

(11) (21) (C) **2,022,698**
(22) 1990/08/03
(43) 1991/02/10
(45) 2000/01/25

(72) Evans, Philip Anthony, GB

(72) Harrison, Paul, GB

(73) Evans, Philip Anthony, GB

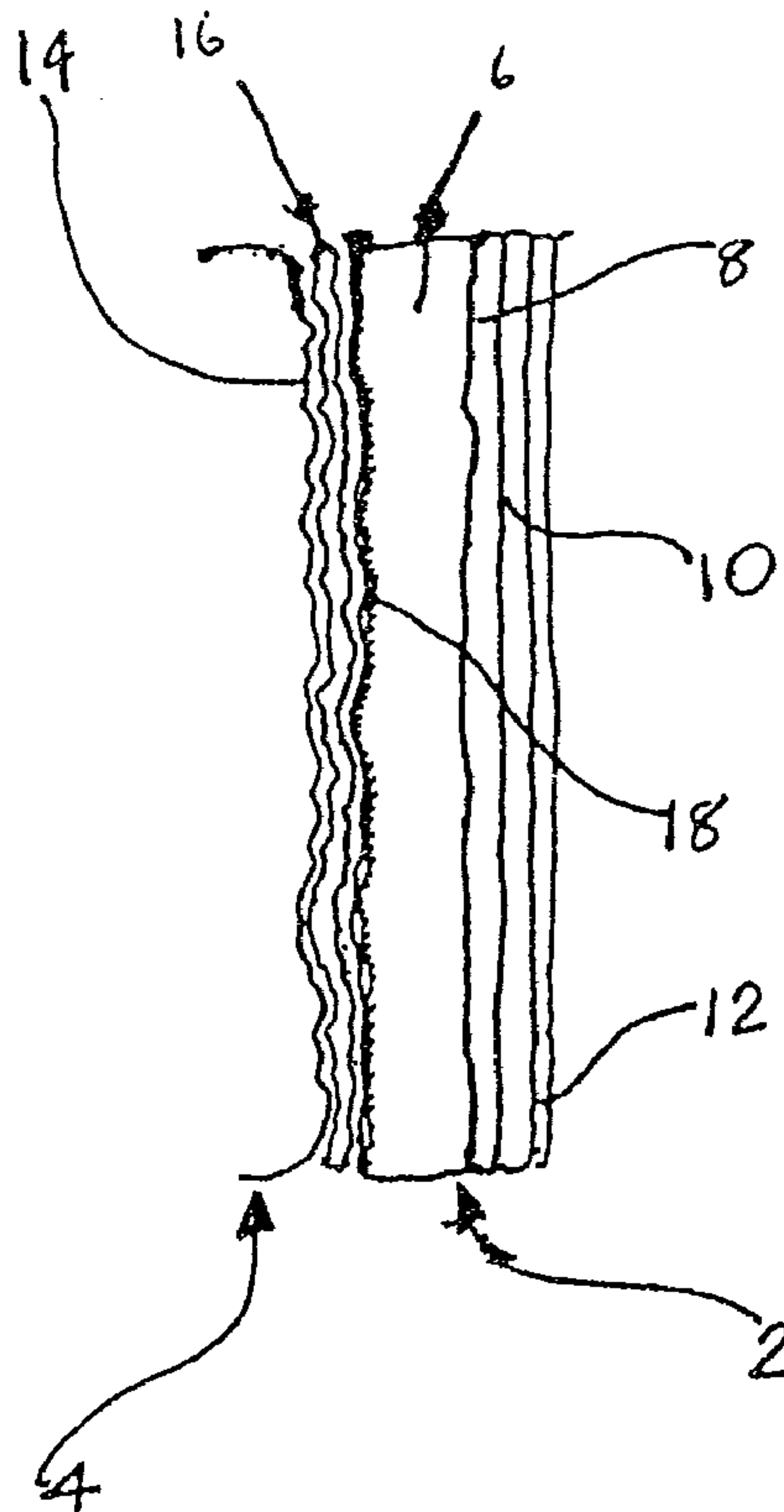
(73) Harrison, Paul, GB

(51) Int.Cl.⁵ A61C 5/00

(30) 1989/08/09 (89 18178) GB

(54) **RESTORATIONS DENTAIRES**

(54) **DENTAL RESTORATIONS**



(57) A method for the production of full or partial dental restorations including veneers, crowns, inlays, onlays, and bridge structures, and dental restorations produced by the method. The method utilises the technique of flame spraying to form a basal layer of a technical ceramic based material upon which porcelains are applied to produce a strong, aesthetically acceptable and custom made dental restoration. The technical ceramic based material may be Alumina, Zirconia, Titania, or combinations thereof, and the flame spraying may be a direct method or an indirect method. The technical ceramic based material may include small amounts of silicate based materials.

2022698

ABSTRACT OF THE DISCLOSURE

- 05 A method for the production of full or partial dental
restorations including veneers, crowns, inlays, onlays,
and bridge structures, and dental restorations produced
by the method. The method utilises the technique of flame
spraying to form a basal layer of a technical ceramic based
10 material upon which porcelains are applied to produce a
strong, aesthetically acceptable and custom made dental
restoration. The technical ceramic based material may be
Alumina, Zirconia, Titania, or combinations thereof, and the
flame spraying may be a direct method or an indirect method.
15 The technical ceramic based material may include small
amounts of silicate based materials.

Dental Restorations

05 This invention relates to the fabrication of full or partial dental restorations, including veneers, crowns, inlays, onlays, and bridge structures, hereinafter referred to as dental restorations.

10 The invention utilises the technique of flame spraying to produce a relatively dense basal layer of a technical ceramic based material which firstly acts as a permanent form upon which porcelain can be applied in order to yield ultimate aesthetics of the restoration, and which secondly serves
15 to strengthen the restoration and provide a means for bonding the restoration to a prepared tooth in which the contribution made by the mechanical bonding mechanism is enhanced.

20 The invention overcomes the problems of shrinkage and subsequent loss of fit traditionally associated with the application of technical based ceramic materials to produce custom made dental restorations.

25 Ceramic materials in the form of porcelains have been used and developed since the turn of the century. For example, in 1900 Ernsmere reported that Charles Land had developed a technique of fabricating jacket crowns on platinum foil matrices utilising porcelain as a restorative material, and although these original all-porcelain jacket crowns were
30 considered to be aesthetically acceptable, they were weak in tension and flexion and were thus prone to breakage during clinical service. In an effort to overcome this problem, much of the development of dental ceramics has addressed itself to the need to increase the strength of dental restorations in
35 order to provide adequate clinical performance.

Advances in dentine and enamel bonding resin technology have

led to the possibility of applying dental restorations of thinner section, thus increasing the need for greater inherent strength in restorations.

In order to enhance the strength of dental restorations, it has been common practice to employ the ceramo-metal technique. United States Patents Nos 3 052 982 and 3 052 983 to Weinstein et al disclose specific compositions and fabrication conditions of porcelains for bonding to metals, and the United States Patent No 3 819 366 to Katz and the United States Patent No 3 961 420 to Tuccillo both disclose details of ceramo-metal dental restorations incorporating gold palladium silver and improved white gold alloys respectively. The ceramo-metal technique has traditionally been employed for use with crown and bridge type restorations, and although such restorations display satisfactory strength properties they have the disadvantage that they cannot be considered to be conservative of tooth tissue; also, they require the use of opaque porcelain to mask out the underlying metal structure.

Japanese Patent No 81 014295B to Sumitomo discloses the plasma spraying technique for use in the manufacture of dental crowns, but it is noted that the disclosure in the Sumitomo patent involves the application of metallic, metallic-ceramic mixtures and technical based ceramic materials in the masking out of a metallic substructure prior to the application of dentine and enamel porcelains. The technique represents a substitution of these materials for the opaque porcelain layer. The present invention represents the use of the flame spraying technique to form a basal layer of a technical ceramic based material alone which ultimately exists as a structure in its own right and not as a coating on a metal substructure or substrate.

In 1968, United Kingdom Patent No I 105 III to McLean et al proposed that improvements in the strengths of porcelains

05 themselves could be afforded by the introduction of aluminous
porcelains. This represented the introduction of the technical
ceramic based material Alumina as a strengthening, particulate,
second phase into a porcelain matrix. Such strength improve-
ments however have not been sufficient to allow the manufacture
of dental restorations such as posterior crowns and bridges.
McLean et al subsequently disclosed, in United Kingdom Patent
10 No 1 483 362, a method for improving the strength of dental
crowns by the bonding of a platinum foil to the inner fitting
surface of the aluminous porcelain, but this method is not at
all suited to the fabrication of aesthetically acceptable thin
sections due to the necessity of masking out the metal.

15 More recently, United States Patents Nos 3 732 087, 4 189 325
and 4 515 634 to Grossman, Barret et al, and Wu respectively,
introduced systems utilising glass-ceramic, and United States
Patent No 4 265 669 to Starling et al introduced a system
20 utilising a non-shrink ceramic, but such systems have not been
widely accepted and commonly have had problems associated with
aesthetics, particularly where in-situ alterations have to be
conducted involving the removal of surface stain/glaze areas.

25 A fluormica based glass-ceramic material known as DICOR has
been used to form a basal layer in the manufacture of a
WILLI'S crown, but the strengths of such glass-ceramic mater-
ials are only equivalent to the aluminous porcelains above
referred to. Decreases in strength are also known to occur if
30 the surface layer of crystallisation is removed or damaged.
For these reasons, such materials are not thought to be suit-
able for use in the manufacture of acceptable thin sections.

35 Methods have been disclosed, for example in United States
Patent No 4 473 353 to Greggs and in United States Patent No
4 579 530 to McLaughlin, for the manufacture of a thin section
all-porcelain veneer type restoration to cover anterior teeth.

05 The patent to Greggs discloses the application of porcelain onto a platinum foil, and the patent to McLaughlin discloses the application of porcelain onto a suitable refractory investment model, and whilst such thin-section all-porcelain, veneer type restorations are finding increasing application, they do however suffer from breakage on placement due to relatively low strength.

10 The disclosure by Faunce in his United States Patent No 3 986 261 of the use of a pre-formed, fully polymerised, plastics material as a veneer facing with uniform colour throughout its sectional thickness has been improved somewhat
15 more recently. In this more recent disclosure, United States Patent No 4 433 959 to Faunce allows for the lamination of the veneer facing using other resins, glass, and ceramic or glass-ceramic resin composite materials, or combinations thereof, to afford aesthetics which more closely match normal
20 human tooth tissue. Further, the disclosure refers to the laminar structure having an outer layer which is dense and relatively hard in order to prevent the discolouration which is associated with relatively porous polymers, whilst the inner layer is less dense, porous or cellular in structure, in
25 order to promote efficient bonding to the labial surface of the tooth. This inner surface or layer in one form can be manufactured by the electrostatic spraying of microcrystalline particles which are subsequently sprayed with one or more layers of resin which flow around the particles to form a
30 smooth surface.

35 The present invention on the other hand provides a high temperature flame spraying technique which forms a relatively dense technical ceramic based layer which is rough on the microscale. This type of surface enhances the contribution made by a mechanical bonding mechanism, in bonding such a dental restoration incorporating such technology, to a prepared

tooth. The present invention is applicable to the fabrication of basal layers of technical ceramic based materials for all types of dental restorations and is not restricted to the labial face.

According to a first aspect of the present invention there is provided a method for use in the manufacture of a dental restoration including the step of forming a base layer of predetermined thickness of said restoration by flame spraying.

The flame spraying may be a direct flame spraying technique or an indirect flame spraying technique.

The flame spraying will preferably utilise a free flowing powder or liquid which incorporates a technical ceramic based material. Said technical ceramic based material will preferably be Alumina, Zirconia, or Titania, or combinations thereof.

The method will include the additional step of applying a plurality of layers of porcelain to the said base layer.

According to a second aspect of the present invention there is provided a dental restoration including a base layer of predetermined thickness formed by flame spraying.

The said base layer will preferably be composed of a technical ceramic based material.

The dental restoration will preferably include a plurality of layers of porcelain carried by said base layer.

In order that the invention may be more readily understood, an embodiment thereof will now be described, by way of example, reference being made to the accompanying drawing, the single figure of which is a cross-sectional elevation of a dental

restoration in accordance with the invention.

05 Referring to the drawing, there is shown a section of a dental restoration indicated generally by reference numeral 2, and positioned in relation to a natural tooth 4.

10 As will be seen, the dental restoration 2 comprises a base layer 6 of a technical ceramic based material such as, for example, Alumina, Zirconia, or Titania, or combinations thereof, and subsequent layers 8, 10, and 12 of dental porcelains which are applied to the base layer to enhance the aesthetics of the restoration.

15 The base layer 6 is formed by a flame spraying technique which includes plasma spraying and detonation gun methods of application, and the dental restoration 2 is applied to the natural tooth 4 through the intermediary of a layer 16 of a bonding agent. Prior to the application of the dental restoration to the natural tooth 4, treatment of the tooth surface 14 may be necessary - depending upon which bonding material is used - such treatment involving the use of the phosphoric acid etching technique.

25 The flame spray process used in the method of the invention utilises a free flowing powder or liquid which incorporates a technical ceramic based material such as Alumina, Zirconia, or Titania, or combinations thereof. The free flowing powder or liquid is introduced into the flame/plasma whereupon it is given kinetic energy and thermal energy and directed at the target, i.e. a tooth positive, which will have been formed by casting a refractory type material into an initial polymer impression which incorporates the tooth to be restored.

35 The rate of spraying is controlled by the design of the nozzle in the flame spray gun and the pressure of the fuel gas used.

2022698

05

Swift passes are made so as to deposit the technical ceramic based material onto the tooth positive target in a series of successive layers. This action serves to facilitate the fabrication of a relatively dense microstructure.

10

Small amounts of silicate based materials may be added to the pre-cursor feed materials to facilitate the production of a fully dense technical ceramic based material layer.

15

It should be noted that, dependent upon the type of technical ceramic based material used and the end result that is required, post-flame spray heat treatment of the base layer 6 may be necessary prior to the application of the layers of porcelain, not only to fully densify the base layer but also to homogenise alloying additions or phases present and to enhance the optical properties of the base layer 6.

20

Due to the nature of the microstructure produced following flame spraying, any small amount of remaining shrinkage of the layer is promoted throughout the depth of the layer, thus not affecting the fit of the final dental restoration.

25

Utilising the optimum conditions outlined, a base layer 6 approaching theoretical density can be produced. The finished thickness of the base layer 6 will be dependent upon which type of dental restoration is being manufactured and may vary from a single particulate layer in the order of 1 micro-metre to a substantial layer in the order of 3 millimetres.

30

35

The flame spray process used to produce the base layer 6 may be a 'direct' technique or it may be an 'indirect' technique. The 'direct' technique involves flame spraying directly onto a refractory tooth positive target. The 'indirect' technique involves burnishing a thin layer of platinum foil over the

2022698

05 refractory tooth positive and then flame spraying onto this
foil. The platinum foil serves to facilitate the removal of
the technical ceramic based material base layer 6 from the
refractory tooth positive, following the furnace heat treat-
ments involved with the application of the porcelain layers
8, 10, and 12. Use of the 'direct' technique necessitates
removal of the refractory material from the base layer 6
10 following the application of the porcelain layers.

Following the formation of the base layer 6 as above related,
conventional techniques are used for the application of the
layers 8, 10, and 12 of the dental porcelains.

15 The first layer 8 of porcelain must have a co-efficient of
thermal expansion which is matched to, or preferably lower
than, that of the technical ceramic based material base layer
6. A porcelain having this slightly lower co-efficient of
20 thermal expansion will be placed into slight compression upon
cooling, thus yielding a dental restoration with optimum
strength properties and aesthetics.

25 A dental restoration incorporating a base layer 6 produced in
accordance with the invention has excellent shape retention,
since the normally large shrinkages (15 to 20 vol %) experienced
on sintering a technical ceramic formed by casting
or die pressing techniques are greatly reduced or overcome.
The strength of the dental restoration/^{produced} in accordance with the
30 invention is greater than similar dental restorations which
are manufactured from porcelain based materials.

35 In addition, the surface area for the bonding of the dental
restoration to the natural tooth is increased due to the
mainly crystalline nature of the technical ceramic based
material. Pre-treatment of the surface 18 of the base layer 6
may be carried out with an agent designed to enhance bond

2022698

strength. Such treatment involves the application of a silane bond coating.

05

Finally, satisfactory aesthetics can be produced by a combination of materials and process variations which take account of hue, value, chroma, translucency, shape, outline form, contour, proportion and soft tissue harmony with the oral cavity.

10

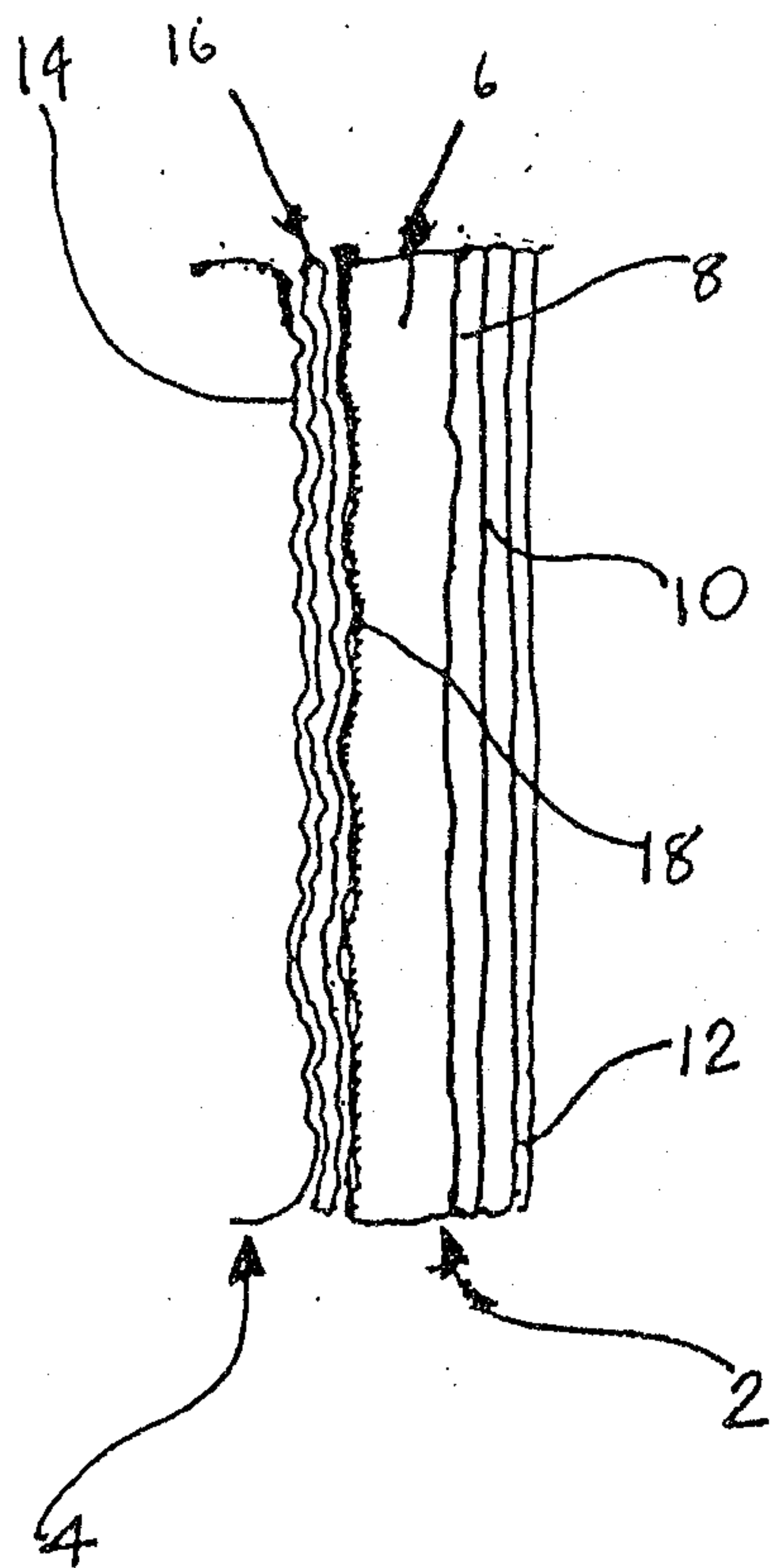
We Claim:

1. A method for use in the manufacture of a dental restoration including the step of forming, by flame spraying, a base layer of technical ceramic based material of a predetermined thickness of said restoration.
2. A method in accordance with claim 1, wherein the flame spraying is a direct technique.
3. A method in accordance with claim 1, wherein the flame spraying is an indirect technique.
4. A method in accordance with claim 1, wherein the flame spraying utilizes a free flowing material which incorporates said technical ceramic based material.
5. A method in accordance with claim 4, wherein the technical ceramic based material is selected from the group consisting of Alumina, Zirconia, Titania, and combinations thereof.
6. A method in accordance with claim 4, wherein the free flowing material includes small additions of silicate based materials.
7. A method in accordance with claim 1, including the additional step of applying to said base layer of technical ceramic based material a plurality of layers of porcelains.
8. A dental restoration including a base layer of technical ceramic based material of

predetermined thickness of said restoration, said base
layer of technical ceramic based material being formed
5 by flame spraying.

9. A dental restoration in accordance with
claim 8, wherein said technical ceramic based material
includes small additions of silicate based materials.

10. A dental restoration in accordance with
claim 8, wherein said restoration includes a plurality
of layers of porcelain carried by said base layer.



Pascal & Associates
Agent for Applicant