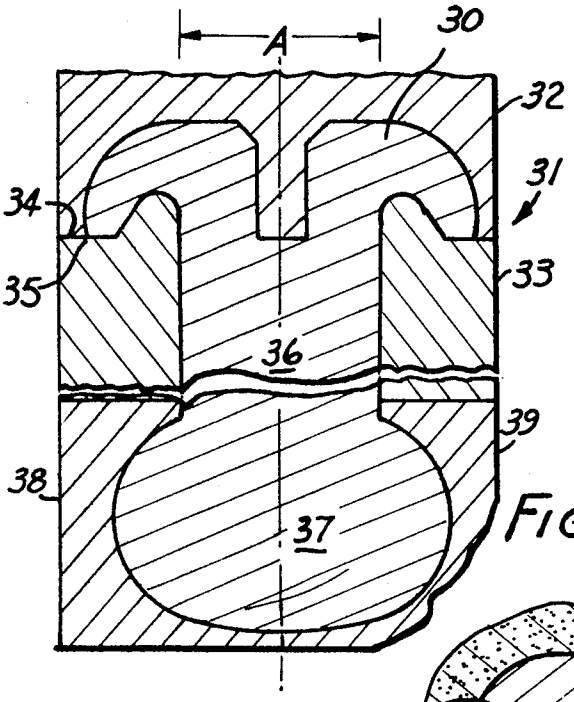


FIG. 4

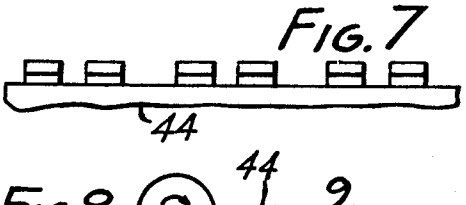


FIG. 7

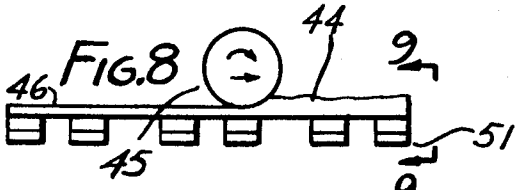


FIG. 8

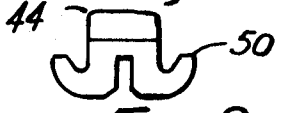


FIG. 9

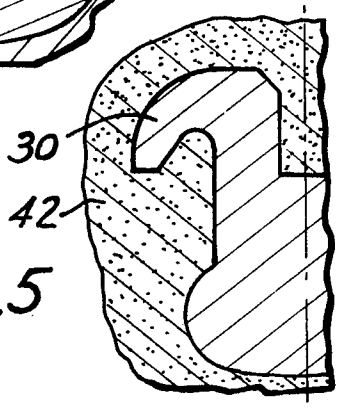


FIG. 5

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PROCESS FOR MAKING ORTHODONTIC BRACKETS

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U.S. Cl. 29—160.6 10 Claims

ABSTRACT OF THE DISCLOSURE

A process for making an edgewise orthodontic bracket having a rectangularly bottomed dimensionally critical longitudinal edgewise slot which in use receives a critically dimensioned rectangularly sectioned wire, a wing extending laterally from the slot which in use is engaged by a ligature wire, and a base pad beneath the slot. The process includes casting a body in a mold having a parting line, the body including said slot formed to its critical dimension, the wings, the base pad, and a longitudinally extending flange. The flange is removed and the remainder of the body is abrasively treated such as by slide honing, to create the product. In a preferred embodiment of the process, a plurality of groups of said wings are formed, and the body is cut laterally to form a plurality of pieces which are then abrasively treated, and then the flange is removed in two steps. In the first said step the major proportion of the flange is removed, and in the second the remaining minor stem flange is removed by grinding to form a planar surface on the bottom of the base pad, after which the semi-finished strip is cut into segments which are metal-finished, such as by slide honing.

This invention relates to a process for making an edgewise orthodontic bracket of the class having a rectangularly bottomed dimensionally critical longitudinal edgewise slot, and an overhanging wing extending laterally from the slot with a base pad disposed beneath the slot.

Edgewise orthodontic brackets are widely used in corrective dentistry. Customarily they are spot welded to a metal band which embraces the tooth, and a rectangular wire is placed in the slot of the member. The wire then extends between two such members so as to control the positioning of the teeth by being ligatured thereto, and twisted to adjust the length. The wire itself is rectangular in cross section and has a very critical dimension of width which must be critically matched by the width of the slot itself. Even very small tolerances result in unacceptable variances in tooth placement. A nearly zero tolerance is necessary, and the slot of this device is ordinarily held to tolerances of plus 0.0002, minus 0.0000.

This is an extremely difficult product to make with such a closely dimensioned slot with at least one and perhaps two hanging wings which are used to retain ligature wires that hold the wire in place. The existing high cost of these very small articles has resulted in part from the high scrap rates and prior art manufacturing procedures involving expensive and difficult milling and undercutting processes, to which are often added high overhead expenditures derived from interplant deliveries, tools, maintenance, and inspection of interim configurations.

With the process of this invention, the cost of manufacturing the article is drastically reduced, the process is reduced to a few simple, easily performed steps, and materials of construction may be used for the product which are not readily machined and which therefore have not heretofore been useful for making this product. For example, utilizing the process of this invention the bracket may be made of 304 stainless steel which can be cast but which is not readily machined. The functional advantage of this material is that it is more ductile than rod or bar

type stainless steel which are used because of their machinability but which are not significantly ductile. Ductility is a desirable property in brackets of the type involved herein, because ductility reduces the amount of breakage from shock and other forces. The ductility of castable alloys which can be used with the invention is significantly greater than that of other alloys which have heretofore been used because of their machinability.

Other resulting advantages derived from the materials which can be used with this process include an improved weldability to the band. Less pressure and heat are required to produce a stronger weld between the castable alloys of this invention than are needed to produce a less reliable weld with materials which heretofore had to be used for their other properties. Persons skilled in the art will note that alloying elements such as sulfur and selenium which are provided to improve machinability, interfere with the function of weldability. The new capacity, furnished by this invention, to use castable alloys, simultaneously enables the manufacturer to provide products which are more readily welded, because they do not include alloying in materials for machinability which are deleterious to weld and welding.

This invention also permits the manufacture of devices with closer total envelope accuracy than is obtainable with any machining process. Close geometrical similarity is desirable because of the inherent nature of orthodontic usage.

The process of this invention includes casting a body to be lost in a lost-wax process, in a mold having a parting line, whereby to form the slot with its critical dimension together with the wing or wings and also the base pad. The parting line is disposed at the tip of the wing or wings. The mold also forms in the body a longitudinally extending flange beneath the base pad integral therewith. Thereafter this body is encased in a frangible casting jacket, is lost in the lost-wax process, and is replaced in the jacket with the castable alloy to produce a duplicate body which is then removed from the jacket. Thereafter, the flange is removed, and the body is metal-finished.

According to a preferred but optional feature of the invention, a plurality of groups of two of the wings are formed, and the cast body is cut laterally to form a plurality of pieces which are abrasively finished. As another refinement, the flange may be removed in two steps, in the first of which the major proportion of the flange is removed leaving a minor amount, and then the remainder is ground to the required thickness and to form a planar surface on the bottom of the base pad.

The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawings in which:

FIG. 1 is a top view of a band incorporating an edgewise orthodontic bracket produced by the method of this invention;

FIG. 2 is a side view showing a pair of teeth joined by a wire held by two of said brackets;

FIG. 3 is an end view of one of said brackets according to the invention;

FIG. 4 is a cross section showing a first step in the process of this invention;

FIG. 5 is a view like that of FIG. 4 showing the body of FIG. 4 encased in a jacket for the lost-wax process;

FIG. 6 is a side view of a body duplicated from that of FIG. 5 by means of the lost-wax process;

FIGS. 7 and 8 are side views showing two sequential steps in the process; and

FIG. 9 is a right hand end view of FIG. 8.

FIGS. 1 and 2 show two bands **10** embracing respective teeth **11, 12,** whose position relative to the jaw and to each other is maintained by a stiff wire **13.** The wire extends in a longitudinal direction, and has a rectangular

cross section. Ligature wires **14** tie the wire **13** in position (of which only one is shown).

The edgewise bracket **15** is spot welded by weldments **15***a* to the band at the base pad **16** of the bracket. The base pad is initially made planar but is bent to conform to the shape of the band. Rising from the base pad are four wings, **17**, **18**, **19**, **20**, which form a group of two pairs, the members of which are opposed to each other laterally and which overhang in an outward direction as best seen in FIG. 3, so as to form an underlying channel **21** beneath the outside of each of the wings. This invention also comprehends a structure wherein only two axially spaced-apart wings are provided with channels, instead of two pairs, such a construction being suitable for many applications.

Between the wings there is located a longitudinally extending critically dimensioned rectangularly bottomed edgewise slot **22**. The bottom **23** of the slot is flat and the two side walls **24**, **25** are accurately parallel to each other and their lateral spacing apart is the critical dimension.

A pair of radiused chamfers **26** extend between the side walls and the tops of the wings to facilitate the insertion of the wire into the slot. The tips **27** of the wings are gently rounded and the entire device is devoid of sharp edges as a result of a process yet to be described. The following is a set of suitable dimensions for an edgewise bracket according to the invention (dimensions in inches):

(A) 0.070
(B) 0.057
(C) 0.0335
(D) 0.018
(E) 0.130
(F) 0.0182, +0.0005, —0.0000

As can be seen, the formation of the underlying channels **21** and the accurate slot in a device as dimensionally critical and as small as this can be difficult when standard machining procedures are utilized. It is an advantage of this invention that conventional machining techniques need not be utilized, but that instead casting and bulk finishing procedures may be utilized. As a further advantage, more advantageous materials of construction can be used.

The process begins as shown in FIG. 4 by casting a body **30** in a mold **31** made according to standard designs. This mold may conveniently be made in four parts. The critical mold parts are parts **32** and **33** which have a parting line **34** which parting line intersects the walls of the wings, preferably at the tips. In the manufacture of the device sharp edges **35** are formed on the tips but these will be removed in a later step. In the mold, the wings, base pad, and slot are accurately formed and also there is a longitudinally extending flange **36** integral with the base pad and extending below it terminating in a bulb **37** or other flue means in parts **38**, **39** of the mold. It will now be seen that the body can be cast and removed from the mold by separating parts **38** and **39** and then parts **32** and **33**. The resulting body is shown in side view in FIG. 5 where it will be noted that the groups of four wings are spaced apart by a spacing **40** which is greater than the spacing **41** between pairs of members of the same group. This enables a cut to be made between adjacent groups still leaving an adequate overhanging base pad of indeterminate length which can thereby be used to make edgewise brackets of different total length.

The mold is a conventional metal mold. To pour molten stainless steel in such a mold would result in excessive wear. Accordingly, the well-known lost-wax process is used. Body **30** is meant to be destroyed in the formation of an identical cavity in a ceramic mold which is used one time and is frangible to release the product. Accordingly, body **30** is cast of a plastic material which is dimensionally stable, and which will decompose to gases when strongly heated. Styrene is one such substance.

FIG. 5 shows body **30** cast into a ceramic jacket **42**. When the jacket is baked to form a rigid mold, body **30** gassifies, disappears, and leaves an internal wall which exactly duplicates the shape of the body. Next, the cavity is filled with molten metal, to which the ceramic jacket is thermally resistant, and the jacket and product are cooled. Then the jacket is cracked and broken off, leaving body **43**, which is a complete duplicate of body **30**. Like numbers are used in the drawings because of the identity of structure. A light sandblast may be applied at this stage to remove all traces of jacket material.

It is possible, with this construction, greatly to reduce one's inventory of sizes. There are a number of standard slot widths in use, and it is possible while the device is still in strip form, to mill out the slot to a somewhat greater width. The amount of material to be removed is only of the order of a thousandth of an inch or so, and there are no substantial distortive forces exerted by a milling cutter in removing such a small amount. This contrasts with the prior art attempt to mill the slot directly. Climb milling is preferred for this step when it is used, and the step will be performed on the strip before it is cut into pieces. This is an optional "sizing" step for the slot.

The next step is the removal of the major portion of the flange **36** which can be done by cutting, punching, or grinding, as preferred. Any surface may be used as a guide for this step. This flange mold may not be a section of reduced width as shown, but may simply constitute a thickening of the base pad structure, which is reduced to the desired thickness by grinding. The term "flange" is therefore used broadly to mean excess material below the base pad portion. Preferably, this step will leave a minor amount of material **44** (sometimes called a "stem flange") adjacent to and contiguous with the base pad which stem flange will next be removed as shown in FIG. 8 by a surface grinder **45** which grinds the base pad bottom surface **46** to an accurate smooth plane. The initial condition showing the minor stem flange is shown in FIG. 7, and the resulting strip is shown in the left-hand portion of FIG. 8.

When the brackets are cast as individual pieces, as they may be, instead of a strip of many brackets, the devices go directly to a metal-finishing process.

When they are made in strip form they are next cut apart, using the edges of the wings as guides, and depending on the size of spacing **40**, a straight cut is made, or a section removed, to secure the desired flats on each axial extreme of the bracket.

The individual brackets will now be finished. The pieces obtained from body **43** are somewhat oversize, also there are sharp edges. A metal-finishing process such as slide-honing is now used. This will break and round all sharp edges, and corners, for example edge **50** and corner **51**. A smooth, rounded, dimensionally accurate device is thereby secured. The inside of the slot is not affected by slide honing, and the critical dimension is not changed. The changes in outside dimensions are regulated by choice of honing medium, and duration and severity of honing, in accordance with known techniques.

Should a brighter finish be desired, an electropolishing step may also be used, and often will be a step preceding the final finishing. The term "metal-finishing" means a material-removal process in which surface material is removed to create a smooth surface with new dimensions, and includes buffing, sand blasting, vapor blast, slide honing, electropolishing, and the like.

The foregoing process produces in bulk an accurately dimensioned device which heretofore has been most difficult and expensive to make. The smooth edges and corners are in themselves an improvement over that which could be produced by prior art processes.

The result is a bracket of high quality, close tolerances, improved materials of construction, and elegant appearance obtained by conventional casting and finishing tech-

niques, devoid of the troublesome machine work which has caused brackets of this type to be so expensive and troublesome in the past.

I claim:

1. The process of making an edgewise orthodontic bracket having a rectangularly bottomed dimensionally critical longitudinal edgewise slot, an overhanging wing extending laterally from the said slot, and a base pad beneath said slot comprising:

(a) casting a body in a mold having a parting line whereby to form said slot, wings and base pads, the parting line being disposed at the walls of said wings and parting in a direction parallel to the dimension of depth of the slot, said mold also forming a longitudinally extending flange beneath the base pad and integral therewith;

(b) reproducing the body in molten metal by the lost-wax process;

(c) removing said flange; and

(d) metal-finishing the remainder of the body.

2. The process of claim 1 in which the metal-finishing process is slide-honing.

3. The process of making an edgewise orthodontic bracket having a rectangularly bottomed dimensionally critical longitudinal edgewise slot, an overhanging wing extending laterally from the said slot, and a base pad beneath said slot comprising:

(a) casting a body in a mold having a parting line whereby to form a plurality of groups of said wings with the slot formed adjacent to two of the same, and to form said base pad together with a longitudinally extending flange beneath the base pad and integral therewith, the parting line being disposed at the walls of the wings;

(b) reproducing the body in molten metal by the lost-wax process;

(c) removing said flange so as to form an extended strip;

(d) laterally cutting the strip into a plurality of pieces; and

(e) metal-finishing the pieces.

4. The process of claim 3 in which the metal-finishing process is slide honing.

5. The process of claim 3 in which the pieces are electropolished.

6. The process of claim 3 in which the wings are cast in groups of two pairs, adjacent groups being longitudinally spaced from each other by a distance greater than the longitudinal spacing between the pairs of each group, whereby the base pad may extend longitudinally beyond the wings.

7. The process of claim 4 in which the wings are cast in groups of two pairs, adjacent groups being longitudinally spaced from each other by a distance greater than the longitudinal spacing between the pairs of each group, whereby the base pad may extend longitudinally beyond the wings.

8. A process of claim 3 in which the flange is removed in two steps, the first removing the major proportion thereof and leaving a relatively minor part, and the second step comprising grinding off said minor part so as to finish the bottom of the base pad as a smooth plane.

9. A process according to claim 8 in which the pieces are electropolished.

10. A process according to claim 9 in which the wings are cast in groups of two pairs, adjacent groups being longitudinally spaced from each other by a distance greater than the longitudinal spacing between the pairs of each group, whereby the base pad may extend longitudinally beyond the wings.

References Cited

UNITED STATES PATENTS

2,527,526	10/1950	Brusse	32—14A
3,178,822	4/1965	Fogel et al.	32—14A
3,224,050	12/1965	Redtenbacher	164—34X
3,259,949	7/1966	Moore	164—34
3,343,247	9/1967	Dillberg et al.	29—160.6
3,498,365	3/1970	Wittmoser	164—34X

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U.S. Cl. X.R.

29—417, 527.6; 32—14A; 164—76, Dig. 4