April 10, 1928. 1,665,357

A. GYSI

ARTIFICIAL MOLAR TOOTH AND METHOD OF MAKING SAME

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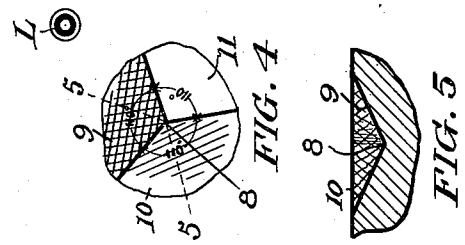


FIG. 4

FIG. 5

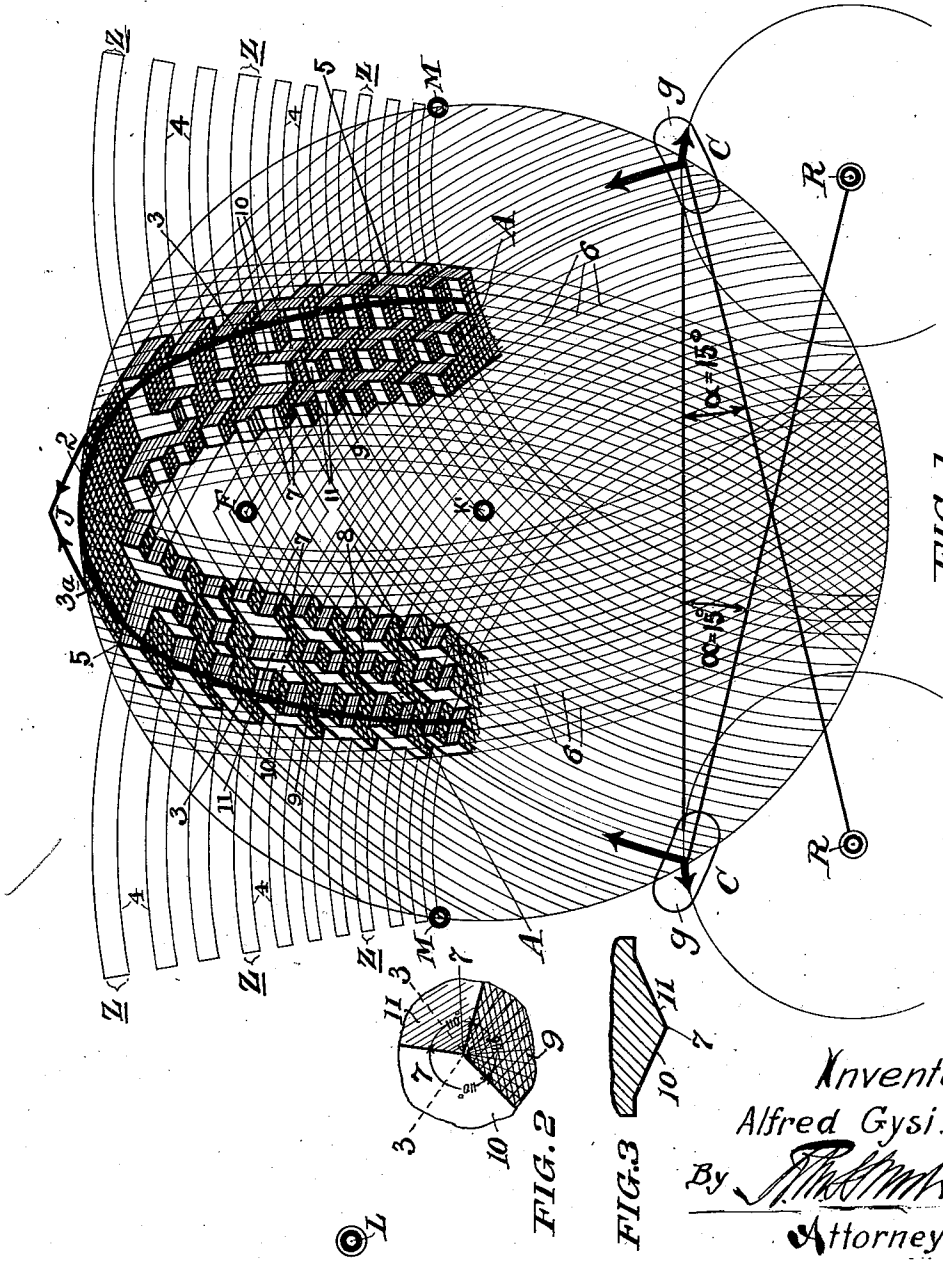


FIG. 1

FIG. 2

FIG. 3

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FIG. 6

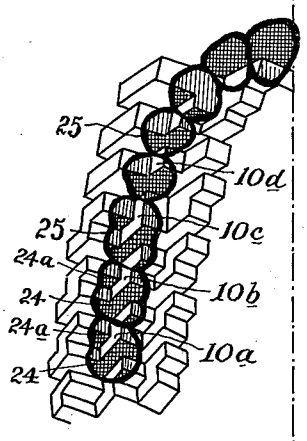


FIG. 10

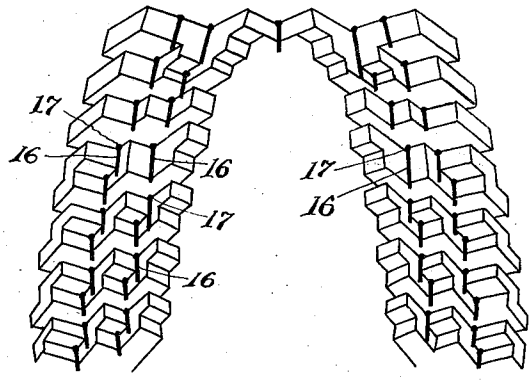


FIG. 12

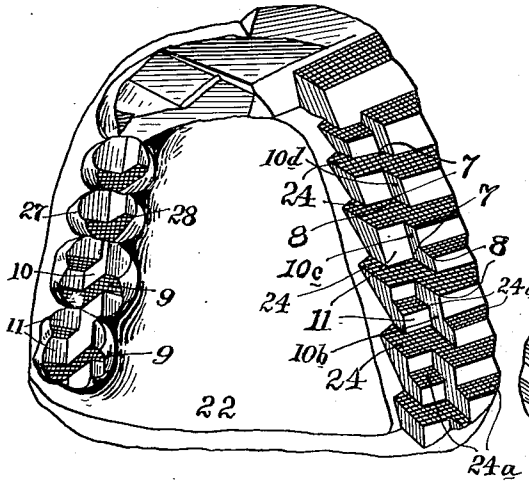
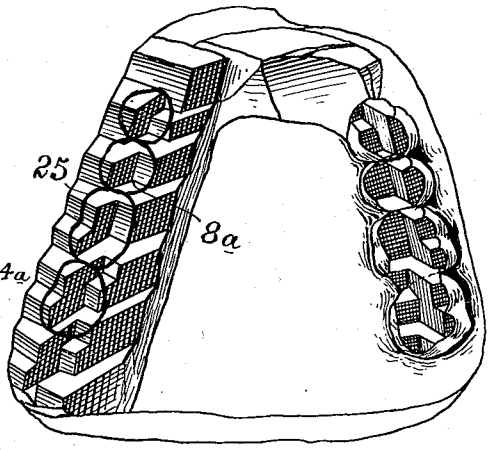


FIG. 13



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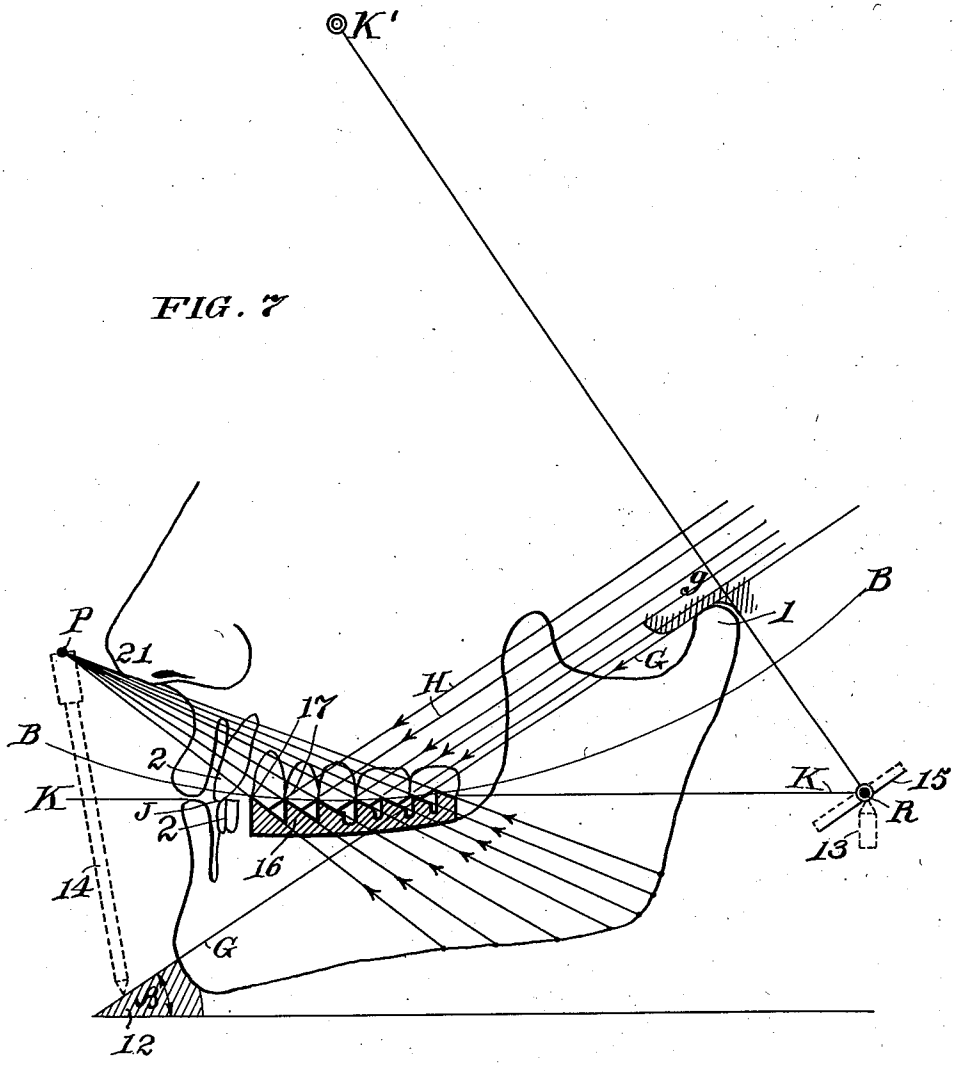
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FIG. 7



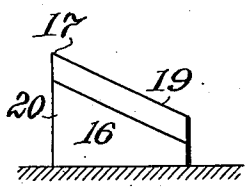


FIG. 8

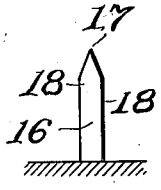


FIG. 9

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ARTIFICIAL MOLAR TOOTH AND METHOD OF MAKING SAME

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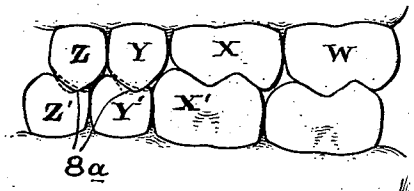


FIG. 15

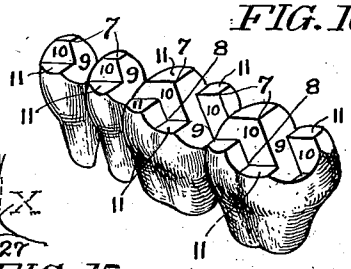


FIG. 16

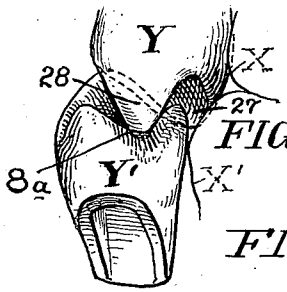


FIG. 15a

FIG. 17

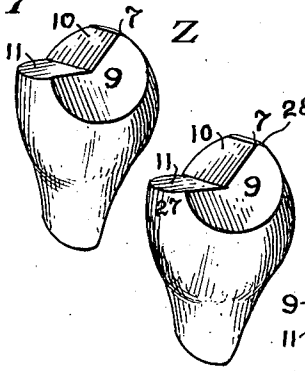
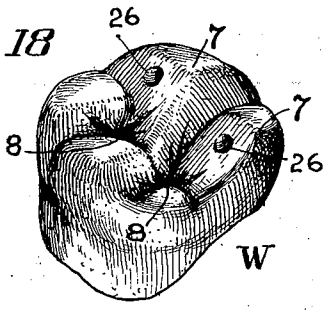


FIG. 18



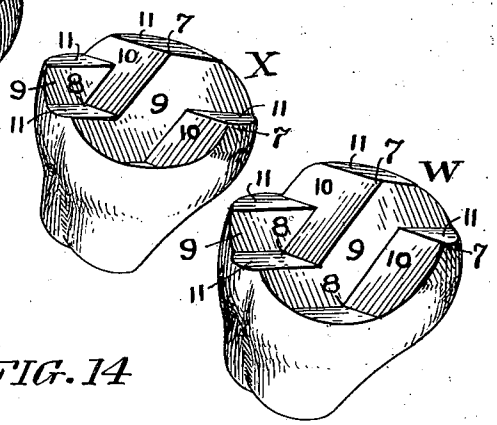
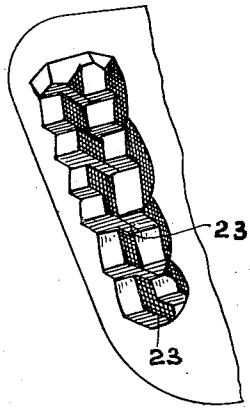


FIG. 11



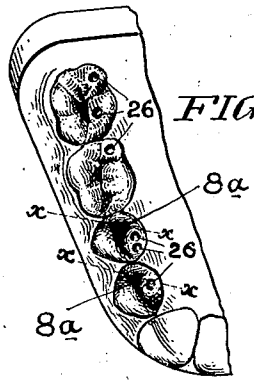


FIG. 14

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UNITED STATES PATENT OFFICE.

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ARTIFICIAL MOLAR TOOTH AND METHOD OF MAKING SAME.

Application filed February 26, 1926, Serial No. 90,726, and in Germany March 14, 1925.

The human mandible, in addition to up and down movements during mastication, makes the following grinding movements: (1) retrusive; (2) side bites from left to right and from right to left; and (3) incising or protrusive bite. Besides these three main movements, the mandible can also make all movements which are intermediary or between these main movements and are known as "intermediary" movements. As all the back teeth, namely the bicuspids and molars, are provided with cusps on their masticating surfaces, these cusps are positioned on the natural teeth in such a way that they do not hinder the above named masticating movements. These above named masticating movements do not take place in a horizontal plane, that is, not in a plane parallel to the occlusal plane K, K, (Fig. 7), but really take place in a plane G, G, which has an inclination to the occlusal plane K, K, of from 5° to 50° to the said occlusal plane. By reason of this, the cusps on all the back teeth have to be limited by facets or defined surfaces which have the inclination of the arrows H, H, in Fig. 7, and which are more or less parallel to the plane G, G, which has the same inclination as the so-called condyle path movement of the mandible.

In an ideal natural denture all of the teeth of the lower jaw should be in contact with the corresponding teeth of the upper jaw during the masticating movements. In civilized countries, however, where the people subsist mainly upon soft cooked foods, the above named ideal conditions can rarely be found because the teeth which are fixed by their roots in the mandible and in the maxilla can and do stand more or less deviation from the ideal condition without impairing the masticating function and without loosening the teeth.

When, however, artificial teeth on plates must take the place of the lost natural teeth, it is essential that these artificial teeth shall be so shaped and placed that substantially all of the teeth of the lower denture will contact with the corresponding teeth of the upper denture during the masticating movements. It might be assumed that the simplest way to make artificial posterior teeth (bicuspids and molars) would be to copy natural teeth as has been done for many years, and then to depend upon the up and down movement for mastication, but experience has shown that in this way only a very limited masticating power can be secured.

Investigations have demonstrated that while it is necessary to come as near as possible to the natural teeth forms of the posteriors in making artificial teeth, the latter should be made more mechanically perfect in operation than natural teeth, because of the great difference in the force or power that can be exerted by the natural teeth as compared with that available when employing artificial teeth. The natural teeth being firmly fixed in the bone, they are capable of exerting much greater force than an artifical denture which is much less firmly fixed in position. Artificial teeth being mounted on plates which rest on the mucous membrane, are capable of transmitting much less masticating force than the natural teeth, and hence should be so constructed that their cutting and grinding capacities are increased with less power than is available with natural teeth.

The object of the present invention is to provide forms of teeth with masticating surfaces that function like the parts of a cutting and grinding machine, in order to secure greater masticating efficiency than is possible with natural teeth and thereby make up for the loss of power due to the way the artificial teeth have to be fixed to and manipulated in the mouth.

A further object is to provide a construction which will cause the upper and lower sets of teeth to so cooperate that, when masticating, the contact of the upper teeth upon the occlusal surfaces of the teeth of the lower denture will cause it to be held at all times in position upon the arch ridge of the lower jaw.

The present invention relates to artificial posterior teeth which differ from natural teeth and are constructed in such a way that the above named three main masticatory movements are secured in a technically perfect manner; and, in addition, my artificial teeth contain improvements in operative structure over natural teeth and all artificial teeth which have heretofore been produced prior to my invention, whereby greater efficiency in the cutting and grinding or machine power of the teeth, considered as a chewing or masticating machine, is secured.

The form of each posterior tooth in a set

of natural teeth differs greatly from the forms of the adjacent teeth because each tooth depends for its masticatory efficiency upon its relation to the adjacent and opposing teeth. Therefore, in order to properly design posterior teeth, it would be improper to design each tooth independently, but, on the other hand, all the posterior teeth, namely, the eight uppers, consisting of two right and two left bicuspids, two right and two left molars, and the eight lowers, consisting also of two right and two left bicuspids, two right and two left molars, must be designed as if they were two contiguous units, the upper set of eight teeth constituting one of the operative units and the lower set of eight teeth constituting the other operative unit. These two units of eight teeth each must be designed to secure a harmonious relationship and to function together as a cutting and grinding machine. After these units are made they are each divided into two parts consisting of a left half and a right half, each half containing two bicuspids and two molars. Then these four half parts are each subdivided into four parts consisting of two separate bicuspids and two separate molars. In this way a set of sixteen single posterior teeth are secured and which may be properly incorporated into upper and lower dentures which will cooperate and function perfectly.

In the present invention, each posterior tooth is developed from a primordial form, the masticating surface of which has at least one obtuse corner which is formed by three planes or facet surfaces, one of which planes functions with the complementary planes of the opposing teeth of the opposite jaw during the retrusive movement of the lower jaw, another of which planes functions during the protrusive movement, and the third of which planes functions during the lateral movements of the jaw, thus controlling the movement of the mandible as a whole and securing a much truer mechanical movement thereof than is possible with natural teeth. The guiding planes or facet surfaces which control the lateral movements are not continuous from one tooth to another, but are interrupted by other planes and are not of the same shape upon all the teeth, the interruptions forming cutting edges and the differing shapes of the planes securing greater tool or machine-like efficiency in cutting and masticating food. The planes of each of the upper and lower molar teeth and of the lower biscupids form a positive obtuse corner and a negitive or depressed obtuse corner, the positive and negative corners in each tooth being out of alinement, but in which further, the positive corner of either an upper or lower tooth is in alinement with the negative corner on the respective lower or upper teeth which coact with or are complementary thereto in occlusal and masticating relation.

Broadly considered, my invention comprises the artificial posterior teeth embodying the features of improvement above referred to and the method of making same, all of which are more fully described hereinafter and defined in the claims.

Referring to the accompanying drawings: Fig. 1 is a geometrical diagram illustrating a construction made up of associated parts each having a masticating surface embodying the primordial form constituting an upper denture unit containing right and left bicuspids and molars designed to function with the lower jaw unit containing complementary right and left lower bicuspids and molars; Fig. 2 is a plan and Fig. 3 a section on line 3—3 of Fig. 2, showing a primordial obtuse positive corner of a form for use in my improved artificial teeth; Figs. 4 and 5 (section on line 5—5) are similar views in respect to the primordial obtuse negative corners employed in my improved artificial teeth; Fig. 6 shows a portion of Fig. 1 with the outline of the posterior teeth marked thereon; Fig. 7 is a diagram showing the manner of adapting an articulator to the shaping of the primordial tooth form masticating surfaces illustrated in Fig. 1; Fig. 8 shows a side view of one of the cutting knives employed in the articulator; Fig. 9 is a front view of the same; Fig. 10 is a general view showing the relative position of the cutting knives when looking upward upon them when positioned on the articulator; Fig. 11 is a primordial form of a lower tooth row unit; Fig. 12 is a perspective view of a primordial form unit of upper teeth; Fig. 13 is a similar view of a corresponding lower or complementary unit; Fig. 14 is a finished right hand view of a lower unit; Figs. 15 and 15ª are lingual elevations indicating the occlusal relation of the upper and lower posterior teeth at the right side of the mouth and embodying my improvements; Fig. 16 is a perspective view illustrating a row of the upper posteriors corresponding to the left side of the mouth embodying my improvements; Fig. 17 shows the four teeth illustrated in Fig. 16, somewhat separated; and Fig. 18 is a further general view of the second upper molar having thereon the additional grooves, fissures, beauty marks, etc., such as in the commerical teeth.

A primordial form of an obtuse positive corner is illustrated in Figs. 2 and 3 and is geometrically constructed with the three bite guiding planes or facet surfaces of an upper tooth and adapted to guide complementary planes of the denture for the lower jaw and thus insure the three principal masticating movements of the mandible. It is here pointed out that Fig. 2 represents a face view of the position of the three bite guiding planes or facet surfaces 9, 10 and 11, just

as they are shown in Fig. 1, the illustration in Fig. 2 showing one of the obtuse positive corners which appear in plurality in the illustration of the left side of the upper unit but corresponding to the right side of the denture when in the mouth. In the particular illustration of Figs. 1, 6 and 10, the cuttings provide for two bicuspids and three molars for each side of the jaw, whereas in artificial dentures it is customary to employ only two molars on each side, as shown in Figs. 7, 11, 12 and 13.

A primordial form of an obtuse negative or depressed corner geometrically constructed is shown in Figs. 4 and 5, the latter being a section of the former on line 5—5, and said negative corner consists of the three bite guiding planes or facet surfaces of a lower tooth and is complementary to what is shown in Fig. 2. These negative corners constitute the depressions in the occlusal surfaces of the teeth for cooperation with the cusps of the opposite or coacting teeth and consequently the teeth of the upper and lower sets may each have their occlusal surfaces provided with both positive and negative corners.

A primordial form of a lower tooth unit from which four posterior teeth may be shaped is shown in Fig. 11, and it is here pointed out that this lower unit is obtained by taking a plaster impression from the upper unit which was made by the action of the cutting knives arranged in the lower jaw of the articulator, as hereinafter more fully described. In fact, in this invention only the set of molars and bicuspids for one of the jaws are modeled by use of the cutting knives, as indicated in Fig. 7, and the primordial tooth form for the other jaw is made by molding or casting the same from the cut form so that the teeth of one jaw are complementary to the teeth of the other jaw, and this is true irrespective of whether the cut primordial form is made for the upper or for the lower set of teeth.

The right side of Fig. 12 shows the mechanical primordial construction following the essentials of the geometrical design of Fig. 1, whereas the left side of the figure shows a similar construction from which all of the superfluous material has been removed, leaving the bicuspid and molar teeth which contained the bite guiding planes or facet surfaces in their natural outline upon the occlusal surfaces.

Fig. 13 is a corresponding lower or complementary unit with the occlusal surfaces inversely formed to those shown in Fig. 12, just as would occur by casting or molding it from the structure of Fig. 12 as a pattern. On the right hand side, the material has been cut away to show clearly the shape of the two molars and two bicuspids, whereas on the left hand side of the primordial form, the general position and shapes of the two bicuspids and two molars are indicated by the boundary lines 25 and within which the biting planes are indicated.

Referring more specifically to Fig. 1, points C, C, correspond to the natural position of the temporo mandibular articulation (also seen in Fig. 7 at g, 1,), and the points R, R, correspond to the rotation centers which are in the articulator behind the condyles g, 1, and constitute the common geometrical center of the opposing angle and side bite angle of the teeth, by reason of which rotation centers, the axis for the normal side bite movement to the left and to the right, can be geometrically determined. The centers R bear such a relation to the position of the condyles g, 1, that the upper articulator frame is permitted to move in the directions according to the curved lines 4, 4, in Fig. 1. The connecting lines between the points C, R, in Fig. 1, form generally an angle "alpha" with the connecting line between the two condyles. This angle may vary between 5° and 30° and is shown as 15° in the instance described. In Fig. 7, the angle "beta" is shown as set at 33°, but where an adjustable articulator is employed, this angle may be varied, that is to say, it may be greater or smaller. These angles, "alpha" and "beta", are not varied for each individual case, but are predetermined, preferably as aforesaid as a basis for producing primordial form units to correspond to required teeth forms for general use to be produced having my improved masticating or occlusal surfaces suitable for proper action with maxilla and mandible of sizes and shapes and condyle and temporo mandibular articulations corresponding to a natural skull. The points C, C, J, in Fig. 1, are the three main points of the equilateral triangle of the mandible, J being the point where the two (upper and lower) central incisors meet, otherwise indicated at 2 in Fig. 7. The points M, M, F, are the centers by which the natural arc 3, 3^a and 3, of the tooth rows can be constructed and by using the two points L, L, successively as centers for the compass, the equally spaced arcs 6, 6, corresponding to the grooves of the upper bicuspids and molar teeth may be drawn, and by next placing the compass at the point F, the arc 3^a of the curve of the anterior teeth may be drawn. Also, by placing the compass successively at the center points R, R, concentric arcs 4 are drawn from each of said centers, starting approximately from the centers M, M, and twenty of these arcs are respectively grouped into ten arc sections Z of increasing widths and spaces, determined in the manner hereinafter described. The radial distances Z of the arcs 4 are determined as follows: Referring to Fig. 7, and keeping in mind the radial lines with the arrow marks leading to the point P at the front of the

movable frame of the articulator which gives the vertical angles of the cutting edges of the knives 16 and also keeping in mind the lines H parallel to the condyle socket line G also formed by the part *g* on the upper or movable frame of the articulator and the guide portion 12 at the front of the base or stationary part of the articulator over which the pin 14 travels, we will find that the said parallel lines H intersect the radial lines leading from the point P at what would be the apex of one of the positive corners of cusps of the upper teeth, as very clearly shown in Fig. 7. If now we draw radial lines from the point K′ to these intersecting points of the parallel and radial lines above mentioned, we will obtain distances between these radial lines from the point K′ measured along an arc B, B, also struck from the center K′ and passing through the highest points 17 of the cutting knives 16, which distances will represent the radial distances Z in the diagram Fig. 1. As stated, the point K′ corresponds to the average arc of a natural row of teeth with a radius of about 15 to 20 centimeters, (page 12, line 20). It is to be understood that the distances and angles between the operative parts of the articulator are already determined in the commercial articulators by giving to them average distances and angles based upon investigation of natural skulls. After drawing the tooth arc or arch 3 from right center M and the arcs 4 from the left center R, the equi-spaced arcs 6 from the right center L may be drawn between the left hand arcs 4 in pairs (Z) and close to the tooth arc 3, giving intersecting points 5. These arc portions 6 give the position of the knives 16 in Fig. 7. Then the arcs 4 from the right center R are drawn through the intersecting points 5. In practice, when the knives 16 have been positioned in the articulator and the articulator's parts given the relative movements, such as occur in mastication, the points 17 thereof cut or scrape the grooves in the plaster corresponding to the negative corners 8 lying in arcs 6 and indirectly form the positive corner 7 by the cooperation of the two adjacent knives. While the short arc portions 6 between the arcs 4 in pairs may be individually considered as straight lines, they would be tangential to the arcs 6. The center L for these arcs 6 may be positioned as follows: This center L will lie in a horizontal line (from L to L) across the rear ends of the second or posterior molars (whereat the cutting knives 16 on the right and left sides of the denture are parallel) and where a tangent from the uppermost arc 4 crosses it, the tangent beginning adjacent to the tooth row arc 3; and the arcs 6 described about said center L are substantially concentric arcs equally spaced apart, said spacing predetermined for the width to be provided for in the tooth buccal-lingually considered. Having once positioned the knives, they, by reason of the possible movements insured by the articulator, cause the proper cutting or carving of the plaster to the design depicted in Fig. 1 of the drawings. In this way, we get an exact geometrical design of a "relief" A for each right and left tooth row which can be used as the primordial form of a left and right upper denture or set of teeth which has positive corners (cusps) 7 and negative or depressed corners 8 of the same formation limited by three planes or facet surfaces 9, 10, and 11, as graphically illustrated in Figs. 2 to 5. The "design of the relief" is produced automatically in the plaster when the knives 16 are set as described hereinafter in connection with Figs. 1, 7, 8, 9, and 10, and the upper movable frame of the articulator carrying the plaster is moved over the knives in the various directions permitted by the articulator; and in Fig. 1, this "relief" is indicated by the shading whereby the positive corners 7 (cusps) (Figs. 2 and 3) are formed as well as the negative or depressed corners 8 corresponding to the depressions in the teeth. The various arcs 4, 4, and 6, 6, are definitely positioned on the diagram as explained, and as these are all definitely determined by the movable points of the articulator and the angle, shape and positions of the cutters 16, the final design in the relief produced by the cutters is caused to have a form in which the various facets 9, 10 and 11 lie in planes at 110° apart (Figs. 2 and 4), whether they form positive corners or negative corners. The shading on Fig. 1 and on others of the figures is merely to indicate the different portions in the actual relief in plaster and whose defining lines are formed by the corresponding arcs 4 and 6, as explained.

The general sizes of the teeth to be formed are predetermined by the dentist and when roughly laid out, as in Fig. 7, the cutting points 17 of the knives are definitely positioned in the arc B, B, which is also a predetermined arc for the occlusal surface. These cutting points where they lie in the arc B, B, are then connected by the oblique radial lines with arrow heads from the common center P, this will give the radial angles which definitely give the angle of the anterior facets 11 of the teeth and thereafter lines H parallel to the line G, G, (through the condyle) and extending through the points 17 of the teeth gives the obliquity of these parallel lines and form the angle of the posterior facets 9 of the teeth.

It is to be understood that the arcs 4 from the right hand center R are not continued from the right hand side across the center of the diagram into the left hand side, but that

these arcs from the right hand center R are struck from the crossing points 5 of the left hand arcs 4 and 6 and, therefore, these left hand arcs crossing the points 5 described from the right hand center R will be formed from all the crossing points 5 without regard to the position of the arcs 4 at the right hand side. In regard to the choosing of the points 5 as to which shall form parts of the positive or negative corners, it will be noted that in Fig. 7, the tooth facets have high and low points alternately and, therefore, the points 17 would represent the points 5 on the upper arcs 4 of each pair while the intermediate depressed points would correspond to the points 5 which would be formed by the crossing of the arc 6 with the lower arcs 4 of each of the pairs. The direction of the arcs 6 indicates the positioning of the knives 16 as shown in Fig. 10 and the points 17 of these knives would be located at one of the intersecting points 5 and which would, in its operation upon the plaster, cut one of the depressed corners. The distance apart of the arcs 6 is uniform, and this distance is selected in respect to the width of the teeth in a lingual-buccal direction and to provide the necessary number of facets to form a tooth structure of normal width. It will be understood that for a small jaw the widths will be less than for a large jaw. The distance apart of the concentric arcs 6 is predetermined to suit the widths of the tooth structures to be made.

The oblique arcs from the right hand center R do not bear any relation to the right hand arcs 4, except that they are made from the same center. They are positioned to pass through the points 5 at the left hand side without any regard to the arcs 4 at the right hand side of Fig. 1, and consequently they are not arranged with that uniformity which is peculiar to the paired arcs 4 at each side of the diagram Fig. 1 in connection with the letters Z.

The three planes or facet surfaces of each corner 7 and 8 are the guiding surfaces of the teeth during the masticating movement. In the preferred form of obtuse corners adapted to my invention of artificial teeth, the corners are best made in a manner similar to one of the corners of a rhombic-dodecahedron or a pentagon-dodecahedron, in which the angles between the ridges or junctions of the planes or facet surfaces 9, 10 and 11, are 110°. taken in the plane of said surfaces, as indicated in Fig. 2, such corners, constituting essentials to the masticating surfaces of the teeth, are best suited for the natural movements of the jaw in biting and masticating. The facet surfaces 9 (Figs. 1 and 12, for example) are the guiding surfaces of the teeth during the protrusive or incising bite. The facet surfaces 10 are the guiding surfaces during the side bite movement and the facet surfaces 11 are the guiding surfaces during the retrusive movement. For the lower teeth, a mirror picture or inverse view of the upper "relief" A is taken by a cast therefrom.

A "relief" A taken as a primordial form with its positive and negative obtuse corners and their three guiding planes or facet surfaces 9, 10 and 11, may be made according to the geometrical construction shown in Fig. 1, in any plastic material such as wax, plaster, etc., by a sculptoring process to serve as the model for an upper set of teeth as indicated in Fig. 6, and outlined at 25, the unit teeth in this figure having the primordial masticating surfaces which are preserved intact, although by hand carving the corners can be slightly rounded, additional curves, fissures, beauty marks, etc., added, to constitute a tooth model (Fig. 14), following which, in shape and design, the corresponding porcelain teeth may be made. The unit containing an upper set of teeth as shown in Fig. 6 can be divided into individual parts each separate part bounded by outline 25 being the model for a single tooth. In Fig. 1, the primordial form is shown for an upper set of posterior teeth, but in Fig. 6 one-half or one unit is shown by way of illustration when outlining the teeth at 25. Fig. 6 illustrates how the upper right posterior teeth can be isolated in their natural outline from the geometrically constructed unit shown in Fig. 1, by a process of cutting away of the surplus material (not shaded). In Fig. 6 the tooth outlines denoted by 10^b, 10^c and 10^d and the next upper outline thereto denoted by 25, represent the four posterior teeth, as shown by themselves in Figs. 16 and 17. The principle involved in this invention will apply in producing the required angles and facet shapes for the whole possible sixteen teeth of the upper jaw, but as a commercial proposition, it is customary to make four posterior teeth, namely, two bicuspids and two molars for each side of the denture by this method and form the other six frontal teeth more for artistic appearance since they have no depressions associated with cusps. There is an entire omission of the back molars or wisdom teeth. Only four posterior teeth on a side are actually shown in Figs. 13 to 17, although the process would indicate the required shapes for the whole sixteen teeth in the upper jaw, and Fig. 7 shows the making of five teeth on each side.

The making of a "relief" according to the design of Fig. 1 can be easily done by a simple mechanical procedure with the aid of an articulator. For this purpose, I use any good articulator, such as the articulator described in my German Patent No. 293,074,

or in my United States application filed April 29, 1925, Serial No. 26,718, of which articulator Fig. 7 shows only the parts 12, 13, 14 and 15, wherein parts 12 and 13 belong to the lower portion of the articulator and parts 14 and 15 belong to the upper portion thereof. I secure upon the lower frame of the articulator a double row of cutting knives in the shape of sharks' teeth 16, Fig. 7 and Fig. 10, which knives correspond to the negative corners 8 (Fig. 1) in such a way that the points 17 of the knives 16 shown in Fig. 10 coincide with the recesses or negative corners 8. In Fig. 10 is shown a general view of the relative positions of these cutting knives when looking upward upon them, and the points at the end of the heavy black marks 17 represent the points of the cutting knives which are arranged in a schematic reproduction of Fig. 1. In shape the knives (Fig. 8 and Fig. 9) have parallel sides 18 and the cutting edges thereof are oppositely beveled and the front end is perpendicular. The cutting edges 19, in plan, are arranged in the directions of the arcs 6 described from the centers L, L, Fig. 1. The points 17 of the knives are also preferably arranged in a concave arc B, described from center K' (Fig. 7), which corresponds to the average arc of a natural row of teeth with a radius of about 15 or 20 centimeters. The cutting edges 19 are directed towards the common center P which is about one centimeter in front of the point of the nose 21, said center being also determined on the articulator (Fig. 7) by the point P. This new form of cutting knife makes it possible to mechanically produce a model of the upper tooth row. If in the upper part of the articulator a block of plaster 22, Fig. 12, is fixed, and if it is moved upon the cutting knives by making side bite movements to the right side and to the left side, protrusive movements forward and backward and all intermediary movements (in an anatomically correct articulator), the plaster block will become cut into the form of "relief" shown by Fg. 1 with its positive and negative corners A, and as can be seen on the right side of Fig. 12 and as also shown in Fig. 12 at the left hand side where the unnecessary portions of the plaster on both sides of the row of teeth have been cut away, whereby instead of three series of corners (7 and 8), as shown in Fig. 1, only two series of corners remain in Fig. 12. But, in Fig. 12 can still be seen the positive corners 7 and the negative corners 8, each of which is formed by the three planes 9, 10 and 11. If we draw on the "relief" of the lower tooth row Fig. 13, the prolongations of the ridges as at 23 in Fig. 11 of the corresponding planes, then this "relief" can be compared with a double row of rods or piles of rectangular cross section projecting varying distances from the base, all of the rods corresponding to one side of the block having the appearance of being inclined downward and inward in the same general direction. In Fig. 1, the corresponding double row of rectangular planes or facets 11 of opposite tooth rows are inclined toward a common median line above the figure. These rectangular planes or facets are formed at different levels, and by this arrangement in Fig. 12 (having two molars and two bicuspids in the row), two sets of longitudinal series of steps are formed in the direction of the row of teeth, and four sets of transversal steps.

In Fig. 12 at the right side of the figure in the bicuspid region are shown a series of uninterrupted transverse planes 24 extending across the tooth rows. In the molar region these planes 24 are interrupted alternately, one plane extending across the tooth and the next plane being interrupted as at 24^a. It is also important that the planes 10 on the right side of Fig. 12 and which guide the side bite movement are differently shaped and not continuous with each other. This non-continuity is shown in Fig. 6 at 10^a, 10^b, 10^c and 10^d, and in Fig. 12 at 10^b and 10^c. By this non-continuity, ridges are formed that act as cutting edges and which increase the tool or machine-like action of the masticating surfaces so that the effective masticating power may approximate the masticating power of natural teeth that are rigid in the bone.

In Fig. 12, the "relief" illustrated on the right side of the figure representing the upper tooth row (inverted) and in Fig. 13 at the left side is shown the "relief" of the corresponding lower tooth row, the same being a cast counter or impression taken therefrom. The portion of the plaster material not required for the formation of the teeth, that is, the material outside of the circumference line 25, has to be removed so that there will then remain the teeth forms as illustrated in the left side of Fig. 12 and in the right side of Fig. 13. These constitute the primordial forms of the teeth. It is now necessary to carve the outlines, deepen the grooves and round off the corners so that the teeth will present a more natural appearance, with the result shown in Fig. 14, in which is shown a series of depressions 26 made in the masticating surfaces for the purpose of facilitating the crushing of food and which may also be used for identifying the respective teeth. In the first bicuspid one depression only appears. In the second bicuspid two depressions may appear. In the first molar one depression only appears, while in the second molar two depressions appear. These depressions do not destroy the planes or facet surfaces, but they reduce the area of the planes or facet surfaces and

increase the cutting power of the teeth. For the purpose of securing greater masticating efficiency, the lingual cusp 28 of the second upper bicuspid tooth is formed so that when it is articulated with the corresponding lower bicuspid and first molar tooth it also engages the masticating surface at 8^a of the second lower bicuspid instead of only projecting between the second lower bicuspid and the first molar, as occurs on the buccal side wherein the buccal cusp 27 of the upper second bicuspid tooth does project into the inter-dental space between the second lower bicuspid and the first lower molar (Fig. 15^a). In my improved teeth, the lingual cusp of the first upper bicuspid is also formed so that it similarly engages the masticatory surfaces of the first lower bicuspid instead of projecting into the inter-dental space between the first and second lower bicuspids, whereas the buccal cusp of the upper first bicuspid does project into the inter-dental space between the first and second lower bicuspids, as heretofore. This construction of the bicuspids providing increased masticating capacity is shown in Figs. 15 and 15^a, in which it will be observed that the lingual cusps of the upper bicuspids Y and Z are respectively received in depressed corners 8^a in the upper surfaces of the lower bicuspids Y′ and Z′, and it will further be noted that the oblique planes or facets of the upper bicuspid Y cooperates with the complementary planes on the lower bicuspid Y′ and first lower molar X′, whereas the upper first bicuspid Z has its planes or facets complementary to and cooperating only with planes or facets on both the lower bicuspids Y′ and Z′. To insure this coaction at 8^a between the occlusal surfaces of the upper and lower bicuspids, it is necessary that the lingual sides of the lower bicuspids are provided with the corners or depressions 8^a to the rear of these lingual cusps and for the upper bicuspids Y and Z to be given, as it were, a horizontal twist so that the lingual cusps are advanced relatively to the buccal cusps whereby the former engage the masticating surfaces of the depressions in the lower bicuspids. In this manner, the bicuspids coact to insure improved masticatory action.

In respect to the lower bicuspid teeth X′ and Y′ having three cusps as indicated at 8^c in Figs. 13 and 15^a, it is pointed out that as above explained these bicuspids have the depressed corners 8^a and from the explanations as to the same being formed by the three planes 9, 10 and 11 at an angle to each other and the further fact that the general occlusal surface is more or less circular, it will necessarily result that the said planes project to form three cusps about the depressed corner 8^a, and the shapes and extent of the cusps varying in shape according to the outside configuration of the final tooth form and the position of the depressed corner away from the center of the occlusal surface. In the present case, these depressions are considerably away from the center and hence they differ in size.

After the tooth models have been prepared in the manner hereinbefore described, the porcelain teeth are manufactured in quantity by the usual processes comprising the making of molds shaped to produce biscuited duplicates of the models in porcelain material and which are subsequently vitrified. These artificial teeth may be produced as an integral structure comprising a unit of four teeth or separate units for the two molars and for the two bicuspids, or, on the other hand, each tooth may be molded separately as indicated in Fig. 17, in which the two molars W and X and two bicuspids Y and Z of the upper set are indicated in their relative positions but separated interdentally to illustrate their independence. Furthermore, the illustration of the individual teeth in Fig. 17 and the correlation of these teeth when properly positioned, as indicated in Figs. 15 and 16, will make the fundamental features embodying the corners and planes of the upper set more clearly understood; and reference to Fig. 18, which shows the finished porcelain tooth corresponding to the rear molar X, will give a better understanding of the commercial tooth when the curves, fissures, beauty marks, etc., have been applied to it, without destroying the cooperating planes or facets, and compares with the rear lower molar of Fig. 14 which would cooperate with it when in occlusal relation, as indicated in Fig. 15. As the lower posterior teeth have their occlusal surfaces formed complementary to the occlusal surfaces of the upper teeth, it will not be necessary to illustrate them more in detail than is found in Figs. 11, 13, 14 and 15, but they, as in the case of the upper teeth, may be formed in blocks of two or four or as individual teeth, as desired.

I have described my improved method and the article of manufacture produced thereby in connection with apparatus which I deem to be best suited to the requirements of the invention and on account of economy is preferred in commercial practice, but I do not restrict or confine myself to the minor or secondary details either as to the method of procedure or the means employed in putting it into effect, as variations therein may be resorted to as matters for the skilled artisan and without a departure from the spirit of the invention.

Having now described my invention, what I claim and desire to secure by Letters Patent is:

1. The method for the mechanical pro-

duction of primordial forms of the back teeth to constitute a portion of an artificial denture, which consists in securing to one member of an articulator two rows of cutting knives arranged in a curve corresponding to a natural back tooth row at one side of the jaw and in more or less parallel relation and having cutting edges which slope backward and downward with a gradual lessening obliquity from front to rear, applying plaster to the other member of the articulator, and thereafter causing a relative movement between the knives and the plaster corresponding to the left and to the right side bite movements and to the forward or protrusive movement and backward or retrusive movement and to all possible movements of the articulator corresponding to intermediary masticatory directions so that angular depression and elevations each formed of three planes inclined to each other are cut in and upon the plaster block and which then serve as the primordial form of the maticatory surfaces of the back tooth row.

2. The method according to claim 1, wherein further, from the plaster block having the primordial form of the tooth row masticatory surface cut therein, a second block of plaster or its equivalent is produced by casting or molding it from the primordial form and having inverse elevations and depressions, one of said plaster blocks shaped to represent the masticatory surfaces of the back teeth corresponding to the tooth row of one of the jaws and the other of said plaster blocks shaped to represent the masticatory surfaces of the back teeth corresponding to those of the other jaw.

3. The method according to claim 1, wherein further, from the plaster block having the primordial form of the tooth row cut therein, a second block of plaster or its equivalent is cast or molded therefrom and having inverse elevations and depressions, one of said plaster blocks shaped to represent the masticatory surfaces of the back teeth corresponding to those of one of the jaws, and the other of said plaster blocks shaped to represent the masticatory surfaces of the back teeth corresponding to those of the other jaw, and further characterized, by finally cutting away the surplus plaster material and dividing the tooth row block transversely into sections corresponding to the several back teeth each according to its required occlusal or masticatory surface structure.

4. Back teeth for part of an artifical denture, wherein each tooth is provided with at least one obtuse corner on its masticating surface shaped according to a primordial form which is characterized so that each of these corners is formed by three inclined planes 9, 10 and 11, respectively arranged at angles to each other, one of which planes 9 is inclined in a forward and backward direction and extends in width buccal-lingually and serves as a sliding and guiding surface for the teeth in the opposite jaw during the protrusive or incising bite movement, another of which planes 10 is inclined in a buccal-lingual direction so as to serve as a guiding surface during the side bite movement of the jaw, and the third of which planes 11 is inclined in a forward and backward direction so as to serve as a guiding surface during the retrusive movement.

5. A row of upper back teeth as part of an artifical denture having their mastication surface provided with facets lying in a plurality of planes having different inclinations and three of which planes of different inclinations form obtuse corners of cusps and likewise three of the planes of different inclination form depressions of the same general shape, each of the teeth having one of their facets arranged in a plane corresponding to one of the inclinations and extending in width transversely across the teeth in a buccal-lingual direction, and further, said teeth each having two other facets separated by the transverse facet and lying in the oblique planes corresponding to one of the other inclinations and obliquely presented to the buccal side of the teeth, and in which also, the molar teeth are each provided with an upward corner or cusp at the junction of their anterior and buccal corners and formed by a short transverse facet of substantially the same inclination as the transverse plane first mentioned and a facet lying in a plane corresponding to the third and remaining plane inclination.

6. The invention according to claim 5, wherein further, a corresponding set of lower back teeth constituting a cooperating part of a lower artifical denture is provided having facets and deperssions complementary to the depressions and facets of the upper set of back teeth, and in which further, the lower bicuspids are provided with depressions on the lingual side in addition to the main buccal and lingual cusps, and the upper bicuspids are each provided with two main cusps in which the lingual cusps are advanced whereby they engage the depressions in the corresponding lower bicuspids while the buccal cusps of said upper bicuspids occupy the interdental space between the lower teeth with which they engage.

7. The invention according to claim 5, wherein the upper bicuspids are so positioned relatively to the molars that the lingual cusps are advanced relatively to the buccal cusps, and lower bicuspids are provided for a lower denture having on their

lingual sides two cusps and a depression between them, and whereby said lingual cusps of the upper bicuspids occupy a position to be received in depressions in the adjacent lower bicuspids instead of wholly occupying the interdental space between the corresponding lower teeth.

8. An artificial molar tooth having facets on its masticating area formed of a plurality of surfaces arranged in inclined planes abutting in sets of three planes when arranged at an angle to each other, two of which facets extend in a buccal-lingual direction of the tooth, one entirely across the tooth and the other partway only, and the surfaces of the other facets forming parts of inclined planes arranged in a direction from the posterior to the anterior parts of the tooth, said planes forming at least six facets arranged in pairs at an angle to each other and said latter planes interrupted in a posterior-anterior direction by the buccal-lingual planes.

9. An artificial molar tooth having facets on its masticating surface formed of a plurality of smaller surfaces arranged in planes at an angle to each other, two of which facets extend in a buccal-lingual direction, one entirely across the tooth and the other partway only of the tooth, and the remaining facets extending in a direction from the posterior to the anterior parts of the tooth and arranged in pairs at an angle to each other and in planes which are interrupted by the buccal-lingual plane of the first mentioned facets.

10. An upper bicuspid for an artificial denture, in which there is a longitudinal main groove and a buccal cusp and a lingual cusp on opposite sides of the main groove, and wherein further, the lingual cusp is advanced beyond the position of the buccal cusp whereby the alinement between the two cusps is greatly oblique to the alinement of the main longitudinal groove and as though the lingual cusp of the tooth was given a horizontal twist.

11. A lower bicuspid for an artificial denture, in which the buccal side is provided with a single cusp and the lingual side is provided with an anterior large cusp and a posterior small cusp with a depression between them and the buccal cusp for receiving the lingual cusp of an upper bicuspid.

12. The invention according to claim 11, wherein further, the depression is formed by three oblique facets lying in corresponding oblique planes making equal angles with each other and located near the posterior side of the occlusal surface of the tooth.

13. A row of upper back teeth, including molars and bicuspids as part of an artificial denture, having their mastication surface provided with facets lying in a plurality of planes having inclinations in or parallel to three main planes and in which three of said facets of different inclinations when associated together in one relation form positive corners or cusps and likewise in association in another relation form negative corners or depressions of the same general shape, each of the teeth having one of its facets arranged in a plane corresponding to one of the main plane inclinations and extending in width transversely across the tooth in a lingual-buccal direction, and further, said teeth also having facets obliquely presented to the buccal side of the tooth and having an inclination corresponding to another of the main plane inclinations, and in which also the molar teeth have their facets respectively separated into parts in a mesio-distal direction by the transverse facet portions and facets and respectively lying in oblique planes which are each coincident with one of the two other main plane inclinations and also each molar provided with a corner or cusp at the junction of their anterior and buccal walls formed by short transverse facets and the former having substantially the same inclination as the transverse plane and facet first mentioned.

14. An artificial molar tooth having facets on its mastication area, said facets constituting a plurality of inclined surfaces respectively arranged in abutting relation in sets of three planes, said planes arranged at an angle to each other to form positive corners or cusps and negative depressed corners two of which facets of one inclination extending in a buccal-lingual direction of the tooth, one entirely across the tooth and the other part way only, and the surfaces of the other facets forming parts of the inclined planes arranged disconnectedly in a direction from the posterior to the anterior portions of the tooth by the buccal-lingual facets and forming at least six facets arranged in pairs at an angle to each other.

In testimony of which invention, I hereunto set my hand.

ALFRED GYSI.