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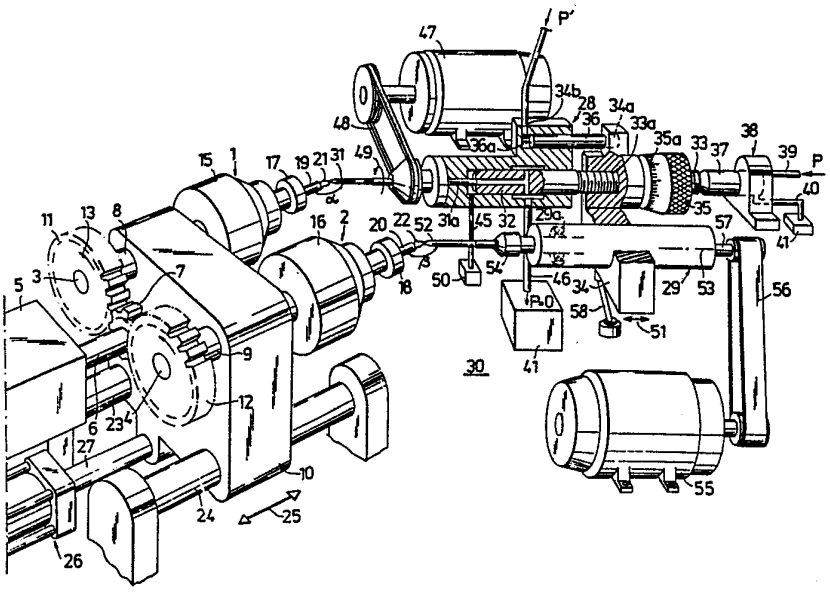

(57) Abstract

An arrangement is used for the efficient mass production of individual bodies for the artificial rebuilding of teeth, for example. The arrangement comprises a first pair of co-rotating elements, of which the first element (1) is so arranged as to support a replica (21) of a body which is to be produced, and the second element (2) is so arranged as to support a blank from which the body is to be produced. The replica and the blank are caused to rotate synchronously about the axis of rotation (3, 4) of the respective element. In a second pair of elements a third element supports a sensing device (31) which is capable of interacting with the external contour of the replica, and a fourth element supports a tool (52) by means of which the blank is capable of being machined. The first and second pairs of elements are capable of being displaced relative to one another. The fourth element is adjustably connected to the third element (29) in such a way that the tool executes movements which correspond to the shape of the external contour of the replica sensed by the sensing device (31).

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TITLE

A method and an arrangement for the production of insert bodies for the artificial rebuilding of teeth and human limbs, etc.

TECHNICAL FIELD

The present invention relates to a method and an arrangement for the production of insert bodies for the artificial rebuilding of teeth and human limbs, etc., or equivalent three-dimensional bodies having external contours with individual (mutually different) characteristic features. The arrangement can also be used in conjunction with supplementary, previously disclosed equipment in order to produce internal contours with characteristic features.

BACKGROUND

The production of metal supporting bodies for dental crowns and similar has until now taken place as a general rule on a purely manual basis by skilled craftsmen. The dentist has used previously disclosed techniques to produce a desired cast impression of the residue(s) of the tooth concerned, whereupon a dental technician has used the cast impression to complete the production process by mechanical means. This previously disclosed procedure was possible provided that castable materials, such as gold, were used for the aforementioned metal supporting bodies, for example.

The desire to be able to use other materials or alloys in the production of bodies of the kind in question exists for a variety of reasons. It can be mentioned by way of example that there is a wish to be able to produce metal supporting bodies for dental crowns and supporting bodies for limbs, etc., in titanium and other hard materials or alloys.

DESCRIPTION OF THE PRESENT INVENTION

TECHNICAL PROBLEM

The production of insert bodies in hard materials is costly to

execute due to the fact that each insert body has its own characteristic shape which must be capable of being reproduced with comparatively high accuracy.

It is also difficult to find a solution to the problem of the efficient production of insert bodies with individual shapes at the same time as the production operation is subject to pricing pressures.

THE SOLUTION

The present invention has as its object amongst other things to propose an arrangement for the efficient production of bodies of the kind referred to above. The new method is characterized essentially in that, amongst other things, a replica of a body which is to be produced is secured to a first element which, together with a second element, forms part of a first pair of elements. A blank from which the body is to be produced is secured to the aforementioned second element. The first and second elements are caused to rotate in such a way that the replica and the blank rotate about the axis of rotation of the respective elements. The first pair of elements and a second pair of elements are displaced relative to one another. The aforementioned second pair of elements contains a third element which supports a sensing device and which is capable of interacting with the external contour of the replica. The aforementioned second pair of elements also contains a fourth element which supports a tool by means of which the blank is capable of being worked. The aforementioned fourth element is controlled by the third element in such a way that the tool executes movements which correspond to the shape of the external contour of the replica sensed by the sensing device. The new arrangement is characterized essentially in that, amongst other things, in a pair of co-rotating elements, a first element is so arranged as to support a replica (a cast impression) of a body which is to be produced, and a second element is so arranged as to support a blank from which the body is to be produced, in

such a way that the replica and the blank are caused to rotate about the axis of rotation of the respective elements. A second characteristic is that, in a second pair of elements, a third element supports a sensing device which is capable of interacting with the external contour of the replica, and a fourth element is so arranged as to support a tool by means of which the blank is capable of being worked. A further characteristic is that the first and second pairs of elements are capable of being displaced relative to one another, and the fourth element is capable of being controlled by the third element in such a way that the tool executes movements which correspond to the shape of the external contour of the replica sensed by the sensing device.

In further developments of the idea of invention it is proposed that the sensing device should include a longitudinally displaceable component part which, via a servo system, provides control of the fourth element and thus of a tool which is capable of interacting with the blank. The servo system may be of a hydraulic or electrical/electronic nature.

The first and second pairs of elements are arranged preferably in such a way that the longitudinal axes of the third and fourth elements face in the direction of the axes of rotation of the first and second elements at obtuse angles, which may preferably be of the order of 135°. In this case the longitudinally displaceable component part of the sensing device and/or its means of support should preferably be imparted with friction-reducing rotation.

In a preferred embodiment the servo system includes a hydraulic piston (fluid piston) which is acted upon on either side by fluid pressure. The longitudinally displaceable component part is so arranged in this case, depending on the variation in longitudinal displacement, as to regulate a constriction in the hydraulic piston. In this way the fluid pressure on one side of the piston

is varied so that a differential pressure is created across the piston, producing a corresponding displacement of the fluid piston. In an embodiment of this kind the fluid flow on that side of the fluid piston which is situated on the longitudinally displaceable component part leads from a pressure source initially via a fixed constriction and then via the aforementioned variable constriction to the inside of the fluid piston which is capable of being connected to a drainage receptacle.

A piston/piston rod connected to the aforementioned hydraulic pistion or fluid piston can constitute an attachment point for a bearing component which supports the fourth element.

The novel arrangement can be used for the production of the graphite electrode for an electro-erosion apparatus which is used to produce a cavity inside a metal body of the kind in question. The wall of the cavity in this case can be of essentially the same shape as the outside of the metal body, resulting in a hollow, thin-walled and three-dimensional metal body.

The arrangement is also applicable in conjunction with the reduction of the base of the body in accordance with an outline marked by the dentist. The replica is made of or coated with an electrically conducting material to one side of the marked outline, whereas an electrically non-conducting material or coating is used to the other side of the marked outline. The aforementioned sensing device is thus able to function as an electrical reducing device which, with the help of actuating devices, guides the first and second pairs of elements towards and away from one another depending on whether the reducing device is sensing one side or the other of the marked outline.

ADVANTAGES

It is possible, through what is proposed here, to achieve the accurate production of three-dimensional bodies with individual characteristic features. Efficient production can take place in

large quantities and in series with extremely good reproducibility and accuracy.

The arrangement permits considerable freedom of choice with regard to materials, and by the appropriate choice of material the body can be subjected to the necessary accurate control procedures with regard to its dimensions. In the particular case of three-dimensional bodies intended for use inside the mouth, it is possible for production to take place using a material, such as titanium, which is resistant to corrosion by the fluids in the mouth and has no adverse biological effect on the tissues.

The use of the novel arrangement is particularly advantageous in those cases in which the metal bodies are to be provided with cavities. The cavity can be produced by a previously disclosed method by the use of electro-erosion apparatus with an appropriate electrode, for example made of graphite. This electrode (the tool) is given an external form which corresponds to the external form of the body with its individual characteristic features. The electrode is manufactured with dimensions which correspond to the external dimensions of the tooth residue. The metal body in question is given the same external form as the external form of the electrode, although it is made slightly larger in order to permit a wall to be produced in the body. The arrangement permits extremely thin-walled bodies to be produced, which in this case is intended to denote wall thicknesses of, for example, 0.6-0.7 mm. The wall thickness may vary within a wide range, however.

According to the above description, the arrangement also permits the body to be cut off along a marked outline. This is of very great significance in those cases which involve the production of hollow bodies for use as supports in dental crowns. The interface between the support and the tooth residue is critical in this case and calls for a precisely shaped and extremely thin (sharp) edge.

DESCRIPTION OF THE DRAWINGS

A preferred embodiment of a method and an arrangement which exhibit the significant characteristic features of the invention is described below with reference to the accompanying drawing, in which:

Fig. 1 shows in perspective view the most important component parts of the arrangement for the invention;

Fig. 2 shows in longitudinal section the function of a longitudinally displaceable component part contained in the arrangement according to Fig. 1; and

Fig. 3 shows in the form of a basic diagram the manner in which the arrangement is used for the purpose of shaping the lower edge of a three-dimensional body.

BEST MODE OF CARRYING OUT THE INVENTION

A first pair of elements is represented in Fig. 1 by a first element 1 and a second element 2. The aforementioned elements 1, 2 are so arranged as to be capable of rotating about their respective axes of rotation 3 and 4. Their rotation is achieved with the help of a motor, for example a hydraulic motor, which is provided on its drive shaft 6 with a toothed driving wheel 7. The elements 1 and 2 are provided with bearing shafts 8 and 9 by means of which the elements are supported in a bearing housing 10 in a previously disclosed fashion, for example on ball bearings. The bearing shafts are provided with toothed wheels 11 and 12 which are in engagement with the driving wheel 7 of the motor 5, which driving wheel thus causes the elements 1 and 2 to rotate in the same direction 13 and 14. The toothed wheels are also arranged in such a way that the elements 1 and 2 rotate in synchronism.

The elements 1 and 2 are provided with clamping devices (chucks) 15 and 16 to enable holders 17 and 18 to be secured to the elements. The aforementioned holders are intended to secure supporting devices 19 and 20 for a three-dimensional body 21, the

external contour of which is to be reproduced, and a blank 22 from which the three-dimensional body is to be made in, for example, titanium or a metal alloy, etc. The three-dimensional body (= the replica) and the blank are attached to their supporting devices 19 and 20 with the help of an adhesive and/or jointing devices, etc., and the supporting devices are retained in the holding devices by a previously disclosed clamping principle. The housing 10 is mounted on guides 23 and 24 so that the elements 1 and 2 are capable of longitudinal displacement along their axes of rotation 3 and 4 in directions indicated by the arrows 25. The longitudinal displacement is achieved with the help of a longitudinal displacement device 26, for example a hydraulic cylinder, the piston 27 of which is attached to the housing 10. The rate of longitudinal displacement is adapted to suit the particular manufacturing operation.

A second pair of elements contains a third element 28 and a fourth element 29. The third element 28 is securely arranged in the frame of the arrangement, which is symbolized by the designation 30 but is not specifically illustrated. The expression 'third element' shall be understood in its widest sense in this context and may be regarded as constituting an integral part of the aforementioned frame of the arrangement.

The third element constitutes a bearing component for a sensing device 31 which is capable of movement in relation to the frame of the third element. In the illustrative embodiment shown here, the device 31 has the form of a pin (needle) so arranged as to be capable of longitudinal displacement in the third element. The third element also provides support for a piston (hydraulic piston) 32 which is capable of longitudinal displacement, which piston acts as a servo piston in accordance with the following. An attachment 34 is arranged on a piston rod 33 belonging to the servo piston. The piston rod 33 is provided with an external thread 33a, onto which the attachment can be screwed via a matching internal thread in a transcurrent hole for the piston rod

insertion of the rod 36 into the element 28 by means of the pressure P. The pressure P' can be applied in this way by the 'on-off' principle.

At its end which faces away from the frame of the element 28, the piston rod 33 is capable of interacting with a counter-pressure piston 37 which is supported and force-operated in a bearing housing 38. The counter-force is produced with the help of a hydraulic pressure P in a fluid which is supplied to a connection line 39. A drainage line is indicated by the designation 40, and the drainage tank is represented by 41. The pin 31 is provided with a supporting component 43 which is supported in sliding bearings in the frame of the third element.

The mounting and the function of the pin are illustrated in more 33. Also arranged on the thread 33a of the piston rod is a nut 35 or similar which is rigidly anchored to the piston rod in such a way that the piston/piston rod can be displaced longitudinally by hand by means of the nut 35 or similar relative to the attachment (or vice versa). The nut 35 is provided with a scale 35a, by means of which the mutual displacement between the attachment and the piston rod can be determined. A rod 36 is supported in such a way as to be capable of longitudinal displacement in a corresponding hole in the third element 28 and is anchored at its one end to the attachment 34 in a hole 34a in the latter. The end surface 36a of the rod is exposed to an actuating pressure P' which can be applied temporarily. With the help of the pressure P' the attachment 34 can be forced backwards relative to the element 28. This function can be utilized in the course of manufacture when the body is finished and when it is accordingly wished to withdraw the needle 31 and the tool 52 in a rearward sense away from the bodies 21 and 22. The pressure P' is applied via an inlet 34b in the attachment. In one embodiment the pressures P' and P are counterbalanced so that the attachment 34 assumes the desired relative position to the element 28. In another embodiment it is possible to make use of stop devices which limit the degree of

detail in Fig. 2. The front end 31b of the pin is capable of interacting with the external contour 21a of the replica 21. During the sensing operation the pin 31 will describe reciprocating longitudinal displacement movements as shown by the arrows 42. The supporting device for the pin 31 is indicated by the designation 43. The other end 31c of the pin extends into a hole 28a for the piston 32. The end 31c of the pin is capable of interacting with a constriction or an inlet 32a in the piston 32. The space 28a is connected via a fixed constriction 44 to a pressure line 45 for a fluid, for example hydraulic oil. The inside 32b of the piston consists of a hollow space which is connected to a drainage line 46 via a hole 32c. The piston areas, constrictions and pressures are selected so that the piston 32 is counter-balanced at all times through either side of the piston being acted upon by identical fluid pressure forces. Fluid (for example hydraulic oil) is able to flow in this position of equilibrium from the pressure line 45, into the space 28a, through the constriction 32a, into the internal space 32b, and out via the hole 32c to the drainage line. The fluid pressure generated in this way inside the space 28a is counter-balanced by the force from the counter-pressure piston 37 (see Fig. 1).

If, in the course of its continuous sensing of the external contour 21a, the pin is displaced in either of the directions 42, the end 31c of the pin will vary the size of the constriction 32a. The fluid pressure will be increased or reduced inside the space 28a. This variation in pressure causes the servo piston 32 to move in either direction 42. The piston will then endeavour to assume the position of equilibrium indicated above at all times.

The pin 31 has its longitudinal axis 31d facing towards the axis of rotation 3, so that an obtuse angle α is produced. In one preferred embodiment this angle is of the order of 135°. The choice of angle can, however, lie within the range from 90° to approximately 170°. Friction which reduces the sensitivity of the servo system can arise in the bearing 42 in this case. In order to

eliminate the major proportion of this friction, the pin and its bearing are caused to rotate about their longitudinal axis 31d, in conjunction with which the direction of rotation is selected in order to achieve the aforementioned reduction in friction in the bearing 43.

According to Fig. 1, the rotation is achieved with the help of a motor 47 which, via a transmission device, for instance in the form of a belt 48, causes the pin and the bearing to rotate. The speed of rotation of the pin can be 1000 r/min, for example. The direction of rotation is indicated by the designation 49. The pressure tank for the fluid pressure is indicated by the designation 50, and the tank connected to the drainage line 46 is indicated by the designation 41.

The aforementioned element 29 is rigidly supported in the attachment 43 in such a way that the element 29 follows the movements of the servo piston and the attachment in the directions 51 of longitudinal displacement. The element supports a tool 52 which is capable of interacting with the blank 22, which tool may be in the form of a hard metal milling cutter 52 in the case of a blank made of titanium or some other hard alloy. The longitudinal axis 53 of the element 29 extends in the direction of the longitudinal axis 4 at an angle β which should preferably be of the same order of magnitude as the angle α. The fourth element is provided with a clamping device (chuck) 54 for the tool 52. The tool is also caused to rotate, which is achieved with the help of a motor 5 and a device for transmitting the movement, in the present case in the form of a belt drive 56. The aforementioned belt drive is so arranged in this case as to permit the driving of the tool 52 to take place irrespective of the small longitudinal displacement movements which the fourth element 29 executes in the directions 51. The rotation of the tool 52 takes place with the help of the rotatably mounted shaft 57 of the element. The rotatable mounting can be executed in a previously disclosed manner by means of ball bearings 29a. The attachment 34 is secured

with the help of one or more supports 58 in such a way that it exhibits torsional resistance.

The mode of operation of the equipment described above is as follows. The first and second elements 1 and 2 are caused to rotate, for example at 1000 r/min, at the same time as which they are displaced towards the pin 31 and the tool 52. During this displacement the pin is able to sense the contour 21 from its top 21a' to its base 21a''. Depending on this sensing, the servo piston 32 in the rigidly arranged element 28 is caused to execute longitudinal displacement movements in accordance with the sensing by the pin 31. These movements are transmitted to the attachment 34 and thus to the element 29. The tool 52 accordingly executes a pattern of movements on the blank 22 which correspond to the contour sensed by the pin 31. A three-dimensional body corresponding to the replica 21 will thus be produced from the blank 22. Once the elements 1 and 2 have executed a longitudinal displacement movement which corresponds to the sensing of the pin 31 between 21a' and 21a'', the elements can be caused to move in the other direction 25 of longitudinal displacement, and the now finished body can be removed from the element 2 and can be replaced by a new blank, for example in the form of a titanium bar, etc. In order to provide a large unobstructed space around the blank, the needle and the tool, the attachment 34 can be pushed backwards by actuation applied via the surface 36a.

It is possible by the longitudinal adjustment of the attachment 34 relative to the piston rod 33 with the help of the nut 35 easily to achieve different sizes for the external dimensions of the finished three-dimensional body 22. Adjustments are easily made in this respect in such a way that the external contours of the finished body 22 are larger than, the same as, or smaller than the external contour of the replica 21, i.e. the individual body with its characteristic features. It is possible in this way to produce a first body with external dimensions which slightly exceed the size of the replica or the cast impression. This first body is

executed from the blank selected for the body. It is also possible for a second body to be produced which has the same external contours as the replica or the cast impression. This second body can consist of graphite and can be used as a tool or electrode in an electro-erosion apparatus of a previously disclosed kind.

As shown in Fig. 3, the arrangement can also be used to shape the manufactured body in question at its base. An outline 21b is marked on the replica for this purpose. To that side of the line which contains the top 21d of the replica, the replica is executed with an electrically non-conductive surface coating. To the other side 21e of the line, the replica is electrically conductive. A device 59 which is provided with a part 60 made of an electrically conductive material, but which is otherwise electrically non-conductive, is arranged in such a way as to be capable of being secured to the free end of the needle 31. The part 60 interacts with the external contour of the replica and is connected to a source of electrical energy, for example a battery, to one pole of which the part is connected. The other pole of the energy source or battery is connected to a change-over device 62, for example a solenoid switch, which controls the flow of an actuating fluid M, M' to a two-position valve 63 of the 'on-off' type. In the first position (= the position shown in Fig. 3) one side 27a' of the piston 27a of the piston rod 27 is connected to the drainage receptacle 41. In the other position an actuating pressure P_1 is connected to the same side 27a' of the piston 27a. The connection to the piston 27a passes via a fixed constriction 64. The change-over device (its electrical winding) is also connected to earth (the frame of the arrangement), which is symbolized by the connection component 65.

Through the arrangement described above, the direction of movement of the piston 27a will be varied immediately the sensing component 60 crosses the marked outline 21 from one area, for example 21d, to the other area, 21e, or vice versa. When the component 60 is in interaction with the electrically conductive component 21e, the circuit is closed via the negative pole of the battery, the

component 60, the conductive component 21e of the replica 21, the component 19, the frame of the arrangement, the winding in the device 62 and the positive pole of the battery. The change-over device is activated and causes the valve to move to its second position by means of the actuating fluid M, M'. The pressure P_1 is applied to the side 27a' of the piston and produces an actuating pressure on the piston which exceeds a pressure P_2 acting continuously on the piston. What this means is that the replica 21 is caused to move backwards relative to the component 60, which in this case crosses the marked outline 21 and enters into interaction with the electrically non-conductive material. The circuit is broken, and the effect of the actuating fluid M, M' is interrupted. The valve is returned to its initial position with the help of a return spring 63a. The side 27a' of the piston is connected to the drainage receptacle, and the piston rod is caused to move in its other direction, with the result that the part 21 of the replica is caused to move forwards, and the component 60 again crosses the marked outline 21c and enters into interaction with the electrically conductive material, and so on.

The component part 60 will move with small deflections in such a way as to follow the marking 21c. The tool 52 executes corresponding movements and cuts or grinds away the body 22 along an imaginary line 22a which corresponds to the marking 21c.

The change-over device 62 and the valve 63 can be executed from previously disclosed component parts. The component part 59 can be of cylindrical form and can be applied to the pin 31 in a previously disclosed manner. The component part 60 can have the form of a washer secured, for example by glueing, to the component part 59.

In accordance with the novel method the first and second elements are caused to co-rotate and are displaced relative to the third and fourth elements. The fourth element is controlled by the third element in such a way that the tool is caused to produce the desired machining of the blank. The tool executes a movement which

corresponds to the external contour of the replica, in conjunction with which a tooth cap, an entire artificial tooth or a part of an artificial tooth, or some other mechanical body for some other purpose can be produced.

The invention is not restricted to the embodiment described above by way of example, but may undergo modifications within the scope of the following Patent Claims and the idea of invention. Thus, for example, the valve arrangement for the needle 31 may be executed in a different, previously disclosed manner.

PATENT CLAIMS

1. A method for the production of bodies for the artificial rebuilding of teeth and human limbs, etc., or equivalent three-dimensional bodies having external contours with individually characteristic features, characterized in that a replica (21) of a body which is to be produced is secured to a first element (1) which, together with a second element (2), forms part of a first pair of elements (1, 2) which are capable of co-rotating, in that a blank (22) from which the body is to be produced is secured to the second element, in that the co-rotating first and second elements are caused to rotate in such a way that the replica and the blank rotate about the axis of rotation (3, 4) of the respective elements, in that the first pair of elements and a second pair of elements (28, 29), of which the latter includes a third element (28) which supports a sensing device (31) which is capable of interacting with the external contour of the replica, and a fourth element (29) which supports a tool (52) by means of which the blank is capable of being worked, are displaced relative to one another, and in that the fourth element is controlled by the third element in such a way that the tool executes movements which correspond to the shape of the external contour of the replica sensed by the sensing device.

2. An arrangement for the execution of the method in accordance with Patent Claim 1 for the production of insert bodies for the artificial rebuilding of teeth and human limbs, etc., or equivalent three-dimensional bodies having external contours with individually characteristic features, characterized in that, in a first pair of co-rotating elements (1, 2), a first element (1) is so arranged as to support a replica (a cast impression 21) of a body which is to be produced, and a second element is so arranged as to support a blank (22) from which the body is to be produced, in such a way that the replica and the body are caused to rotate about the axis of rotation of the respective elements (3, 4), in that, in a second pair of elements (28, 29), a third element (28) supports a sensing device (31) which is capable of interacting with the external contour (21a) of

the replica, and a fourth element (29) is so arranged as to support a tool (52) by means of which the blank is capable of being worked, and in that the first and second pairs of elements (1, 2 and 28, 29) are capable of being displaced relative to one another, and the fourth element (29) is capable of being controlled by the third element (28) in such a way that the tool executes movements which correspond to the shape of the external contour of the replica sensed by the sensing device.

3. An arrangement according to Patent Claim 2, c h a r a c t e r i z e d in that the sensing device (31) contains a component part which moves in relation to the frame of the third element, said component preferably being capable of longitudinal displacement, and which, via a servo system (32, 33), provides control of the fourth element (29) and thus of the tool (52) which is capable of interacting with the blank.

4. An arrangement according to Patent Claims 2 or 3, c h a r a c t e r i z e d in that the longitudinal axes (31d, 53) of the third and fourth elements face in the direction of the axes of rotation (3, 4) of the first and second elements at obtuse angles (α, β), which should preferably be of the order of 135^{o}.

5. An arrangement according to Patent Claims 3 or 4, c h a r a c t e r i z e d in that the moving, longitudinally displaceable component part (31) and/or its means of support are imparted with friction-reducing rotation.

6. An arrangement according to Patent Claims 3, 4 or 5, c h a r a c t e r i z e d in that the servo system consists of a fluid piston (a hydraulic piston 32) which is acted upon on either side by fluid pressure, in that the longitudinally displaceable component part (31) is so arranged, depending on the variation in the longitudinal displacement, as to regulate a constriction (32a) in the fluid piston (32) and, together with a fixed constriction (44), as to vary the fluid pressure acting on one side of the piston, in such a way that a differential pressure is created across the piston, producing a corresponding displacement of the fluid piston.

7. An arrangement according to Patent Claim 6, characterized in that the fluid flow on that side of the fluid piston which is situated on the longitudinally displaceable component part leads from a pressure source (50) via the fixed and variable constrictions (44 and 32a) to the inside (32b) of the fluid piston, which is connected to a drainage receptacle (41).

8. An arrangement according to any of the Patent Claims 3 – 7, characterized in that a piston rod (33) which is part of a servo system provides an attachment point for a bearing component (34) which supports the fourth element (29).

9. An arrangement according to any of the Patent Claims 2 – 8, characterized in that, with the help of one and the same replica (21), a first body is capable of being produced from a first blank made of metal or a metal alloy, and a second body is capable of being produced from a second blank made of electrode material, for example graphite, and in that, through the relative positioning of the tool in relation to the blank, a difference in size is achieved between the first and the second bodies, such that the second body is smaller than the first body, in which case the second body is capable of being used as an electrode for the spark-machining of the first body in order to provide the latter with the form of a hollow body with a wall thickness which is governed by the relative positioning.

10. An arrangement according to any of the Patent Claims 2 – 9, characterized in that, for the purpose of reducing the base of the body in accordance with a marked outline, the replica (21) is electrically conductive to one side of the marked outline and is electrically non-conductive to the other side of the marked outline, and in that the sensing device functions as an electrical reducing device which, with the help of the sensing device, guides the first and second pairs of elements towards and away from one another depending on whether the reducing device is sensing one side or another.

11. An arrangement according to any of the Patent Claims 2 — 10, characterized in that the third element is arranged in a fixed position relative to the other elements, in that the first and second elements (1, 2) are so arranged as to be capable of being displaced towards and away from the third and fourth elements, and in that the sensing device moves relative to the fixed third element and the fourth element moves in co-ordination with the sensing device (31) by means of a servo, for example an electrical and/or electronic servo or a hydraulic servo.

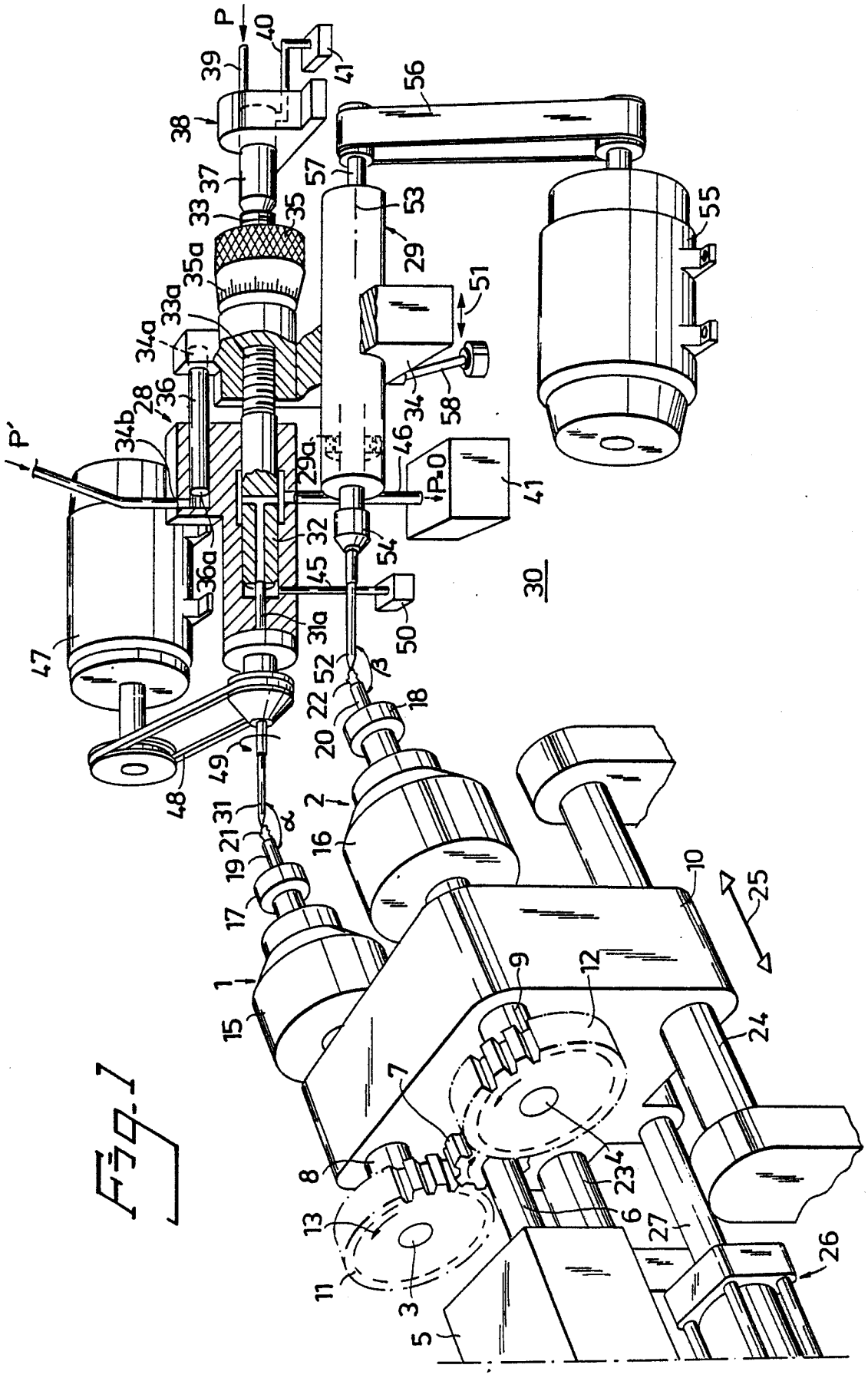


FIG. 1

Fig. 2

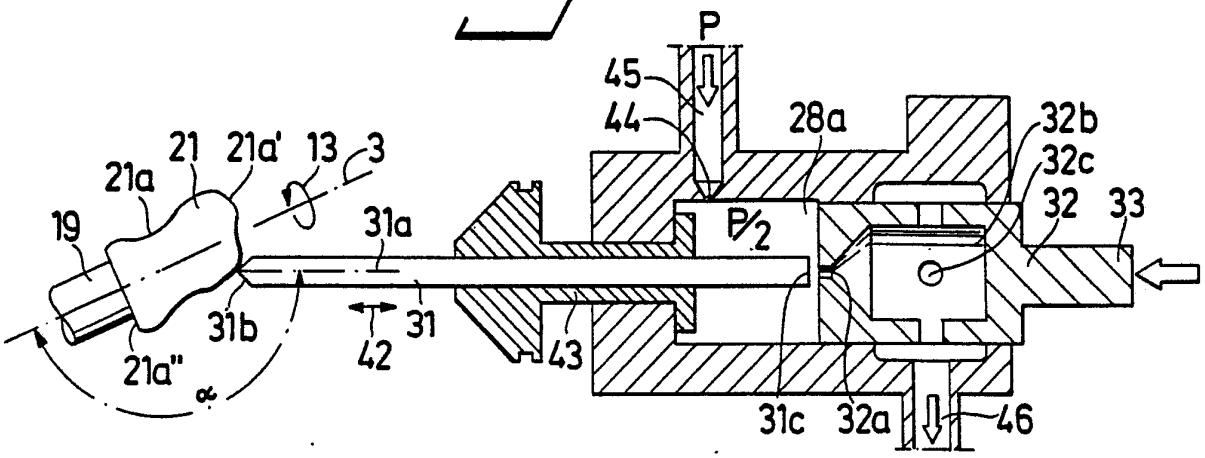
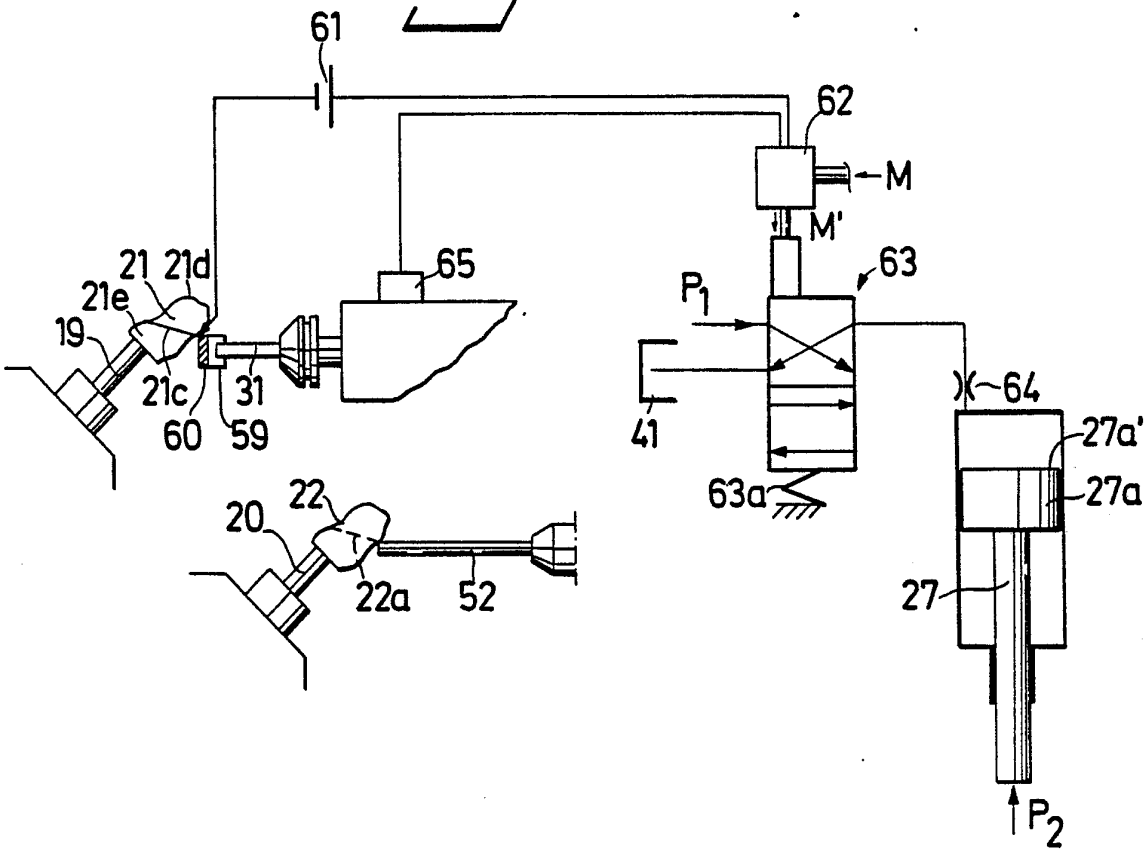

P
45
44
28a
32b
32c
32
33
21
21a'
13
3
21a
19
31a
P/2
31b
42
31
43
21a"
α
31c
32a
46

Fig. 3


61
62
M
M'
63
65
21
21d
21e
19
21c
60
59
31
P1
41
64
27a'
27a
63a
27
20
22
22a
52
P2

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00194

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC [4]

A 61 C 5/10, 13/08

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	A 61 C 5/00, /08, /10, 13/00, /08
US Cl	32:2, 8, 10, 12; 433:49-76, 167-229

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A,P	SE, B, 448 598 (ÖSTERSUNDS DENTAL AB) 1987-03-09	1-11

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1987-06-30	1987 -07- 03
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Jack Hedlund

L.E