

AN APPARATUS TO AUTOMATICALLY POSITION AND OPERATE
SURGICAL INSTRUMENTS

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The present invention relates to an apparatus to automatically position and operate surgical instruments, in particular for refractive keratic surgery, in particular lamellar refractive surgery.

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More particularly, the invention relates to an apparatus of the said type, that allows surgical techniques to be carried out with an extreme safety and a high repeatability.

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It is well-known that in all the fields of surgery one tries to realize equipments that allow to operate to a greater precision, and, moreover, allow surgeons having not a very long experience to carry out delicate operative surgeries.

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This is even more true in those fields wherein it is operated upon delicate organs, and therefore is particularly felt in ophthalmological surgery.

In this field, a very important operation consists in lamellar refractive surgery (keratomyleusis).

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Keratomyleusis is a surgical methodology well known to those skilled in the art, originally set by Prof. Barraquer.

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It has developed during years through three techniques, and the relevant apparatuses have been realized by Barraquer himself, by Krumeich and Swinger and then by Ruiz.

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Among the various equipments that make up the set of the surgical instruments necessary to operate, Barraquer's technique provides the use of a sucking metal ring which is applied on the eye of the patient and whereon the microkeratome slides.

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In order to be able to achieve the exact keratic surface protrusion it is necessary to have a complete set of sucking metal rings at disposal.

Before carrying out the operation, one
5 measures the intraocular pressure caused by the ring and measures, by means of a precalibrated lens, the lenticule diameter that would be obtained with that particular ring.

Only after verifying these variables and
10 selecting the proper ring, one will be able to proceed to the section of the lamella.

Obviously, all these operations render the operation more difficult, less safe and longer.

In the technique set by Krumeich and Swinger
15 also the same type of sucking rings is employed.

In Ruiz's technique, on the contrary, a series is employed of pneumatic rings which present the same already mentioned problems.

Recently, in the Application for Italian
20 Patent No. 48104-A/89 filed on June 21, 1989, an apparatus set has been suggested for carrying out myopical or hypermetropical keratomyleusis wherein a single sucking ring endowed with an adjustment ferrule is provided, for determining the diameter of the flap to
25 be removed, and constituting a track for the sliding of the microkeratome and the precalibrated lens.

As is apparent, such a solution constitutes a considerable progress in comparison with the preceding apparatuses in that it allows to rapidly determine the
30 diameter of the flap to be removed, to measure intraocular pressure and to carry out the refractive section.

Subsequently, it has been suggested, by the same Applicant, a further improvement of the latter
35 apparatus, and particularly a sucking ring realized with an extremely simple mechanics, with a handle that allows

a very safe positioning of the ring on the eye of the patient and able to effect decisely considerable excursions downwards and upwards.

5 All what has been disclosed above if on a hand has allowed the operation technique to be more and more improved, always maintains a very strict link between the result of the operation and the ability of the surgeon.

10 This is true in that the result is strictly connected with the ability of the surgeon.

Moreover, with these apparatuses of the manual type, it turns out to be very difficult to have a high repeatability of the operation.

15 In view of the above, the Applicant has thought of realizing an apparatus that allows the aforementioned operative technique to be executed in an automatic and absolutely repeatable manner.

It is therefore the specific object of the present invention an apparatus for automatically
20 positioning and operating surgical instruments, particularly for refractive keratic surgery, particularly lamellar refractive surgery, comprising means for the correct positioning in correspondence with the operating cot; means for vertically raising all the
25 apparatus; a horizontal guide; a first support member arranged slideably upon said horizontal guide; a horizontal linear actuator, which determines the slide, in both directions, of said support member on the horizontal guide; a vertical guide, integral with said
30 first support member, at right angles to the horizontal guide; a second support member, slideable in both directions upon said vertical guide by means of a first vertical linear actuator; a member for operating and supporting the surgical instrument, borne, by the second
35 support member; a horizontal plane integral with said second support member and endowed with a second vertical

linear actuator that allows the raising and the lowering thereof in an autonomous manner; and an arm, integral with said means for positioning and vertically raising and bearing, at its free end, a member for the correct
5 positioning of the portion which is to be operated.

According to the invention, all the operation and the various functions of the apparatus can be controlled through a pre-programmed and surgeon settable central unit.

10 Preferably, said horizontal linear actuator will be comprised of a continuous current motor, while the two vertical linear actuators will be comprised of two stepper motors.

Said second linear actuator can also be
15 comprised of a nonius.

In a preferred embodiment of the apparatus according to the invention, the member for operating and supporting the surgical instrument can be comprised of a continuous current motor with a spindle bearing, in a
20 stationary or in a removable manner, said surgical instrument.

The surgical instrument will be preferably comprised of a rotating blade, case in which the motor and the spindle are arranged at right angles to the
25 vertical guide.

Moreover, a miller for correcting the section can be mounted on said spindle.

Again on the spindle a little spoon for taking in the cut lamella can be provided.

30 Preferably, said arm, coupled in a stationary or in a removable manner with said positioning and raising means will bear, at its free end, the sucking ring, connected with the vacuum source, for the positioning of the cornea.

35 However, according to the type of operation and of the stage of the same, upon it a bench for

working the lamella will be able to be provided.

The means for the positioning upon the cot can be made up of a magnetic system, brackets or other similar mechanisms.

5 The means for the vertical raising will be able to be of a mechanical and/or pneumatic and/or hydraulic type.

10 The present invention will be now disclosed, as a matter of illustration, but not of restriction, according to a preferred embodiment thereof represented in the figure of the annexed drawing wherein a schematic side view is shown of the apparatus according to the invention.

15 The apparatus shown in the figure provides a connector 1 of a magnetic type for the fastening to the operative cot (not shown), above which a member 2 is provided for raising all the apparatus on the cot, so as to be able to correctly position it.

20 The assembly connector 1-member 2 bears, integral with it, a horizontal guide 3 which serves to position, in a known manner, the whole proper surgical instrument with respect to the eye of a patient.

25 It bears, slideably, a support structure 4 wherewith the rest of the apparatus according to the invention is coupled in an integral manner, in the way that will be seen below.

30 Said support 4 is made to slide upon the guide 3 by the linear actuator 5, which preferably will be a continuous current motor, in that the type of action that it has to perform requires a continuous linear movement.

At the extremity opposite that for the coupling with the guide 3, the support 4 integrally bears a vertical guide 6 at right angles to the guide 3.

35 Upon said vertical guide 6 a second support 7 slides actuated by the linear actuator 8 which, in this

case, will be preferably a stepper motor.

Said support 7 has a vertical arm, which slides upon the vertical guide 6 and a horizontal arm which bears the blade for cutting 9, and the relevant
5 c.c. motor 10, and the plane 11 with the relevant vertical linear actuator 12.

On the arm 13 of the blade 9 a little spoon 14 for picking the cut lamella is provided.

Obviously, to the arm 13 a tool different from
10 the blade 9 can be applied, e.g. a miller, to carry out further stages of the operative surgery.

To said member 2 an arm 15 is coupled in an integral, but removable manner, at its extremity that goes to find itself under the blade 9 and the plane 11,
15 bearing a sucking ring 16.

The sucking system (not shown) of the sucking ring 16 can be provided inside the arm 15.

As will be seen in the following, the plane 11 allows the cut thickness to be adjusted, while the blade
20 13, raising and lowering itself integrally with the support 7, allows the diameter to be adjusted.

In the place of the arm 15 and of the ring 16 other members necessary to carry out subsequent stages of the operative surgery can be provided.

25 All the operation of the various actuators 5, 8, 10 and 12 can be controlled by a pre-programmed central unit instructable step by step during the operative surgery.

30 Compared with the sucking ring employed for the manual execution of keratomeleusis operation, the ring 16 hasn't to be endowed with the guides for the slide of the microkeratome, with the handle and with the raising and lowering mechanisms for finding the zero and determining the thickness of the cut or section.

35 To initiate an operative surgery with the apparatus represented in the figure, it is first of all

necessary to proceed to set all the instruments to zero.

This is achieved by bringing, by means of the horizontal actuator 5 and the vertical actuator 8, the blade 9 into contact with the ring 16, after completely
5 raising the plane 11.

The ring 16 will be electrically insulated with respect to the other components.

When the blade 9 and the ring 16 are in contact one is in the ideal position for the maximum
10 diameter and maximum thickness section. This is the first reference point.

The actuator 12 also is insulated with respect to the actuator 10.

Then one lowers the plane 11 up to touch the
15 sucking ring 16, i.e. in a potential condition of zero thickness section. This is the second reference point.

Then one reraises the whole by a known quantity, by means of the actuator 8.

At this point it is necessary to bring the eye
20 of the patient in correspondence with the sucking ring 16.

The patient is layed down and is made to stare at a luminous point, marking the centre of the cornea.

After the anaesthesia and applying the usual
25 operative techniques, one positions the apparatus on the operative cot, causing the sucking ring 16 to find itself above the eye of the patient.

Before applying the vacuum on the ring, one brings, through the actuator 5, all the instrument in a
30 withdrawon position, and makes the patient to stare upwards in such a manner as to make the centre of the sucking ring to correspond with the centre of the cornea.

Then one applies the vacuum and the eye is
35 fixed in position.

The member 2 is no more touched. The system is

stationary.

Then one measures the pressure of the eye and the proper operation can be initiated.

5 Through the actuator 5 the blade 9 and the plane 11 are brought onto the ring 16 and then, through the vertical actuator 8 one lowers the blade 9, kept firm, up to skim the eye of the patient.

10 The cornea of the patient being a conductor, when the blade 9 skims it one has another reference point of the system.

Indeed, from this point, the more the blade 9 is lowered, the greater the diameter of the section.

15 One withdraws the blade 9 backwards, horizontally, through the actuator 5 and lowers it by the quantity necessary to achieve the section of the desired diameter.

In this position, the plane 11 will go to find itself on the eye of the patient.

20 By acting now on the vertical actuator 12, by raising the plane 11, one determines the desired thickness of the section.

At this point, one actuates the motor 10, making the blade 9 to rotate and the horizontal actuator 5, thereby achieving the section.

25 After finishing the section, one raises the whole and brings back it.

To operate according to Ruiz's technique, it will suffice to execute the second section and then reapply the first removed lamella.

30 Where, on the contrary, it is desired to execute Krumeich's technique, it will suffice to remove the arm 15 with the sucking ring 16 and substitute it with an arm bearing a bench for working the lamella.

35 One executes the correction of the lamella which will thereafter reapplied to the patient.

The blade 9, moreover, can be substituted by a

millar for correcting the section where the existence of a step on the section is recognized.

The present invention has been described with specific reference to some its preferred embodiments,
5 but it is to be understood that variations and/or modifications can be made by those skilled in the art, without so getting out of the relevant protection scope.

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CLAIMS:

1. An apparatus to automatically position and operate surgical instruments, particularly for refractive keratic surgery, particularly for lamellar refractive surgery, characterized in that it comprises means for correctly positioning the equipment in correspondence with the operating cot; means for vertically raising all the apparatus; a horizontal guide; a first support member arranged, slideably, on said horizontal guide; a horizontal linear actuator which determines the slide, in both directions, of said support member on the horizontal guide; a vertical guide, integral with said first support member, at right angles to said horizontal guide; a second support member, slideable in both directions on said vertical guide by means of a first vertical linear actuator; a member for operating and supporting the surgical instrument, borne by the second support member; a horizontal plane integral with said second support member and endowed with a second vertical linear actuator which allows the raising and the lowering in an autonomous manner with respect to the second support member; and an arm, integral with said means for the positioning and the vertical raising and bearing, at its free end, a member for correctly positioning the portion which it is operated upon.

2. The apparatus according to Claim 1, characterized in that it comprises a pre-programmed surgeon settable central unit for automatically controlling all the operation and the various functions of the apparatus.

3. The apparatus according to anyone of the preceding claims, characterized in that said horizontal linear actuator is comprised of a continuous current motor.



4. The apparatus according to one of the preceding claims, characterized in that said first vertical linear actuator is made up of a stepper motor.

5. The apparatus according to one of the preceding claims, characterized in that said second vertical linear actuator is made up of a stepper motor or a nonius.

6. The apparatus according to one of the preceding claims, characterized in that said member for operating and supporting the surgical instrument is comprised of a continuous current motor and of a spindle bearing, at its free end, in a fixed or removable manner, said surgical instrument.

7. The apparatus according to anyone of the preceding claims, characterized in that said surgical instrument is comprised of a rotating blade.

8. The apparatus according to anyone of Claims 1 to 6, characterized in that said surgical instrument is comprised of an oscillating blade.

9. The apparatus according to Claim 6, characterized in that a miller for correcting the section is mounted on said spindle.

10. The apparatus according to anyone of Claims 6 to 9, characterized in that a spoon member for taking in the cut lamella is provided on said spindle.

11. The apparatus according to anyone of the preceding claims, characterized in that said arm, fixedly or removably connected with said positioning and raising means, bears, at its free end, in a position lower than the surgical instrument, a sucking ring connected with the vacuum source.

12. The apparatus according to anyone of Claims 1 to 10, characterized in that a bench for working the cut lamella is provided on said arm.

13. The apparatus according to anyone of the preceding claims, characterized in that said means for



the positioning upon the cot are comprised of a magnetic system, of brackets or other similar mechanisms.

14. The apparatus according to anyone of the preceding claims, characterized in that said vertical
5 raising means are of a mechanical and/or pneumatic and/or hydraulic type.

15. The apparatus to automatically position and operate surgical instruments, particularly refractive keratic surgery, particularly lamellar
10 refractive surgery, according to anyone of the preceding claims, substantially as depicted and disclosed.

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