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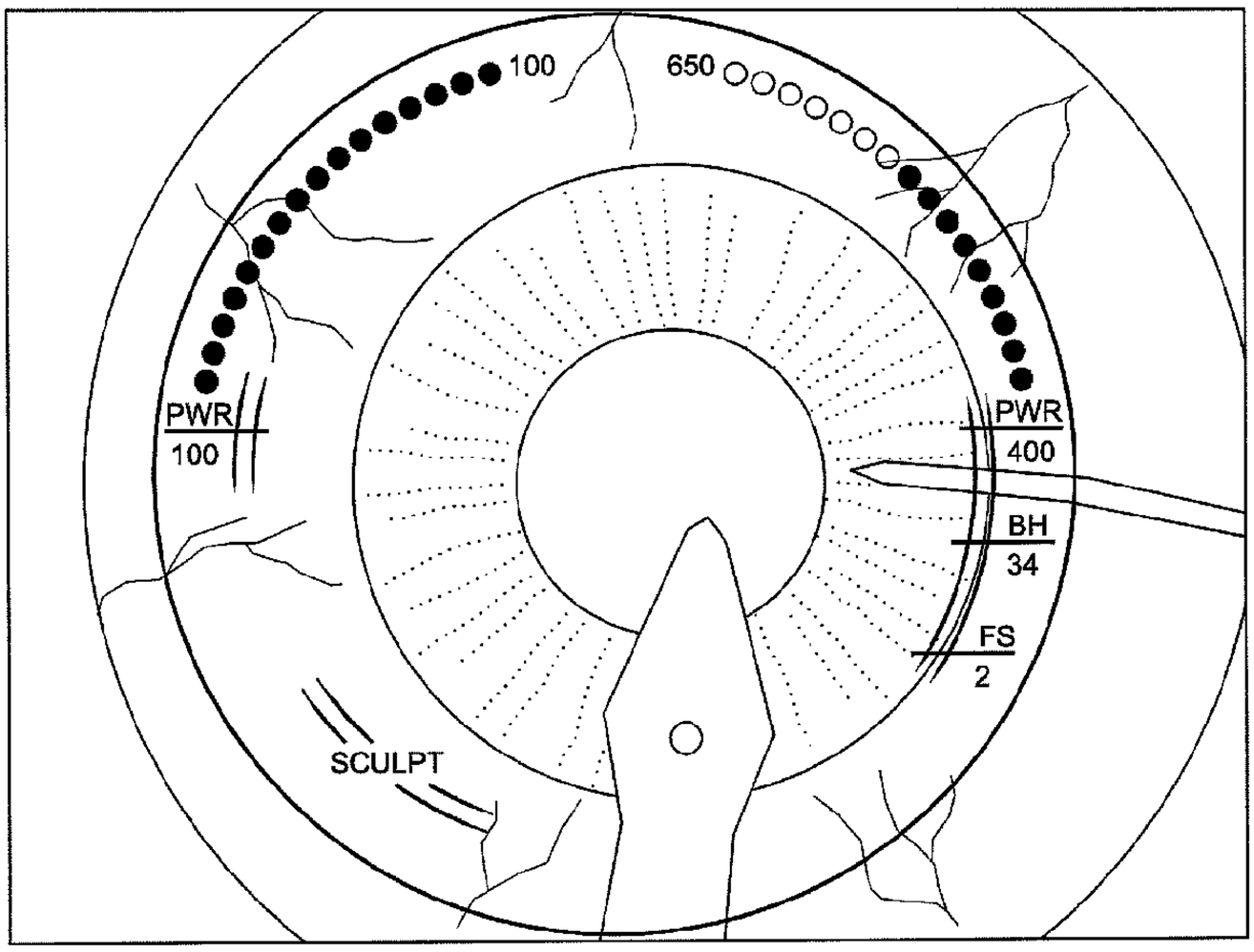

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An ophthalmic surgical system includes a display device and a user interface. The display device generates a display on an image of a patient's eye comprising a plurality of non-overlapping display sectors. Each display sector displays one of a plurality of user-selectable surgical parameters. A user interface receives a user selection of one or more of the user-selectable surgical parameters to be displayed.

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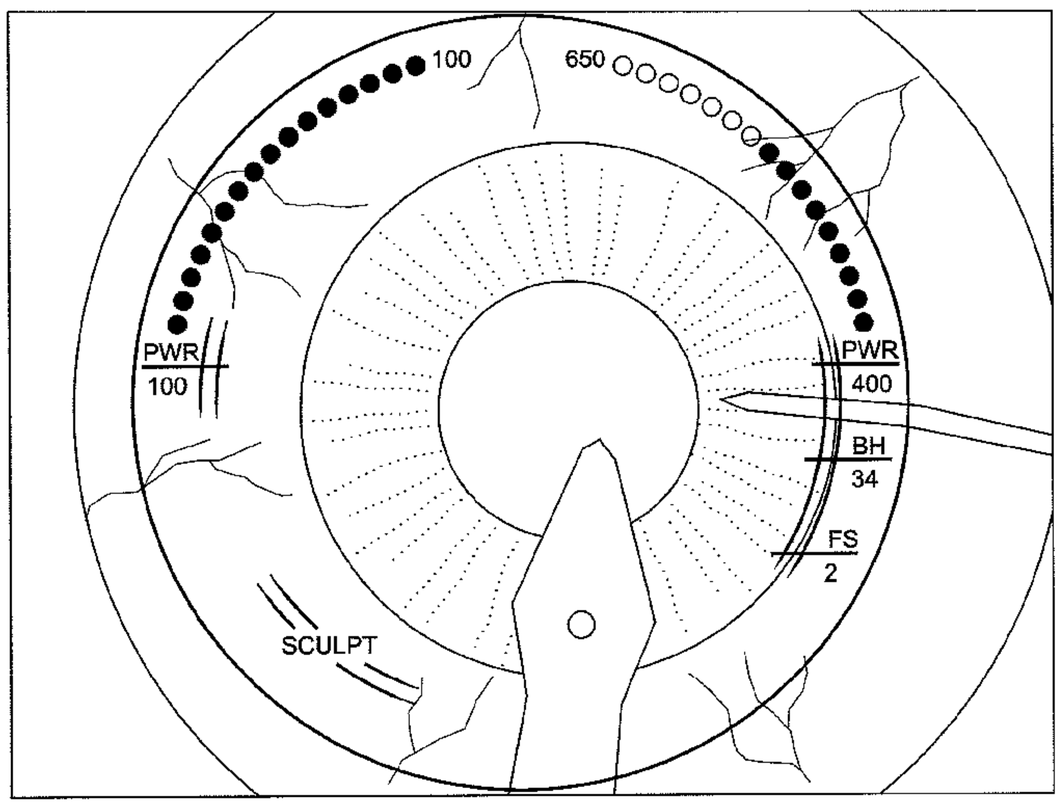

Fig. 2

(57) Abstract: An ophthalmic surgical system includes a display device and a user interface. The display device generates a display on an image of a patient's eye comprising a plurality of non-overlapping display sectors. Each display sector displays one of a plurality of user-selectable surgical parameters. A user interface receives a user selection of one or more of the user-selectable surgical parameters to be displayed.

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DISPLAY FOR OPHTHALMIC SURGICAL CONSOLE WITH USER-SELECTABLE SECTORS

TECHNICAL FIELD

This application relates to ophthalmic surgical devices and, more particularly, to a display for an ophthalmic surgical console with user-selectable sectors.

BACKGROUND

Various displays have been provided for ophthalmic surgical consoles. Such displays may frequently be overlaid on the surgical microscope used to view the eye. Unfortunately, these displays frequently suffer from several drawbacks. First, the displays can often be inconveniently placed, obscuring the surgeon's view of the eye and creating a tradeoff between the additional information provided in the display and clear vision of the surgical field. Second, including additional information in the display can make the display crowded and less usable. Third, the displays frequently use ring-shaped patterns, often including measurement scales. Such patterns can be distracting to the surgeon without being sufficiently visible for the surgeon to easily use them. Accordingly, there is a need in the art for an improved display for ophthalmic surgical consoles.

SUMMARY

Certain exemplary embodiments can provide an ophthalmic surgical system, comprising: a display device for generating an overlay display on an image of an eye, the display device projects the display in the optical path of a surgical microscope, a user interface for receiving a user selection of one or more user-selectable phacoemulsification or vitrectomy parameters to be displayed, wherein

the display device displays, on an image of an eye, a plurality of non-overlapping display sectors falling within a circle centered at the center of the display, each display sector displaying one of the user-selectable phacoemulsification or vitrectomy parameters.

Certain exemplary embodiments can provide a computer-implemented method of displaying surgical parameters on an ophthalmic surgical system with a display device to project the display in the optical path of a surgical microscope, comprising: receiving a selection of at least two user-selectable phacoemulsification or vitrectomy parameters; and generating an overlay display on an image of a patient's eye comprising a plurality of non-overlapping display sectors, falling within a circle centered at the center of the display, each display sector displaying one of the user-selectable phacoemulsification or vitrectomy parameters.

In accordance with other aspects of the disclosure, an ophthalmic surgical system includes a display device and a user interface. The display device generates a display on an image of a patient's eye comprising a plurality of non-overlapping display sectors. Each display sector displays one of a plurality of user-selectable surgical parameters. A user interface receives a user selection of one or more of the user-selectable surgical parameters to be displayed.

In accordance with other aspects of the disclosure, a method of displaying surgical parameters on an ophthalmic surgical system includes receiving a selection of at least two user-selectable surgical parameters. The method further includes generating a display on an image of a patient's eye comprising a plurality of non-overlapping display sectors. Each display sector displays one of the plurality of user-selectable surgical parameters.

DESCRIPTION OF FIGURES

Figure 1 illustrates an ophthalmic surgical system according to a particular embodiment of the present invention;

Figure 2 illustrates an example display according to particular embodiments of the present invention;

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Figure 3 shows an example selection screen that can be used in conjunction with various embodiments of an ophthalmic surgical system according to the present invention; and

Figure 4 is a flow chart showing an example method for displaying surgical parameters according to the present invention.

DETAILED DESCRIPTION

Figure 1 illustrates an ophthalmic surgical system 100 according to a particular embodiment of the present invention. The system 100 includes surgical instrumentation 102, a user interface 104, and a surgical microscope 106. Surgical instrumentation 102 may include any type of component or machine used in ophthalmic surgery, including but not limited to handpieces, pneumatic systems, laser sources, illumination sources. Such components may be used in ophthalmic surgical techniques such as phacoemulsification, vitreoretinal surgery, laser refractive surgery, or any of the other various ophthalmic surgical methods known to one skilled in the art. The user interface 104 may include any kind of keyboard, switch, knob, pedal, button, pointing device, or other suitable component for receiving selections of surgical parameters from the user. The surgical microscope 106 may include any manner of optical or electronic device or collection of components providing a view of a patient's eye to the surgeon.

Surgical instrumentation 102 operates under the control of a processor 108; it also has memory 110 storing surgical parameter information. The processor 108 may be any microprocessor, microcontroller, programmable element, or other device or collection of devices for processing instructions for

the control of surgical instrumentation 102. The processor 108 receives parameter selections from the user interface 104 and controls the operation of surgical parameters accordingly. The processor 108 also monitors surgical parameters during surgery. The memory 110 may be any suitable form of volatile or non-volatile information storage accessible by processor, including but not limited to optical, electronic, or magnetic media.

Various embodiments of surgical systems according to the present invention further include a display device 200. The display device 200 includes any suitable optical or electronic components or collection thereof capable of generating a visually-perceptible display of surgical parameters on an image of the patient's eye. For example, the display device 200 can project light onto a surface of the patient's eye to generate an image that is captured by the surgical microscope 106 along with the image of the eye. In another example, the display device 200 can project the display into an optical path of the surgical microscope 106 to produce the display over an image of the eye. Such embodiments may allow the display to be focused or magnified along with the image of the eye as well; alternatively, they may allow the display and the eye image to be focused or sized independently. In yet another example, the display device 200 can be incorporated into an eyepiece of the surgical microscope 106. The display device 200 may be configured to communicate with and/or share the processor 108 and/or the memory 110 in order to allow the surgical parameter display to be adjusted based on user selection of surgical parameters and variation of those parameters in real time during surgery.

Figure 2 illustrates an example display 202 according to particular embodiments of the present invention. The display 202 includes a number of display sectors 204A, 204B, ... 204n, which will be generally referred to herein as display sectors 204. The term "display sectors" refers to the fact that these portions of the display fall within a sector of a circle centered at the center of display with the sector having a central angle less than 180 degrees. The display sectors are non-overlapping, which is to say that any quantitative portion of the display for any one surgical parameter does not extend circumferentially into another display sector 204 displaying a different surgical parameter. This includes any quantitative measurement scale, such as a scale indicating rotational alignment. However, purely visual elements unrelated to the surgical parameters or measurements, such as the arcs showing the inner edge of the display, may extend circumferentially without being considered "overlapping," so long as the quantitative display of the surgical parameters does not extend into another display sector 204.

The display 202 may be customized according to user-selectable surgical parameters. In particular embodiments, particular elements of the surgical parameter display may be further customized based on user preference. For example, the user may select from a variety of phacoemulsification and/or vitrectomy surgical parameters, including but not limited to power level, vacuum pressure for phacoemulsification, bottle height for irrigation solution, aspiration, footswitch position, phacoemulsification step and occlusion indicator. The user may also select minimum or maximum display values for ranged surgical parameters and displays with analog or digital values. Separating the display 202 into non-overlapping sectors 204

that can be individually selected and adjusted prevents the display 202 from becoming undesirably crowded, while still maintaining all of the information that the surgeon desires in an easily viewed format.

The surgical parameters can include any relevant operating parameter for the surgical instrumentation that is selected by the user and that is monitored or selected during surgery. The quantitative display of the parameter can be a number, a range, and on-off or other binary indicator, or any suitable visible element or combination of elements conveying relevant parameter information. In particular embodiments, real-time values can be shown on a variable gauge. Such gauges may include moving needles, bars with length that varies based on the value (e.g., vertical, horizontal, circumferential, radial), or bubble gauges, such as the ones illustrated in Figure 2. Multiple display formats may also be user-selectable.

Colored elements may also be used in the display 202 to improve visibility, contrast, and the like. For example, a lighted green display taking the form illustrated in Figure 2 would be easily visible when superimposed on the eye image. Gauges could also change color, such as changing to red when a parameter moves to an unacceptable range, when a laser source is active, or when some other notification to the surgeon might be required.

The display 202 may also include one or more axes to indicate directions on the display. For example, the display 202 may include the target axis for astigmatic correction when a toric lens is being implanted. In another example, the axis could indicate a desired incision line for lens implantation. Because the numerical and/or measurement scale displays of such lines do not extend circumferentially across sectors, they are also considered "non-

overlapping" for purposes of this specification. Consequently, the incorporation of such visual elements should not be considered for purposes of determining the non-overlapping display sectors 204.

Figure 3 shows an example selection screen 300 that can be used in conjunction with various embodiments of an ophthalmic surgical system 100 according to the present invention. The selection screen 300 confirms the procedure to be performed with the surgical instrumentation 102, the surgeon, and the patient on whom the procedure will be performed. The selection screen 300 also displays values for surgical parameters. The screen can allow selection of value ranges for the parameters, different parameters, etc., so that the user can appropriately configure the display 202 in advance of the surgical procedure.

Figure 4 is a flow chart showing an example method for displaying surgical parameters according to the present invention. At step 402, a selection screen is provided permitting selection of surgical parameters to be displayed. At step 404, a selection of surgical parameters to be displayed is received. The selection of surgical parameters may include, for example, which parameters will be displayed, what the display format will be, what range of various surgical parameters will be displayed, and the like. At step 406, the surgical parameters are displayed on non-overlapping display sectors. At step 408, the surgical parameters are monitored during the surgical procedure. At step 410, the display is updated based on a change in the surgical parameters. Steps 408 and 410 may be continuously performed until the surgical procedure is complete, as shown by decision step 412, at which time the method is at an end.

Embodiments described above illustrate but do not limit the invention. It should also be understood that numerous modifications and variations are possible in accordance with the principles of the present invention. Accordingly, the scope of the invention is defined only by the following claims.

CLAIMS

1. An ophthalmic surgical system, comprising:

a display device for generating an overlay display on an image of an eye, the display device projects the display in the optical path of a surgical microscope,

a user interface for receiving a user selection of one or more user-selectable phacoemulsification or vitrectomy parameters to be displayed,

wherein the display device displays, on an image of an eye, a plurality of non-overlapping display sectors falling within a circle centered at the center of the display, each display sector displaying one of the user-selectable phacoemulsification or vitrectomy parameters.

2. The system of Claim 1, wherein the overlay display further comprises any one of a target axis for aligning a toric lens, or an incision guide.

3. The system of Claim 1, wherein the user-selectable phacoemulsification or vitrectomy parameters include any one of a vacuum pressure, a power level, or indicate activity of a laser source.

4. The system of Claim 1, wherein at least one of the user-selectable phacoemulsification or vitrectomy surgical parameters is displayed as a variable gauge.

5. The system of Claim 4, wherein the variable gauge is a bubble gauge.

6. The system of Claim 1, wherein the display device displays a lighted display.

7. The system of Claim 1, wherein the display device projects the display onto the eye.

8. A computer-implemented method of displaying surgical parameters on an ophthalmic surgical system with a display device to project the display in the optical path of a surgical microscope, comprising:

receiving a selection of at least two user-selectable phacoemulsification or vitrectomy parameters; and

generating an overlay display on an image of a patient's eye comprising a plurality of non-overlapping display sectors, falling within a circle centered at the center of the display, each display sector displaying one of the user-selectable phacoemulsification or vitrectomy parameters.

9. The method of Claim 8, further comprising displaying a selection screen to a user.

10. The method of Claim 8, wherein the overlay display further comprises a target axis for aligning a toric lens, or an incision guide.

11. The method of Claim 8, wherein the user-selectable phacoemulsification or vitrectomy surgical parameters include any one of a vacuum pressure, a power level, or indicate activity of a laser source.

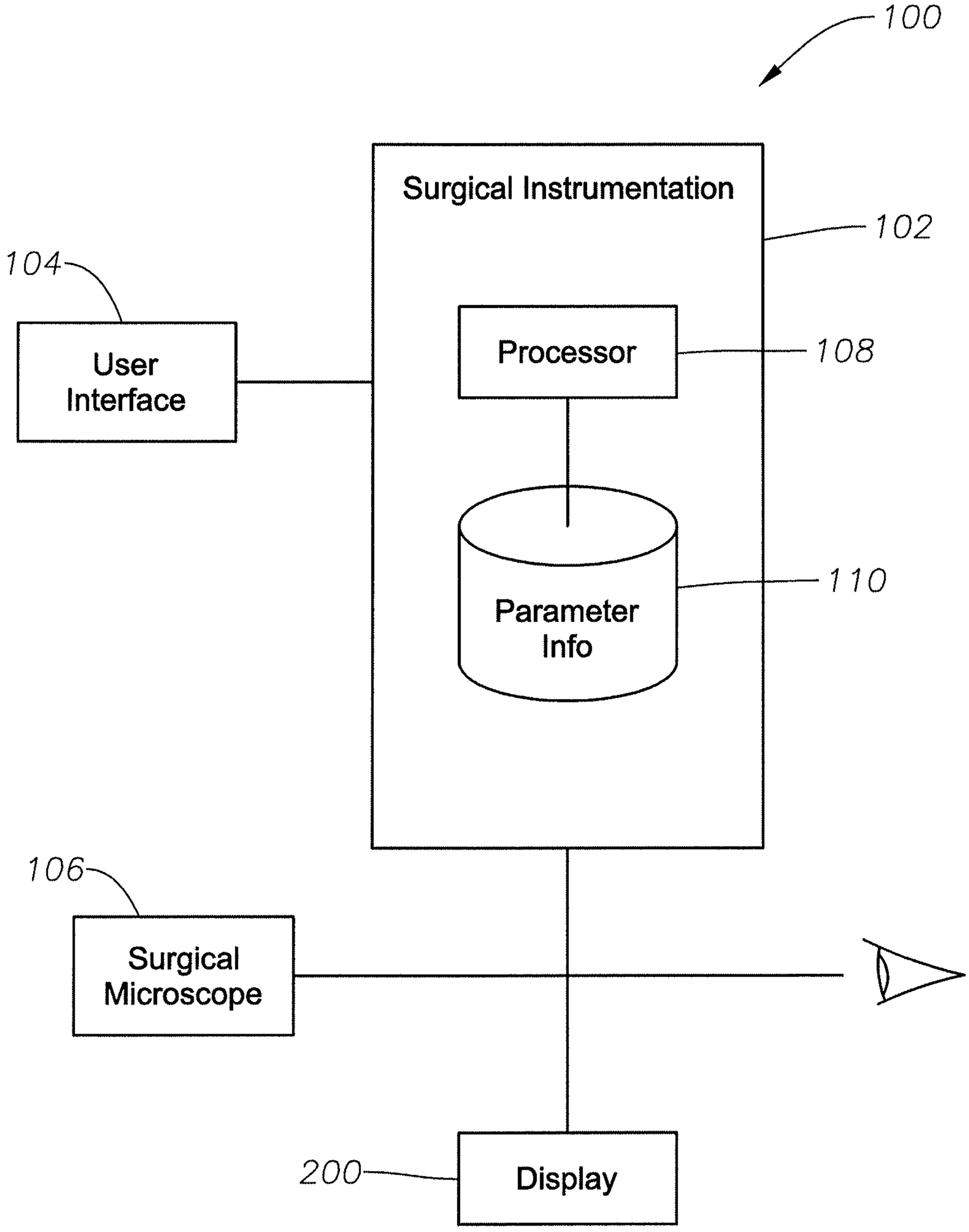
12. The method of Claim 8, wherein at least one of the user-selectable phacoemulsification or vitrectomy surgical parameters is displayed as a variable gauge.

13. The method of Claim 12, wherein the variable gauge is a bubble gauge.

14. The method of Claim 8, wherein the display device is lit.

15. The method of Claim 8, wherein the display device projects the overlay display onto the eye.

Fig. 1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102
104
User Interface
Processor
108
Parameter Info
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Surgical Microscope
200
Display

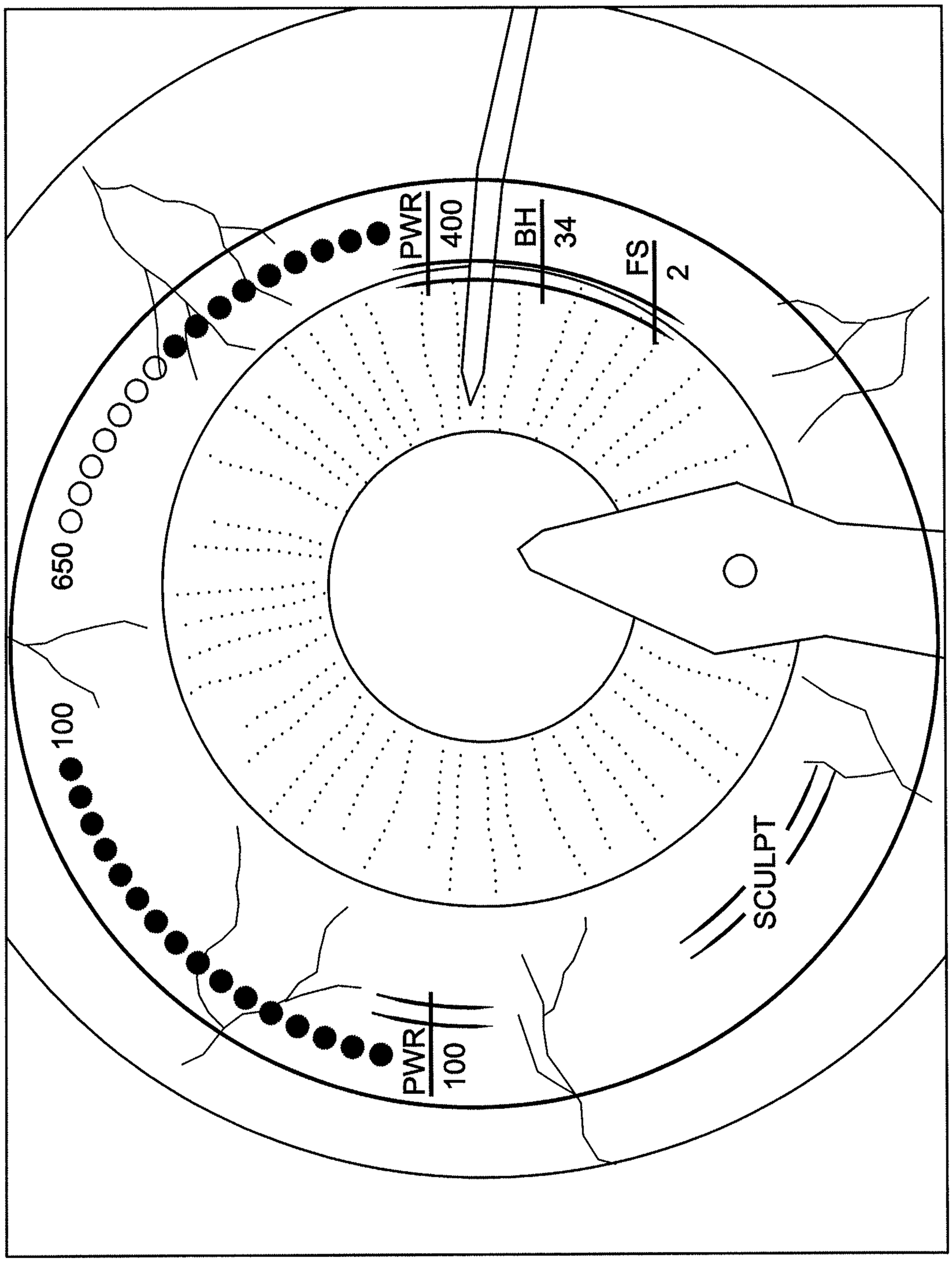
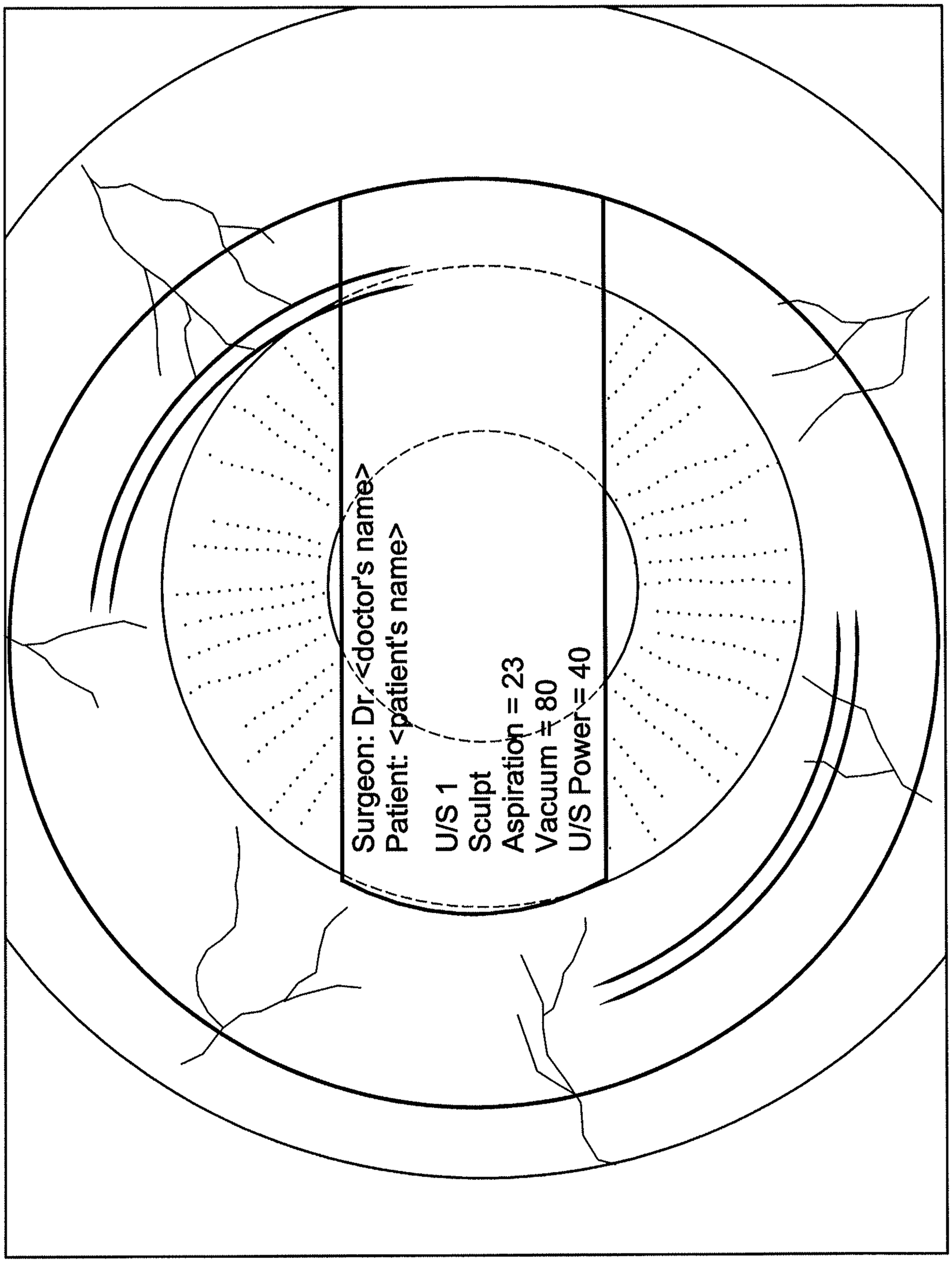


Fig. 2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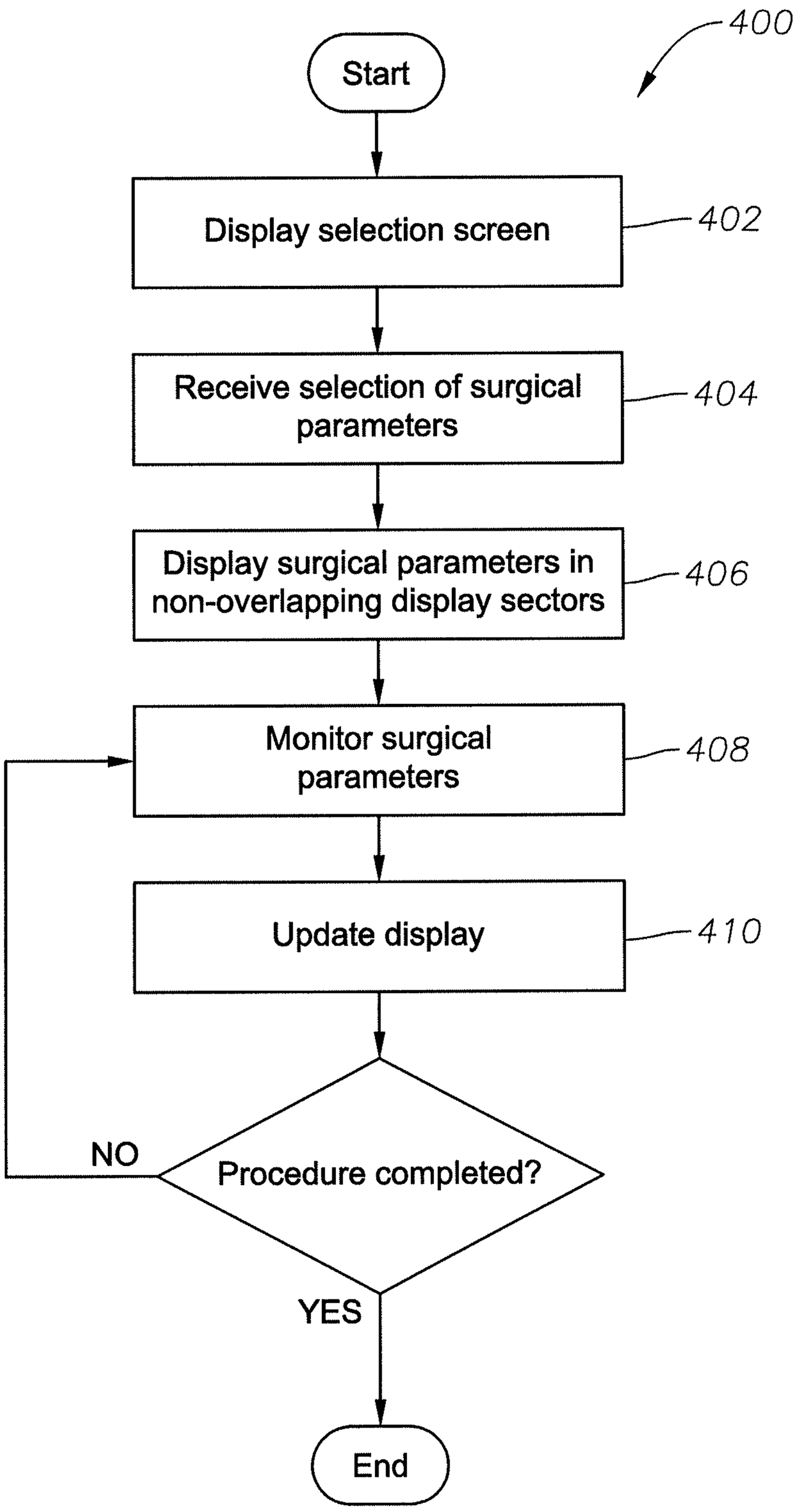
Patient: <patient's name>
U/S 1
Sculpt
Aspiration = 23
Vacuum = 80
U/S Power = 40

Fig. 3

Fig. 4


400
Start
Display selection screen
402
Receive selection of surgical parameters
404
Display surgical parameters in non-overlapping display sectors
406
Monitor surgical parameters
408
Update display
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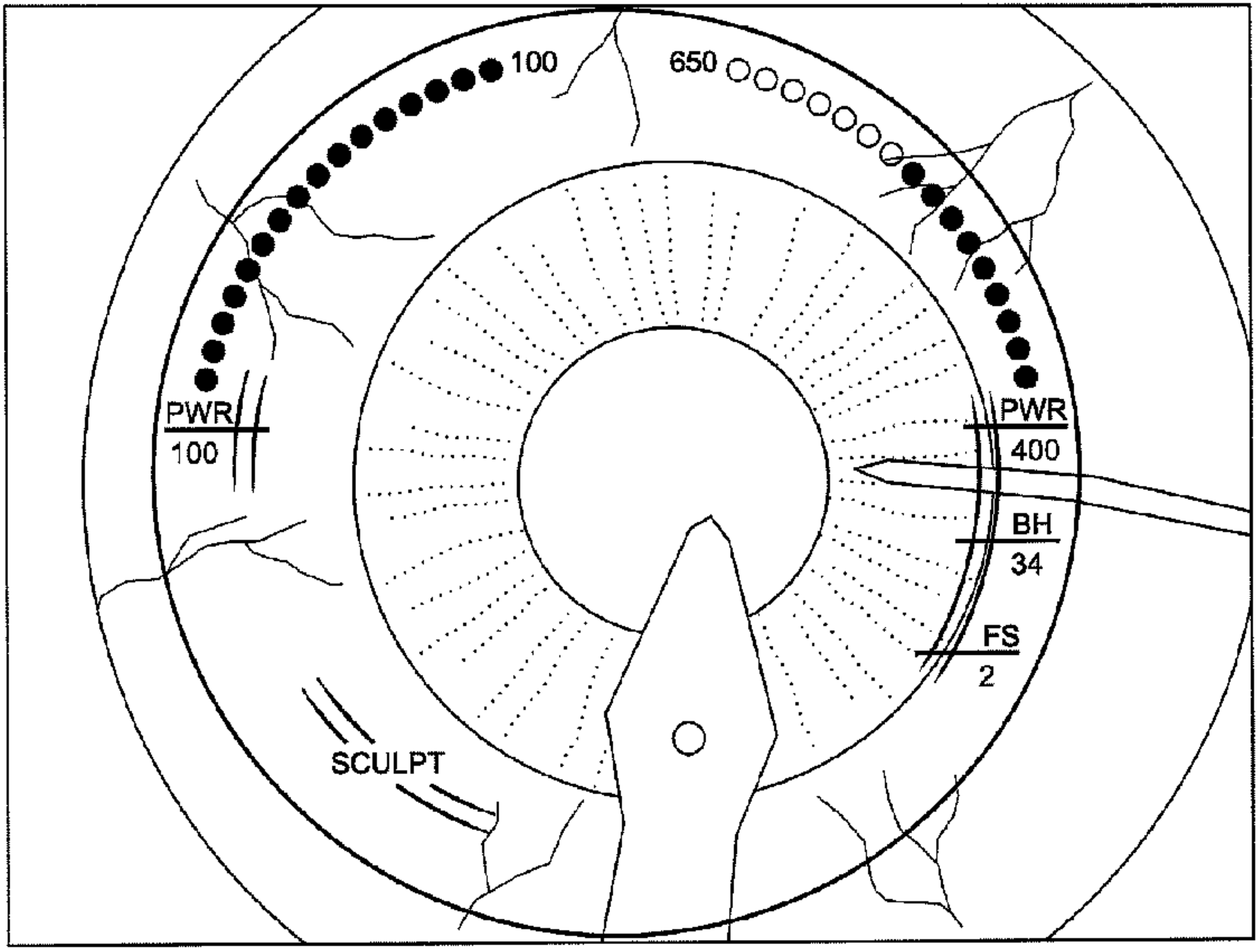
Procedure completed?
NO
YES
End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