Feb. 13, 1973 J. KOCHAVI 3,716,418

METHOD OF MAKING A CASTING HAVING AN OXIDIZED SURFACE LAYER INTENDED FOR USE AS A DENTAL RESTORATION

Filed Aug. 7, 1970

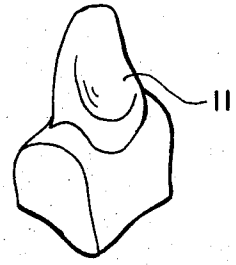


FIG. 1.

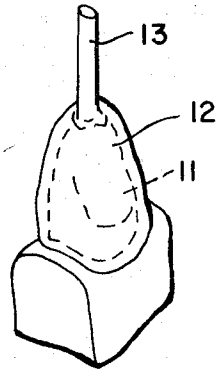


FIG. 2.

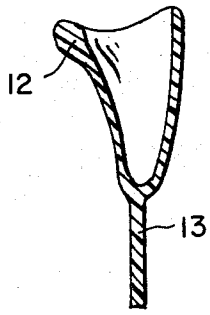
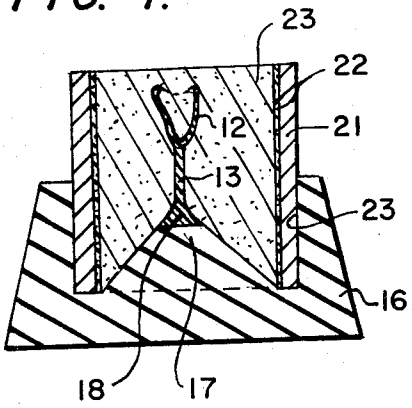


FIG. 3.

FIG. 4.



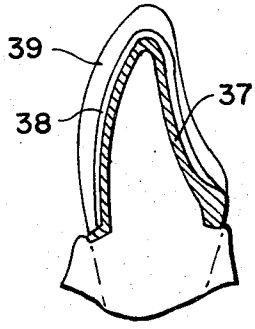


FIG. 6.

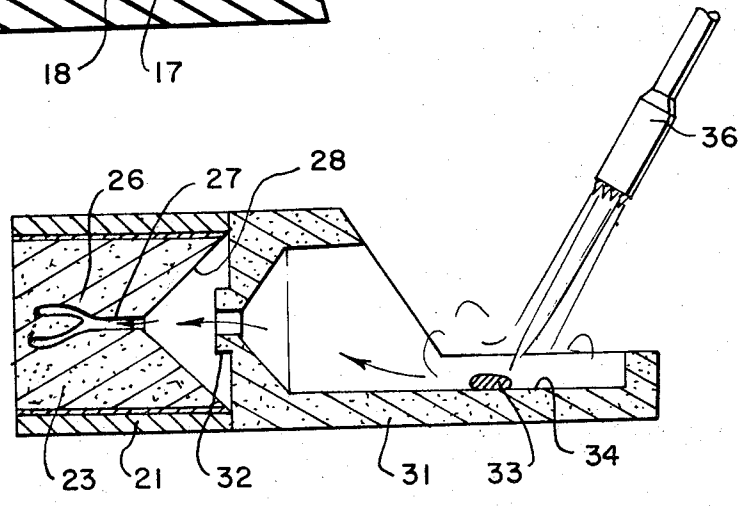


FIG. 5.

INVENTOR.

JACOB KOCHAVI

BY

Julian Caplan

ATTORNEY

United States Patent Office 3,716,418 Patented Feb. 13, 1973

3,716,418

METHOD OF MAKING A CASTING HAVING AN OXIDIZED SURFACE LAYER INTENDED FOR USE AS A DENTAL RESTORATION

Jacob Kochavi, % Star Dental Laboratories, 718 El Camino, San Mateo, Calif. 94402

Filed Aug. 7, 1970, Ser. No. 61,917
Int. Cl. C23c 11/00
U.S. Cl. 148—6.3 1 Claim

ABSTRACT OF THE DISCLOSURE

A restoration is made using an alloy of approximately 80% Ni–20% Cr employing conventional casting techniques heretofore used with precious metals. After the casting has been cleaned it is heated under vacuum commencing at 1400–1500° F. and increasing gradually to approximately 1950° F. The vacuum is released and the casting cooled—a grayish blue colored compound forming on the surface. Porosities and casting defects may be conveniently repaired using ceramic gold paste. The metal may be soldered, to other metal members, whether of the same alloy or gold or any other conventional metal. Porcelain is then applied, again using conventional techniques. The product is characterized by the very good bond of porcelain to metal, extreme dimensional accuracy and relatively low cost of metal.

This invention relates to a new and improved method of making dental restorations and to the product thereof. More particularly, the invention relates to a porcelain or acrylic crown cap, pontic member or the like for a single tooth or to a multiple unit bridge member. The method may also be used in fabricating the appliances of dentures.

The restoration differs from other metal members heretofore used in dental restorations in that it is formed of a stainless alloy consisting of approximately 77.8% Ni, 20% Cr, small amounts of Fe and Mn with traces of Al, Cu, Be, Sb. Such alloys have heretofore been used commercially for products such as electrical heating elements and in the chemical industry, where corrosion resistance is important. However, satisfactory bonding of porcelain to stainless alloy has not heretofore been satisfactorily accomplished. The alloy of the present invention is considerably less expensive than the gold and platinum alloys which have traditionally been used in dental restorations. Hence, the present invention is of considerable economic importance.

One of the important features of the invention is the durable bond of the porcelain to the metal which is accomplished by practice of the present invention. Impact and wear as well as reasonably extreme heat fluctuations in use of the restorations do not cause destruction of the bond of the porcelain to the metal thereby differing from the results obtained heretofore in using non-precious alloys for such purposes.

One of the features of the invention is the fact that metal of the present invention is harder than gold and other restoration alloys and hence is not easily deformed and thus may be brought to a fine edge. Since the fine edge cannot be readily deformed, the overlying porcelain is not damaged. This permits finer edges to be formed on the metal portions than with metals used heretofore.

Although the invention finds particular application in porcelain restorations, nevertheless, by proper design of metal frame or base, particularly by the use of mechanical retainers, plastics such as acrylics may also be used in the visible portions of the restorations. Again, the results achieved by the use of the alloy of the present invention

exceed those of previously used non-precious metal restorations.

Another advantage of the invention is the fact that standard procedures and equipment are, in the main, used in carrying out the method. The impressions are made by the dentist in normal fashion and the procedure in the laboratory is also largely standard. Hence, special equipment and the learning of specialized techniques are not required. Accordingly, the present invention is adapted to use in existing establishments.

Another feature of the invention is the fact that the materials and technique are less expensive in cost and labor than those conventionally employed at present. The cost of the stainless alloy is substantially less than that of gold and platinum alloys, yet the results obtained are at least as satisfactory as with the more expensive materials.

Another feature of the invention is the fact that perforations and imperfections in the casting may be repaired or filled with a standard material, namely a ceramic gold paste. Other non-precious metal alloy castings cannot be repaired in this manner, and hence it is possible to salvage castings made in accordance with the present invention where conventional castings would have to be discarded.

Still another feature of the invention is the fact that the heat treamtent of the casting removes "bubbles" and imperfections in the casting and also makes the bond to porcelain more permanent.

Another advantage of the invention is that the frame of the present invention may be baked as many times as necessary to achieve the desired porcelain finish. Precious metal frames may be fired only about six times, whereupon the alloy loses its physical properties. Hence the quality of the porcelain finish produced in accordance with this invention in some instances is superior to that obtained using precious metals.

Another advantage of the invention is the accuracy of the casing produced by the invention. It is extremely important that caps, crowns and the like fit accurately, both from a standpoint of the bite of the patient and also to prevent decay of the tooth under the restoration. The present invention produces frames of exceptional dimensional accuracy.

In a preferred form of the invention the casting is heated under vacuum, then cooled to form a granular surface. Opaque porcelainizing material may be applied, followed by one or more porcelain enamel coatings. Alternatively, instead of the opaque coating, the surface of the casting which is to be glazed is coated with ceramic gold paste, which is fired and then one or more opaquing and porcelain enamel coatings are applied. The gold paste changes the silvery appearance of the alloy to a gold color. Dental laboratory technicians are more familiar with matching natural tooth shades where the base is gold; hence applying a gold coating to the alloy of this invention results in a more natural match in shade of the porcelain enamel. This technique cannot be used with other non-precious alloys.

Still another feature of the invention is the facility with which the metal may be soldered to adjacent metal structures whether of the same stainless alloy or gold. Thus the present invention may be used to fabricate a bridge unit which may then be attached to existing units made of different material.

A further use for the present invention is in the fabrication of full or partial dentures to cover the same with porcelain at the gum line to prevent contact of alloy with the gum. A metal frame is cast as for the restorations previously mentioned, then heat treated as in the case of restorations and then porcelainized where contact is to occur.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

FIG. 1 is a perspective view showing a die used in preparation of a wax mold in accordance with the present invention.

FIG. 2 is a perspective view showing the die of FIG. 1 coated with wax and a sprue attached.

FIG. 3 is a section of the wax layer and sprue removed from the die.

FIG. 4 is a sectional view showing the wax invested in a crucible former.

FIG. 5 is a sectional view showing the crucible former and crucible as installed on a centrifugal casting machine (not shown) and showing a pellet of stainless alloy being heated with an acetylene torch.

FIG. 6 shows the completed crown installed on a tooth.

GENERAL RESUME OF THE METHOD

The present invention is used in making various restorations such as crowns and caps for a single tooth or abutment units, crowns and pontic units for multiple tooth restorations such as bridges. The metal frame on which the porcelain is applied is prepared from a stainless alloy hereinafter described in detail. Subsequent to the preparation of the metal frame, a porcelain coating is applied.

An impression is prepared from the patient's mouth as in conventional practice. At the laboratory, a "stone" or plaster cast is prepared from the impression and a working model is thus produced. If the restoration is to be applied to a single tooth, that tooth is cut from the working model to form a die. The term "die" is used generally to refer to the male casting which represents the patient's tooth upon which the frame is to be installed.

The die is then coated with oil to facilitate removal of the wax and a coating of inlay wax is applied in accordance with conventional practice to a thickness of approximately 0.030 inch. A wax sprue is applied in proper manner to the wax and the wax is then removed from the die or working model, and mounted inverted on the base of a rubber casting mold of a crucible former. Vents may be added to permit gases to be expelled during the casting operation but the use of such vents is not as essential as in other casting techniques.

An investment material is mixed under vacuum and used to fill a casting ring which is installed on the rubber casting mold. Such investment material sets and is then heated to melt out the wax. While still hot, the crucible former, which now has a cavity complementary to the wax and sprue is then positioned in proximity to the crucible on the table of a centrifugal casting machine. A pellet of material in the centrifugal casting machine, which has been brought up to heat by use of an acetylene torch, is then cast into the plaster investment. The material used in the pellet is of particular importance and is hereinafter described in considerable detail.

The casting is then cleaned, the sprues removed and it is then thoroughly washed and is ready for the porcelainizing operation.

It will sometimes appear that there are perforations or porosities in a casting made in accordance with the present invention as well as made in use of conventional techniques and metals. Heretofore it has been necessary to discard such castings. However, in accordance with the present invention, such perforations and porosities may be filled with a ceramic gold cream and the casting then baked, causing the casting to be then fully useful. Further, it is frequently desirable to solder a unit to an adjacent unit. The units made in accordance with the present invention may be soldered to units of the same material or to gold units using conventional gold solder. The porcelain is not damaged during such soldering operation if care is exercised in performing the operation.

The metal frame of the present invention is particularly useful in porcelain coating. It will be understood however, that acrylic coatings may be used if provision is made in the metal unit for mechanical locks to bond the acrylic in place.

As an important step in preparation of the casting for porcelainizing, after it has been cleaned and washed it is heated in a furnace under vacuum starting at about 1500° F. and gradually brought up to 1900° F. and held for about one minute. Thereupon the vacuum is released and the casting is allowed to cool outside of the furnace. It will be found that the surface has been transformed from a smooth dull finish to a grayish powdery bright finish. Certain oxides are thus formed on the surface and are quite stable in their mechanical linkage to the underlying material. It is believed that the porcelain thereafter applied is mechanically bonded more effectively because of the powdery surface of the casting.

An opaque coating is applied to the frame and baked. This opaque coating reduces the tendency of the metal to be seen through the final coating. After the opaque has been applied an outer porcelain finish of one or more coats is applied and baked, all in accordance with the conventional porcelainizing procedures.

The acrylic coatings are applied to the metal frame in accordance with manufacturer's specifications.

The completed unit is extremely stable in the bond between the porcelain or acrylic and the underlying metal. It will resist considerable impact, abrasion and rapid severe temperature changes. It is thus at least as satisfactory as platinum and gold frames and is substantially less expensive in cost of material.

MATERIAL

One material which may be used in accordance with the present invention is a stainless alloy of the nickel-chrome type which has not heretofore been employed in dental restorations. One such alloy has the following analysis by weight:

	Percent
Ni	77.8
Cr	20.0
Fe	0.5
Mn	0.75
Al	Trace
Cu	Trace
Be	Trace
Sb	Trace

One such material is commercially available under the trade name Tophet A, an alloy produced by Wilbur B. Driver Company of Newark, N.J. Another producer of a similar alloy is Cartech Carpenter Technology Corp. of Detroit, Mich. However, such products have never been used heretofore for this purpose but have been used primarily in resistance wire for furnaces, applicances and other heating apparatus and also in the chemical industry for baskets, belts and certain hardware.

A slightly different alloy composition is:

	Percent
Ni	77.9
Cr	20
C	0.048
Mn	0.06
Si	1.34
Ca	0.03
Pb	0.003
S	0.04
Fe	0.15
Al	0.13
Co	0.03
Cu	0.03
Zr	0.09

The foregoing alloys are generally known as "80–20 stainless" and are thus generally referred to herein.

In accordance with the present invention the material is supplied in pellets of a volume sufficient to adequately fill the casting mold. This alloy has a relatively high coefficient of expansion, such coefficient being about equal to that of the porcelain which is subsequently applied. It is stable to heat, being recommended for use in operating temperatures of up to 2150° F. and a melting point of 2500–2600° F., and has a relatively high tensile strength It will be understood that other alloys produced by other manufacturers are suitable.

PROCEDURES PREPARATORY TO CASTING

An impression is made, usually by the dentist, using standard impression technique. When received in the laboratory, a stone or plaster casting is made from the impression using a plaster which is preferably quite hard and dense. A die **11** may be cut from the stone where a crown or cap for a single tooth is to be fabricated. The invention will be described in using such a die, it being understood that where multiple units are to be fabricated, one skilled in the art will readily understand the adaptations of the techniques hereinafter described.

The die **11** shown in FIG. 1 is first coated with a layer of oil which subsequently permits easy removal of the wax. Inlay wax **12** is then applied using a spatula or other tool in accordance with standard techniques to a thickness of about 0.030". The wax **12** is not necessarily uniform in thickness but is adequate in thickness at all points. A wax sprue **13** of 8 to 10 gauge and of a relatively short length of about ½" is then attached to the top of the wax layer **12**. Thereupon the wax is lifted from the die **11**. It is sometimes necessary to install vents on the opposite end of the wax to permit the gases formed during investment casting to be eliminated. Ventilation canals may be made using 1 mm. wax rods, but the use of ventilation canals is not as essential in the practice of this invention as in the use of other techniques and materials and may be eliminated.

The rubber casting mold base **16** of a centrifugal mold former is cleaned and the sprue is attached to the apex **17** of the interior of the base using inlay wax **18**. Metal casting ring **21** lined with asbestos paper **22** to permit expansion is installed in the cavity **23** in base **16**, preferably the wax **12** terminating about ¼" below the top edge of ring **21**. A debubblizer material such as alcohol is used to clean the wax and remove any oil remaining thereon.

Various investment materials may be used. One suitable investment material is "Ceramigold Investment," a product of The Whip Mix Corporation. The liquid and powder ingredients of such investment material are mixed under about 29" of vacuum in an investor machine in accordance with manufacturer's specifications. The mixture **24** is then poured into ring **22** to fill the ring. The base **16** and ring is vibrated in a vibrating machine while the mixture is being poured to ensure thorough filling of the ring. It normally requires about one-half hour for the investment material **24** to set, whereupon the rubber base **16** is removed. The ring and contents are placed in a furnace and slowly heated to 1400–1700° F. over a one hour period and left at that temperature for about one-half hour. During this period of time the wax comes out of the mold and the investment material **24** is thoroughly dried and hardened. A cavity **26** complementary to wax **12**, sprue **13** and ventilation canals (not shown) is produced, with entrance canal **27** (corresponding to the sprue) communicating with a conical depression **28** in one end of ring **21**.

CASTING

A centrifugal casting machine used in making bridges may best be used in practicing this invention. Crucible **31** is clamped on the inside of the table of the machine and the ring **21**, which is still hot from the furnace, is placed on the outside of the crucible, and fits very tightly thereagainst,

the cavity **28** in the ring communicating with the spout **32** of the crucible. A pellet **33** of the alloy material heretofore described has previously been placed on the hearth **34** of heated crucible **31** and heated with an acetylene torch **36** having between a 4 and 7 tip using 15 lbs. pressure oxygen and 5 lbs. pressure acetylene until the pellet **33** is molten and at a temperature of about 2500° F. The table of the centrifuge is then released for rotation and the centrifugal force causes the molten alloy to flow through the spout **32** and into the ring **21** and to to thoroughly fill the cavity **26** in the ring previously occupied by the inlay wax.

After the metal has cooled, it is broken out of the mold **23** and prepared for porcelainizing. The sprues **27** are cut off and the casting is smoothed up and then surfaced with a semi-rough stone so that it is smooth but not polished. The casting **37** is then washed to remove all oil and foreign material and thereafter the casting is preferably not touched by hand so that no foreign matter comes in contact with the metal surface. The excess material from the sprues, buttons at the cavity **28** and the like may be reused, preferably on adding at least 50% new material.

APPLYING OF COATING

As has been stated, a preliminary step in the treatment of casting **37** preparatory to applying the fundamental coating is to place the casting in a furnace at an initial temperature of 1400–1500° F. under a vacuum of 29". All gases are driven out. The temperature is gradually increased to about 1950° F., and the vacuum is then released. A bluish gray oxide of a powdery nature appears on the surface of casting **37** and it is the belief of the inventor that this assists in forming a good mechanical bond with the porcelain which is next applied. The casting is allowed to cool.

Where the casting is to be porcelainized, conventional porcelain techniques used with gold alloys are employed. The first step is to apply an opaque coating **38** which prevents the dark color of the metal from appearing through the final porcelain. The opaque material is commercially available and consists of a powder which is mixed with water to form a creamy paste which is then coated on to the metal surface with a brush or spatula to a thickness of about ½ mm. The opaque coating **38** is dried by placing near the open door of a furnace which is at a temperature of 1200° F. until the coating is dry. Then the casting **37** is moved into the furnace and the door closed and the temperature raised to 1800° F. at a rate of about 50° F. per minute. The casting is left in the furnace long enough so that the coating **38** becomes shiny and is then cooled in the air.

If the coating **38** is not thick enough the operation may be repeated. Any thicknesses or lumpy spots are then ground off and the opaque casting is then cleaned and rinsed under clear running water. As has been stated, it is usually desirable not to touch the metal once the porcelainizing operation is commenced.

As an alternate procedure, to improve the bond between the porcelain and the metal, the opaque powder is formed in a very thin mixture with oil and applied to the casting. The casting is placed near the open door of a furnace to dry for about three to five minutes. Then the casting is placed in the furnace at about 1400° F. under 29" vacuum and slowly raised to about 1800–1900° F. The casting is cooled at room temperature. The surface is relatively rough and, when the porcelain coatings are applied, a better bond is obtained. The porcelain application is as has already been described.

The opaqued casting **37** is then coated with a series of layers of porcelain **39**. The dental porcelain which may be used in connection with the present invention is subject to wide variation and conventional commercially available porcelain materials may be employed. One suitable dental porcelain is composed of kaolin (aluminum silicate) and feldspar (potassium aluminum silicate) along with binders and pigments. The porcelain powder is mixed

with distilled water to a putty-like consistency. Various porcelain materials are fused at different temperatures. A low fusing porcelain melts at 1600–2000° F., a medium fusing at 2000–2400° F. and a high fusing above 2400° F. Any of these porcelains may be used with the metal frame of the present invention. Each layer is applied by brushing a mixture of porcelain powder and water onto the form, preferably under vibration. The casting is dried and baked as in the case of the opaque.

In a modified procedure, the cooled, de-gassed casting is ground with a semi-rough stone, cleaned, washed and dried. A thin layer of ceramic gold cream is applied to areas to which porcelain is to be applied. The casting is placed near the open door of a furnace (the interior of which is at about 1400° F.) for three to five minutes to dry and then placed in the furnace and gradually raised to 1600–2000° F. The casting is then cooled on the bench. If necessary, the application of gold may be repeated. Thereafter one or several coatings of opaque and several coatings of porcelain enamel are applied as has already been described. The color of the completed restoration is changed somewhat in that the underlying silver color has been changed to gold and a better match to natural shades of teeth may be achieved, as has been mentioned.

Acrylic coatings may be applied as well, following the manufacturer's specifications.

AUXILIARY OPERATIONS PRIOR TO PORCELAINIZING

Occasionally imperfections occur in castings which heretofore have required that the casting be discarded. In accordance with the present invention, however, the imperfections and porosities may be filled with a conventionally available ceramic gold cream. Such cream is commercially available. It is applied in paste form using a brush or spatula. The casting is then heated in a furnace at 1600–2000° F. and the surplus material is smoothed off. This step is best done before de-gassing of the casting.

It is frequently necessary to connect a casting to an adjacent metal member as to a bridge abutment or connector. A dental gold solder may be used and a feature of the present invention is the fact that the metal alloy of this invention may be joined to the adjacent metal member either before or after the porcelain has been applied. One solder which may be used consists of: Au, 67%; Ag, 15%; Cu, 12%; Zn, 3%; Sn, 3%. Such solder melts in the range of 1375–1600° F. and thus does not damage the porcelain, which melts at about 1700–1800° F., or the bond between the porcelain and the alloy of the present invention.

COATING OF DENTURES

Some patients cannot tolerate plastics or alloys which form the frames of full or partial dentures touching the gums. The present invention may be used to obviate such sensitivity. An appliance (equivalent to the frame of the previously described restoration) is cast from the alloy previously described in substantially the same manner. The frame optionally may be heated in a furnace under vacuum as in the preceding instances. Whether de-gassed or not, the frame is finished with a semi-rough stone to remove irregularities, then cleaned and washed. After the casting has cooled a thin layer of ceramic gold cream is applied to areas which are to be porcelainized, but not to retention areas. The gold cream is dried by placing near door of the furnace for three to five minutes, then placed in the furnace at about 1400° F. under vacuum and the temperature increased to about 1600–2000°. The gold coating may be repeated, as required. After the frame has cooled, porcelain glaze may be applied in accordance with manufacturer's specifications. If desired, for cosmetic effect red stain may be mixed with the porcelain glaze material to produce a pink color which matches the gums.

The term "restoration" as used herein will be understood to include appliances for full or partial dentures as well as the crowns, caps, abutments, pontic units, and the like, herein referred to or as will occur to one skilled in this art.

I claim:

1. A new use for a composition of matter, said matter consisting of an alloy having approximately 80% Ni and 20% Cr, said use comprising making an investment casting of said matter complementary to a dental impression for a dental restoration, heating said casting under high vacuum to a temperature of about 1950° F., then releasing the vacuum and then cooling the casting, the casting being characterized by a surface layer of grayish-blue powder.

References Cited

UNITED STATES PATENTS

2,206,392	7/1940	Crocker et al.	148—6.3
2,461,935	2/1949	Stockdale et al.	148—6.3
3,664,884	5/1972	Underwood	148—6.3
2,103,500	12/1937	Touceda	75—171 X
2,156,757	5/1939	Grossman	75—171
3,544,315	12/1970	Asgar	75—171

CHARLES W. LANHAM, Primary Examiner

D. C. REILEY III, Assistant Examiner

U.S. Cl. X.R.

29—160.6, 527.5; 32—2, 8; 75—171; 148—3; 164—61