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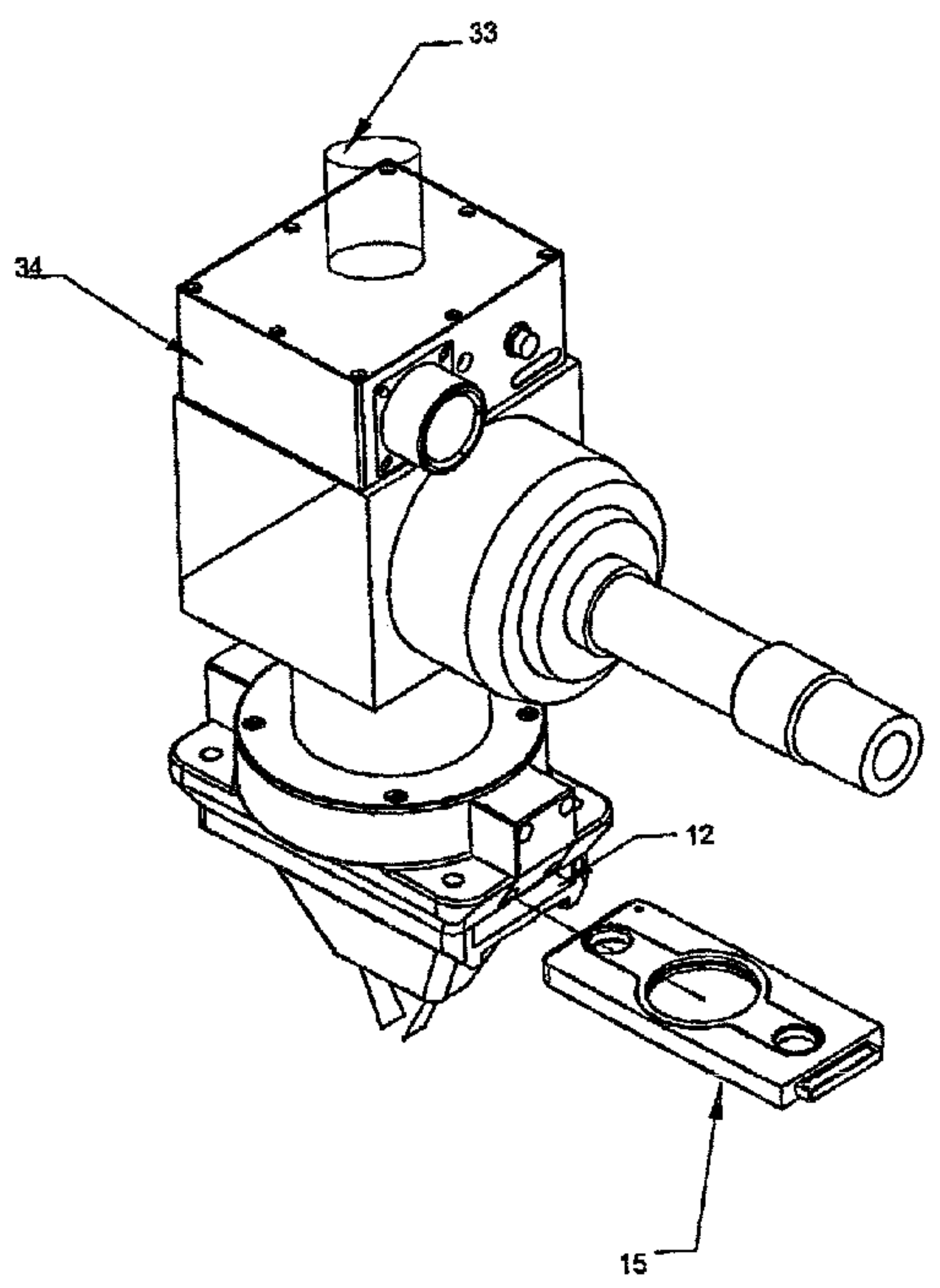
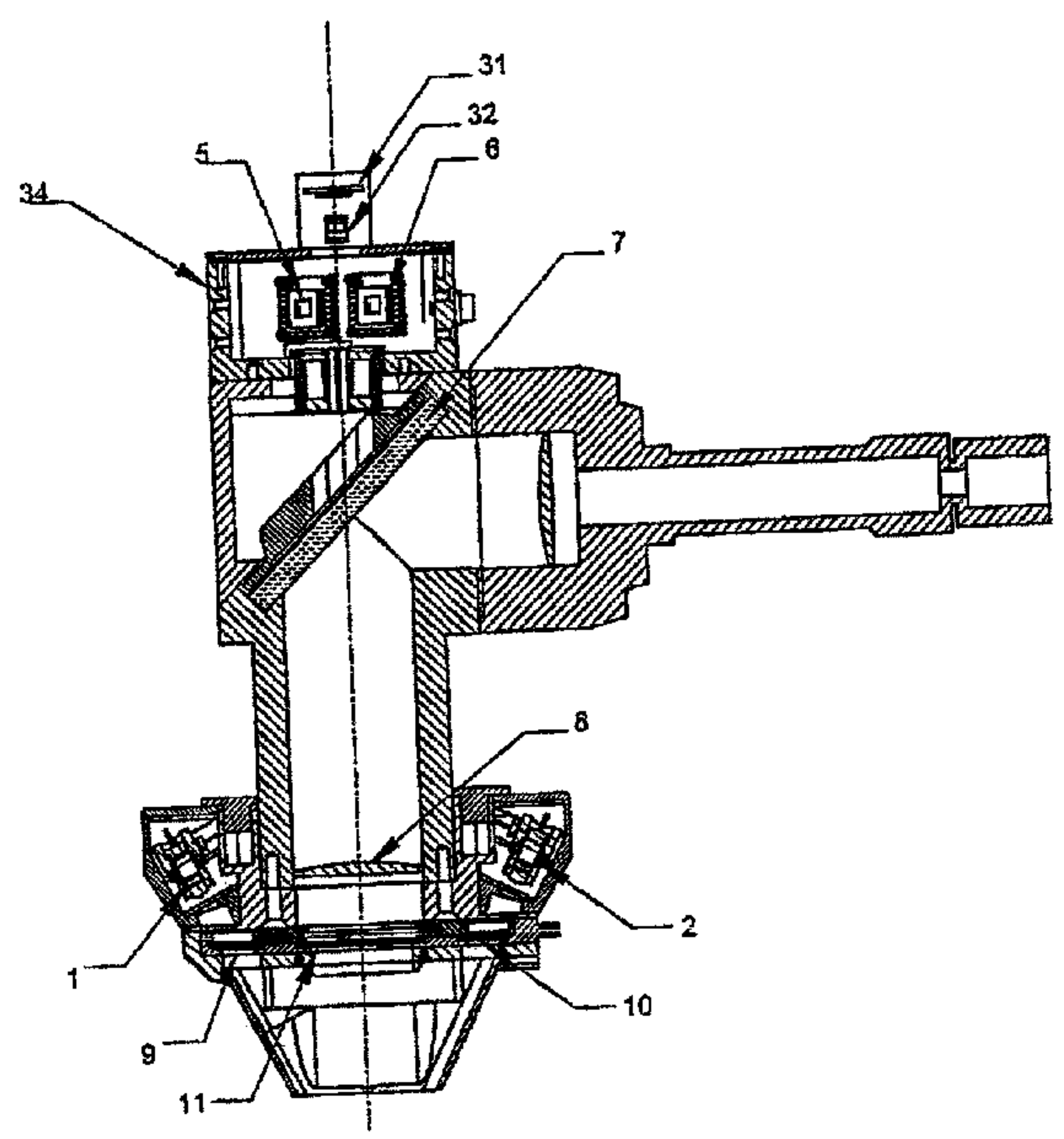
(54) Titre : TETE INTELLIGENTE DE LIAISON A UN LASER
(54) Title: INTELLIGENT LASER JOINING HEAD





Intelligent Laser Joining Head

Purpose of the invention

A single body apparatus for executing laser processing such as laser joining, laser surface cladding, joint tracking and seam inspection simultaneously.

Problem solved

As part of the manufacturing process, laser joining and laser cladding use the energy of a focused high-power laser beam on a small area. In order to automate the process, a control and monitoring system is necessary to minimize the rejected parts due to defects associated with the position of the focal point of the high-power laser beam with respect to the workpiece and other variables. The proposed control and monitoring system will correct for any error in position and fit-up of the parts to be processed and for errors in the programmed laser beam trajectory and laser parameters by the use of an integrated 3-D vision system. After the process point, an integrated 3-D vision system is also used to validate the quality of the result of the process, bond or joint. The complete process area can be viewed and monitored through the coaxial vision channel.

Current tracking and inspection systems are not able to deal with curvilinear joints while welding using high power laser without using cumbersome rotating devices that prevent the vision system to view close to the processing area.

This situation causes two major constraints.
-The necessary space of all required devices to execute all these tasks is too large for easy access to the part without being stopped by the tooling.
- The distance between the process point and the inspection point are too large to enable high accuracy of measurement and quick control action.

The present invention incorporates in a compact construction and in the same body all the necessary elements to perform these tasks. The rotation of the tracking/inspection module is also provided within the apparatus.

Description of the drawings

Figure 1 shows the exterior and the interior of the complete laser welding head with fixed sensors and laser line generators assemblies.

Figure 2 shows three views of the laser welding head with the rotating sensors assembly and the laser line generators assembly.

Figure 3 shows the exterior and the interior of the complete laser welding head with rotating sensors and laser line generators assemblies.

Figure 4 is a detailed view of the nozzle and the protective lenses assembly.

Figure 5 is a detailed view of the complete laser processing head with fixed sensor assembly and rotating laser line generators assembly.

Description of the invention

Laser light generators 1 and 2 project planes of laser light at an angle, in front and behind the process laser beam, through the protective lenses 9 and 10. The intersection of these planes with the work pieces produces laser lines 3 and 4. Inside the sensing module 34, the 2-D imager sensor 5 detects the laser line 4 through the semi-reflective mirror 7, the focusing lens 8 and the protective lens 11. The 2-D imager sensor 6 detects the laser line 3 through the semi-reflective mirror 7, the focusing lens 8 and the protective lens 11. The laser light generator 1 and the sensor 6 measure the depth profile along the laser line 3, using a well known optical triangulation principle. This depth profile provides geometric information about the joint. This information can be used by an external image processor system to provide the joint tracking and monitoring, and adaptive process control functions. The laser light generator 2 and the sensor 5 measure the depth profile along the laser line 4, also using a well known optical triangulation principle. This depth profile provides geometric information about the seam. This information can be used by an external image processor system for inspection and quality control. The integration of the 3-D vision sensors with the laser welding head reduces the size of the complete device, compared to a standard laser welding head equipped with external 3-D vision sensors for joint tracking and weld bead inspection, thus enabling easy access to the work piece and making the device easy to apply with a robot or automatic machine. With this integration, the laser lines can be closer to the focal point of the process laser beam thus reducing the errors in the evaluation of the position of the focal point relative to the position of the joint. As an alternative, only one laser line can be projected. In this case, only one 2-D imager sensor would be used to detect this laser line.

In figure 3, a 2-D imager sensor 31 detects the complete process area through the lens 32 and coaxially through the optical path of the process laser beam, including the area in front of the molten material, the surface of the molten material itself and the solidified area behind the molten material. The information from this sensor is used for monitoring and control of the process laser source for adaptive process control, including process speed, laser beam weaving and others.

As shown in figures 2 and 3, the assembly 14 that contains the laser light generators 1 and 2, and the protective lenses 9, 10 and 11, can be installed on a bearing 24 to rotate around the main process laser beam axis. A double-shaft motor 19 is linked with the assembly 14 through a timing belt 20 and with the rotating sensor assembly 21 through a timing belt 22. This arrangement rotates the assemblies 14 and 21 synchronously. A digital encoder 23 provides the angular position of the rotating mechanism. The rotation of the assemblies 14 and 21 allows parts with small joint radius to be processed and inspected continuously at high speed. As shown in figure 5, if only one sensor is used to detect the two laser lines 3 and 4, it would also be possible to rotate only the assembly 14, keep the sensor assembly 21 fixed and process the information from the sensor in order to compensate for the rotation of the laser lines.

The tracking laser line and inspection laser line are symmetrically disposed respectively to the main process laser beam. The functions of the tracking module and the inspection module can be exchanged to reverse the processing direction without rotating the assembly 14.

The assembly 14 has a slot 12 into which a cartridge 17 slides. This cartridge 17 supports a protective lens holder 15 that contains three protective lenses 9, 10 and 11. A lens cover 16 holds the lenses in place. The cartridge 17 has gas channels 25 that bring pressurized gas through the holes 26 into a cavity 27. The compressed gas fills the cavity 27 below the lens holder 15 and exits through the openings 28 into the nozzle 18. The main function of this nozzle is to extend the protection in front of the disposable protective lenses. The pressurized gas flow prevents the welding fumes from reaching the protective lenses. The nozzle 18 covers the processing laser beam 13 and the planes of laser light. The processing laser beam and the two planes of laser light are protected from spatters and fumes with a single part.

We claim:

1. A joining device that integrates in a single casing all the components required for laser processing, joint monitoring, joint tracking, inspection.

2. A joining device as in claim 1 that provides the rotation of the sensing devices.

3. Laser triangulation through the processing laser optical path for joint tracking and seam inspection.

4. Vision sensors which view the complete process area coaxially through the optical path of the process laser beam, including the area in front of the molten material, the surface of the molten material itself and the solidified area behind the molten material.

5. The tracking laser line and inspection laser line can be rotated around the main processing laser axis in order to track, process, weld and inspect curved trajectories while installed on a gantry positioning system or process robot.

6. Synchronous rotation of the laser line generator and the 3D vision module. This is achieved by using a single motor and two timing belts.

7. Rotation of the laser line generators only while 3D vision module will remain still. The necessary correction of the 3D field is made by software.

8. Collimation optics and laser line generators protected by disposable lenses, the protection being made by creating a positive pressure in front of the disposable lenses.

9. Disposable lenses placed in a single special design cartridge and secured with a lens cover to prevent the accidental slip out of the lenses.

10. A cartridge design incorporating the main protective lens and the laser line generator protective lenses.

11. A single nozzle that extends the pressurized gas protection in front of the disposable protective lenses.

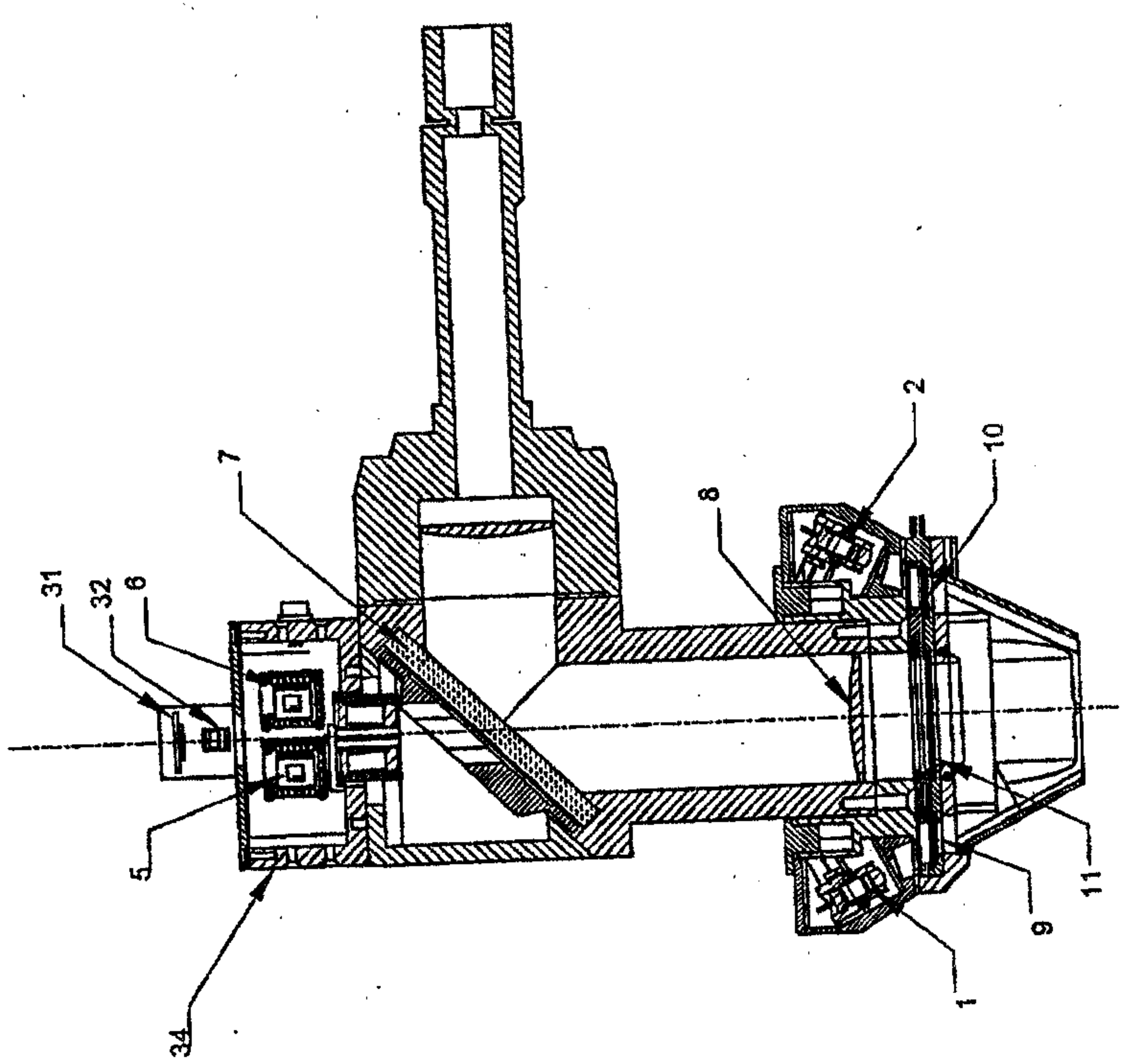
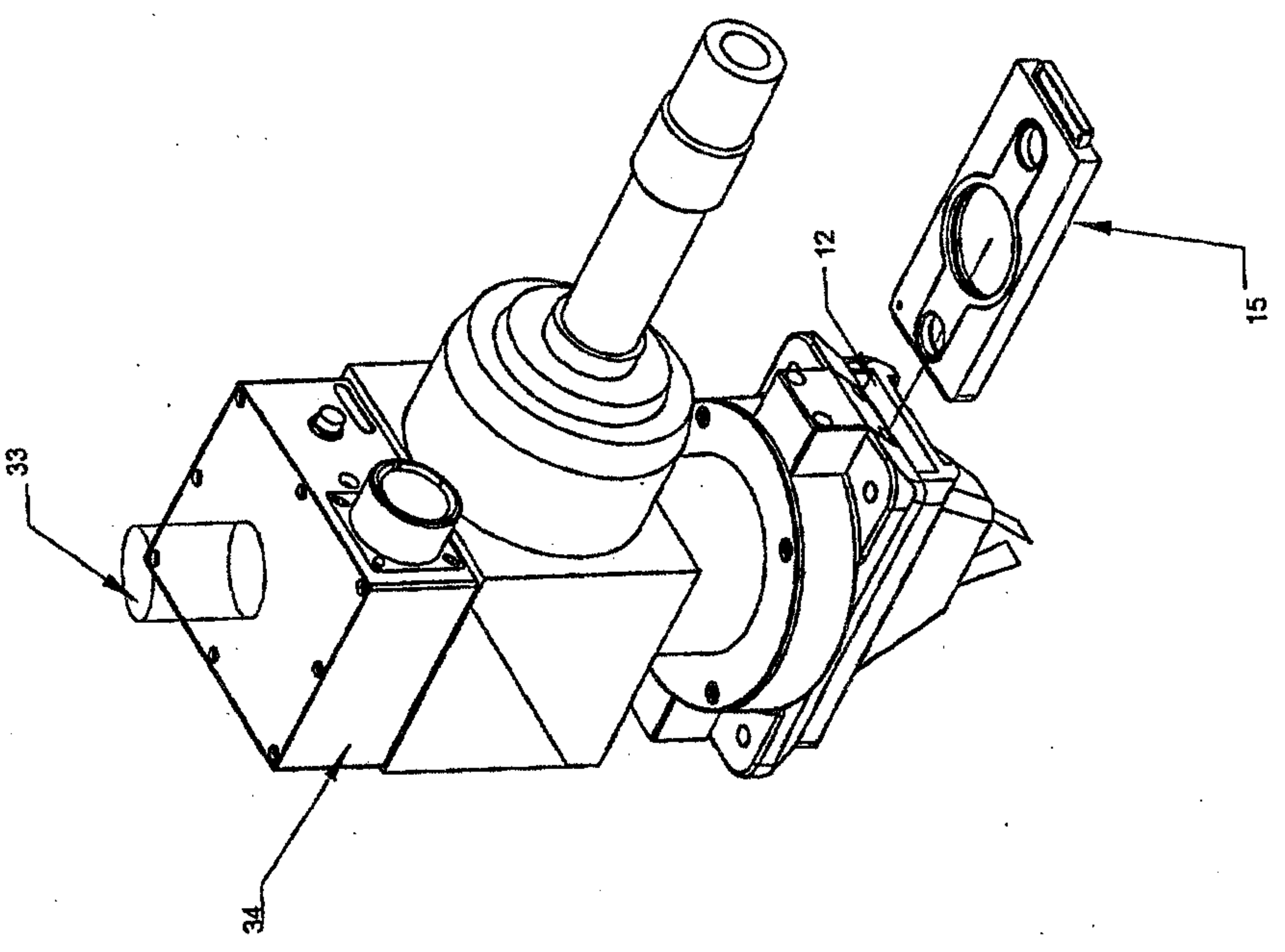


Fig. 1



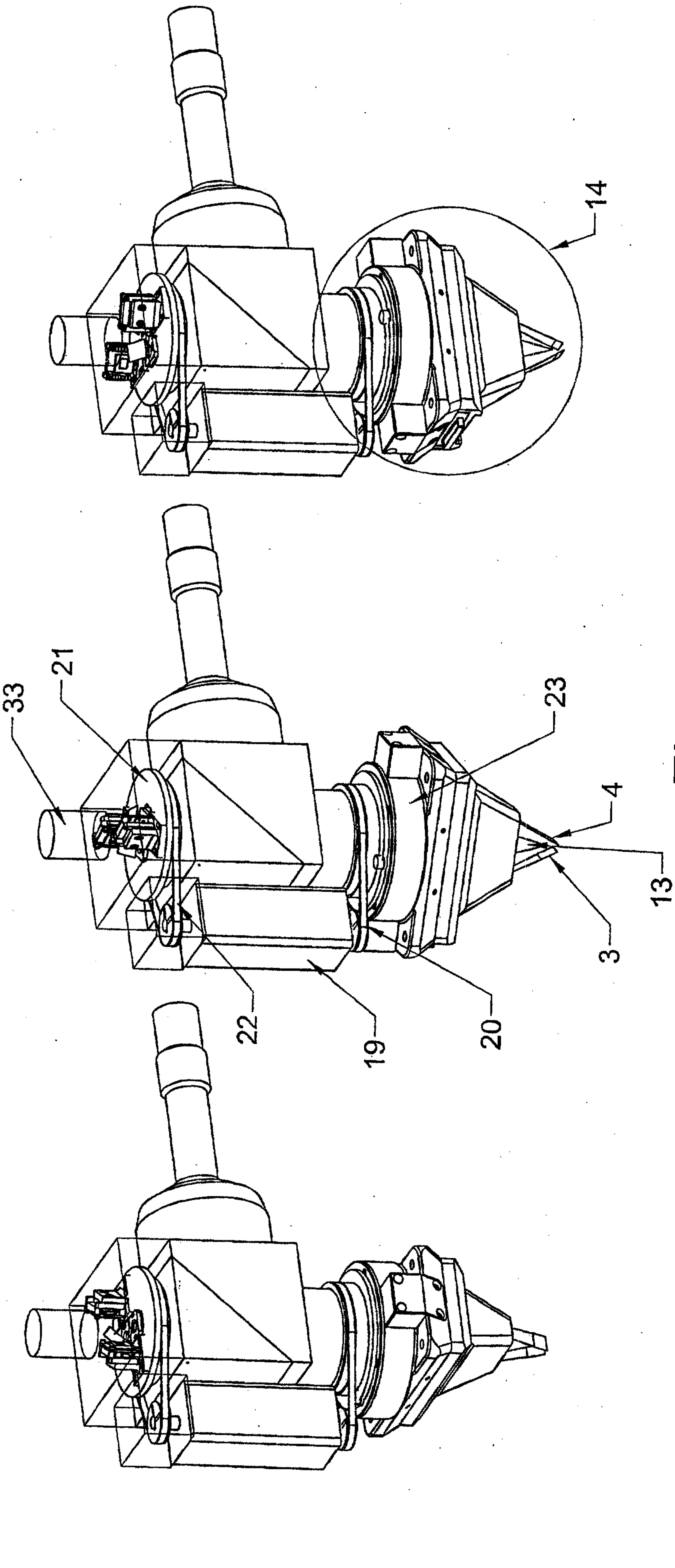


Fig. 2

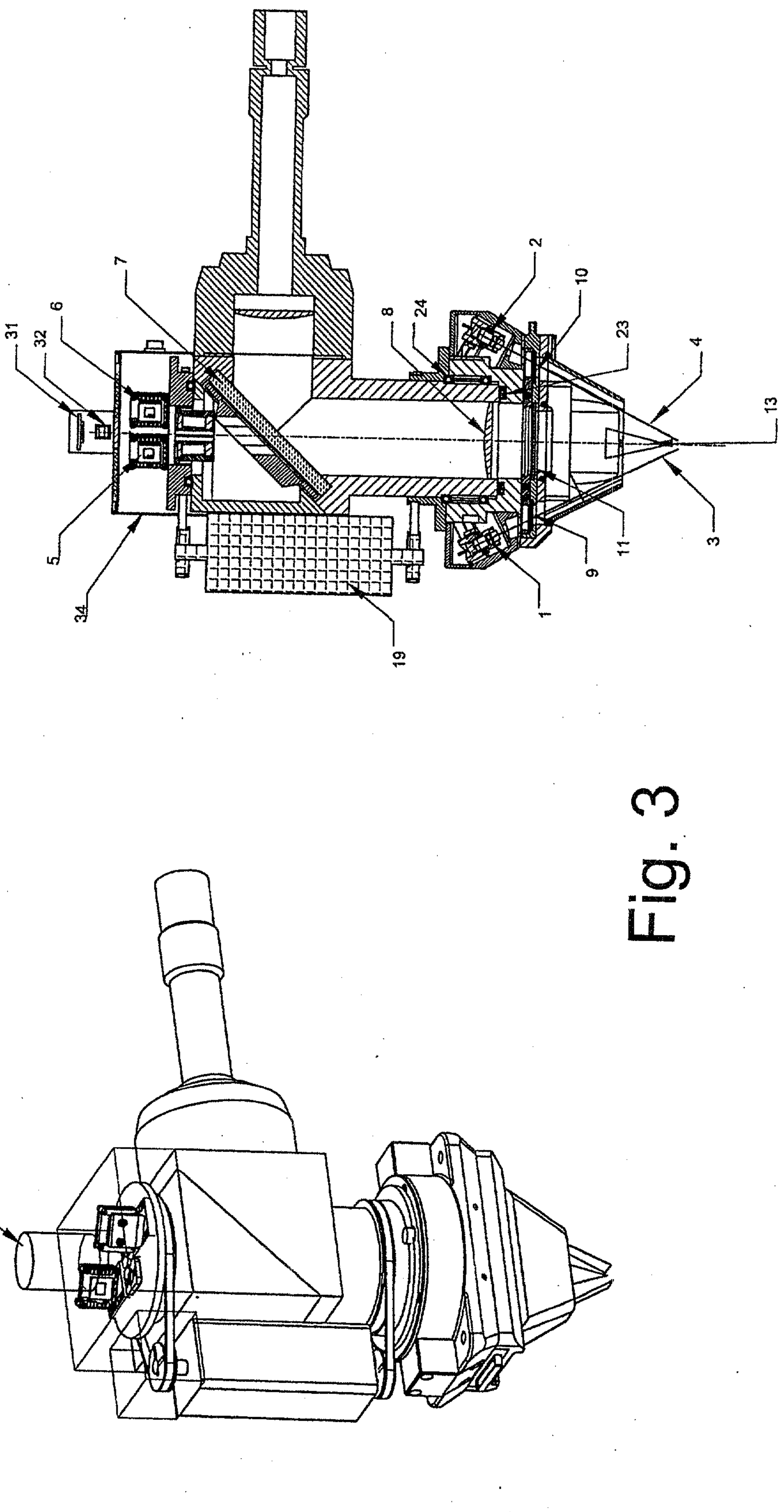


Fig. 3

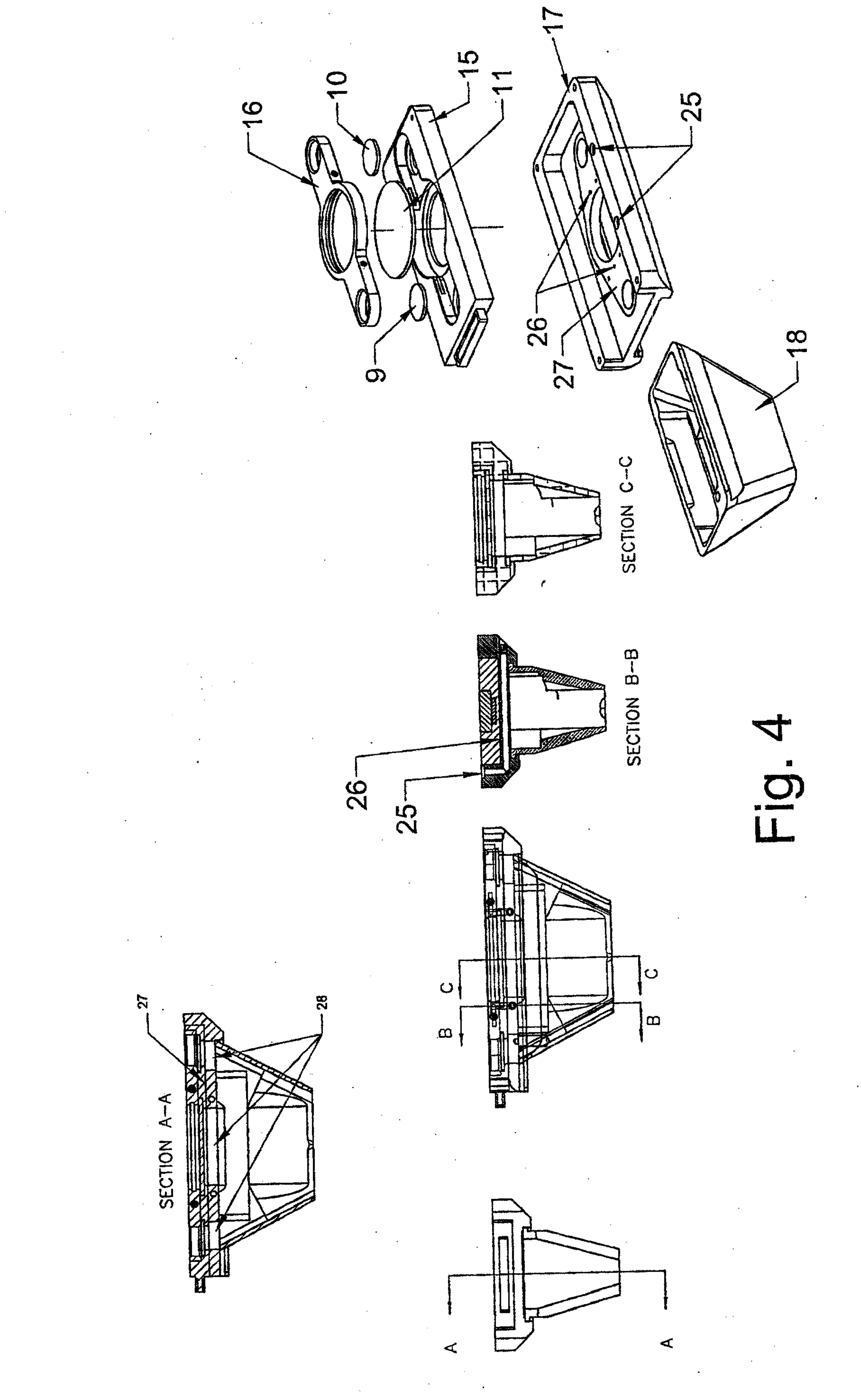

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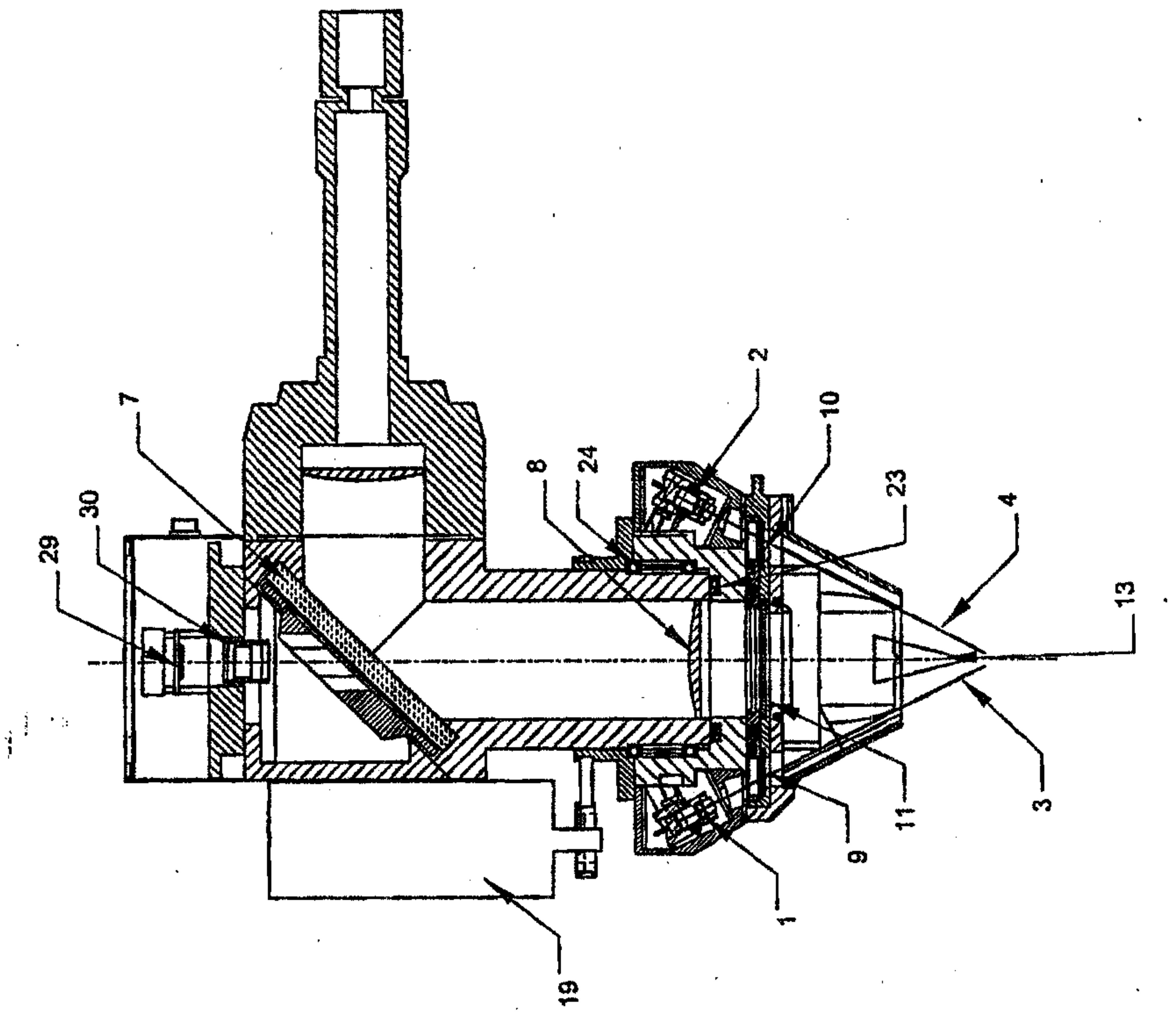
Fig. 4



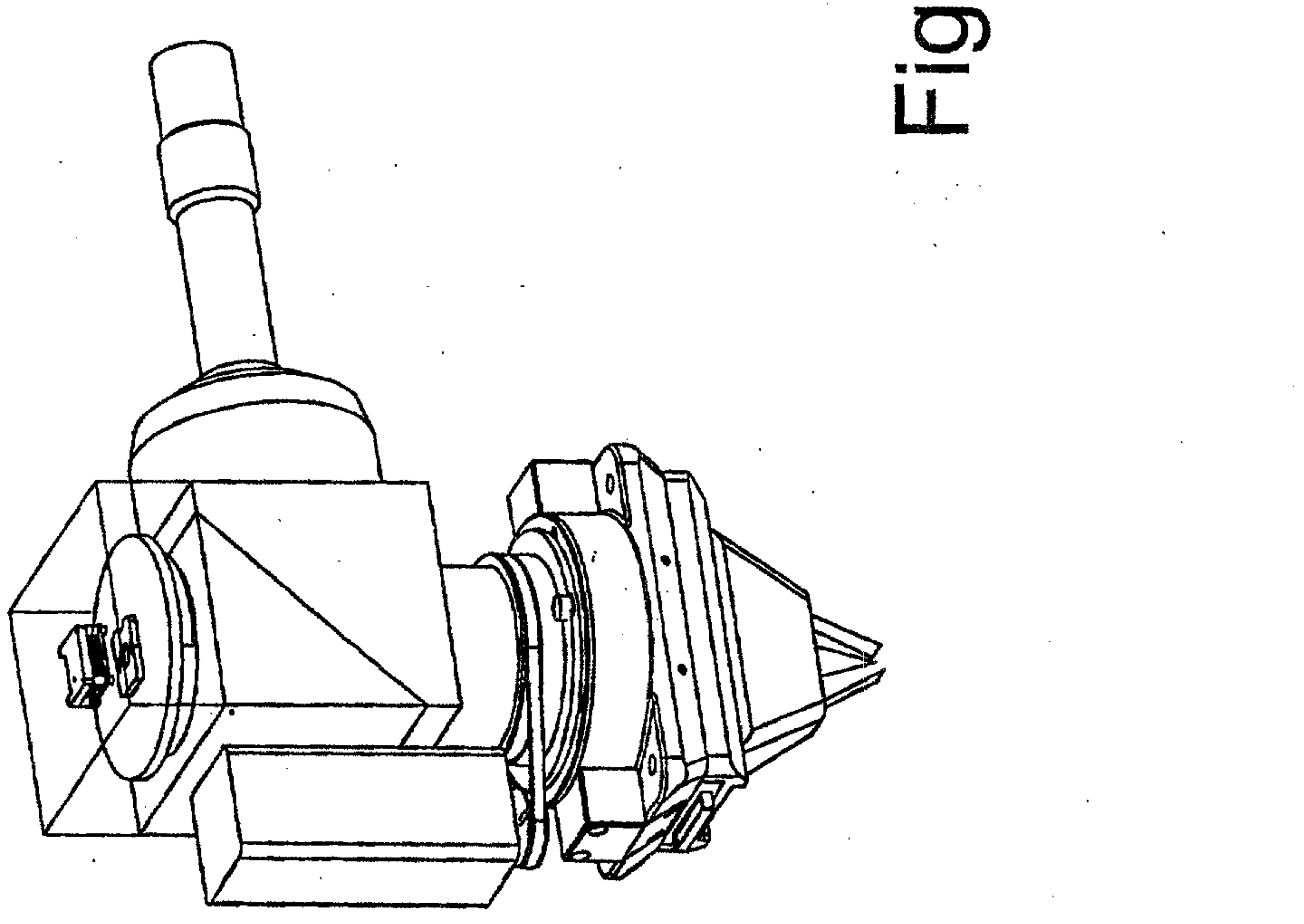
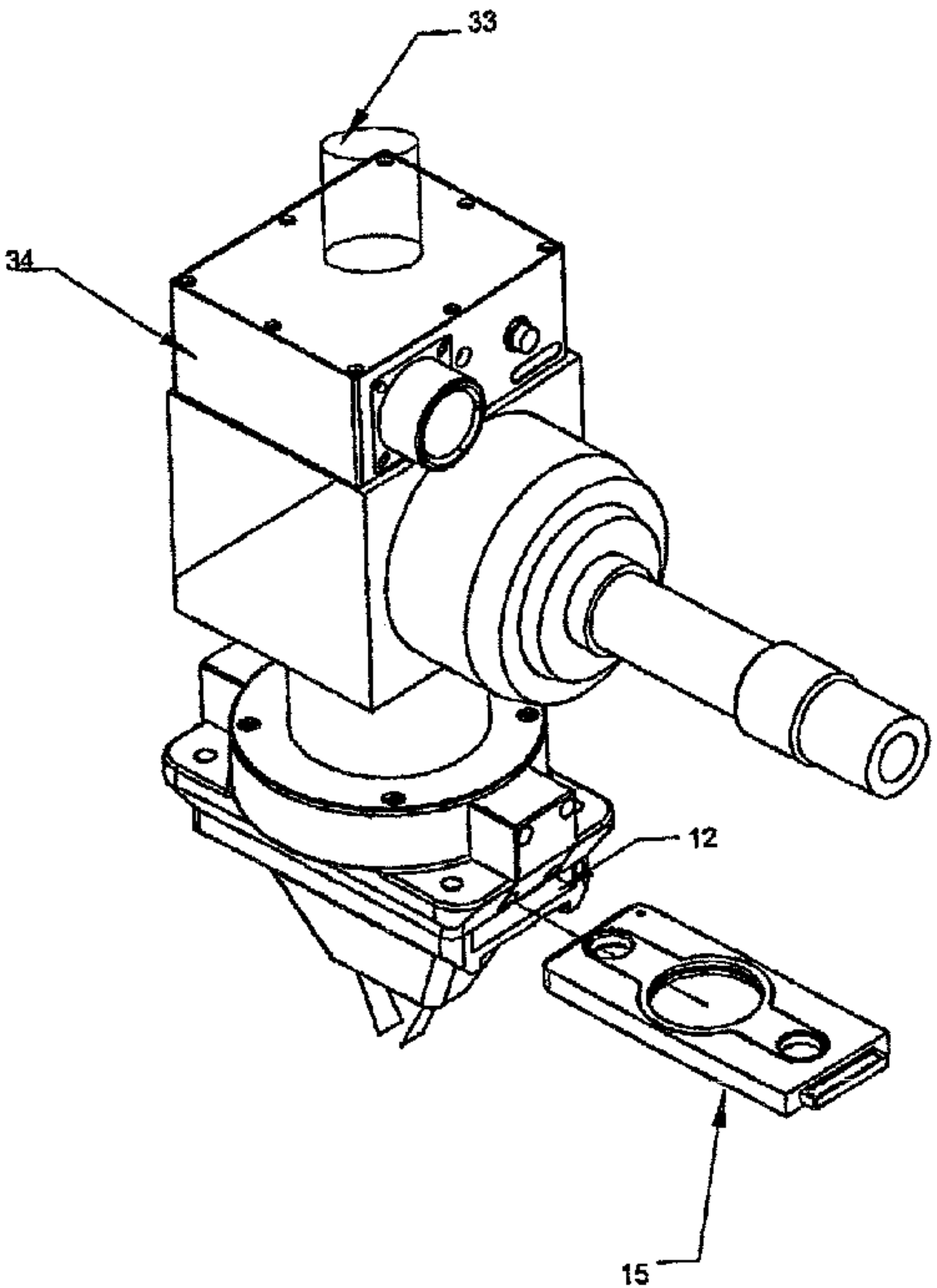


Fig. 5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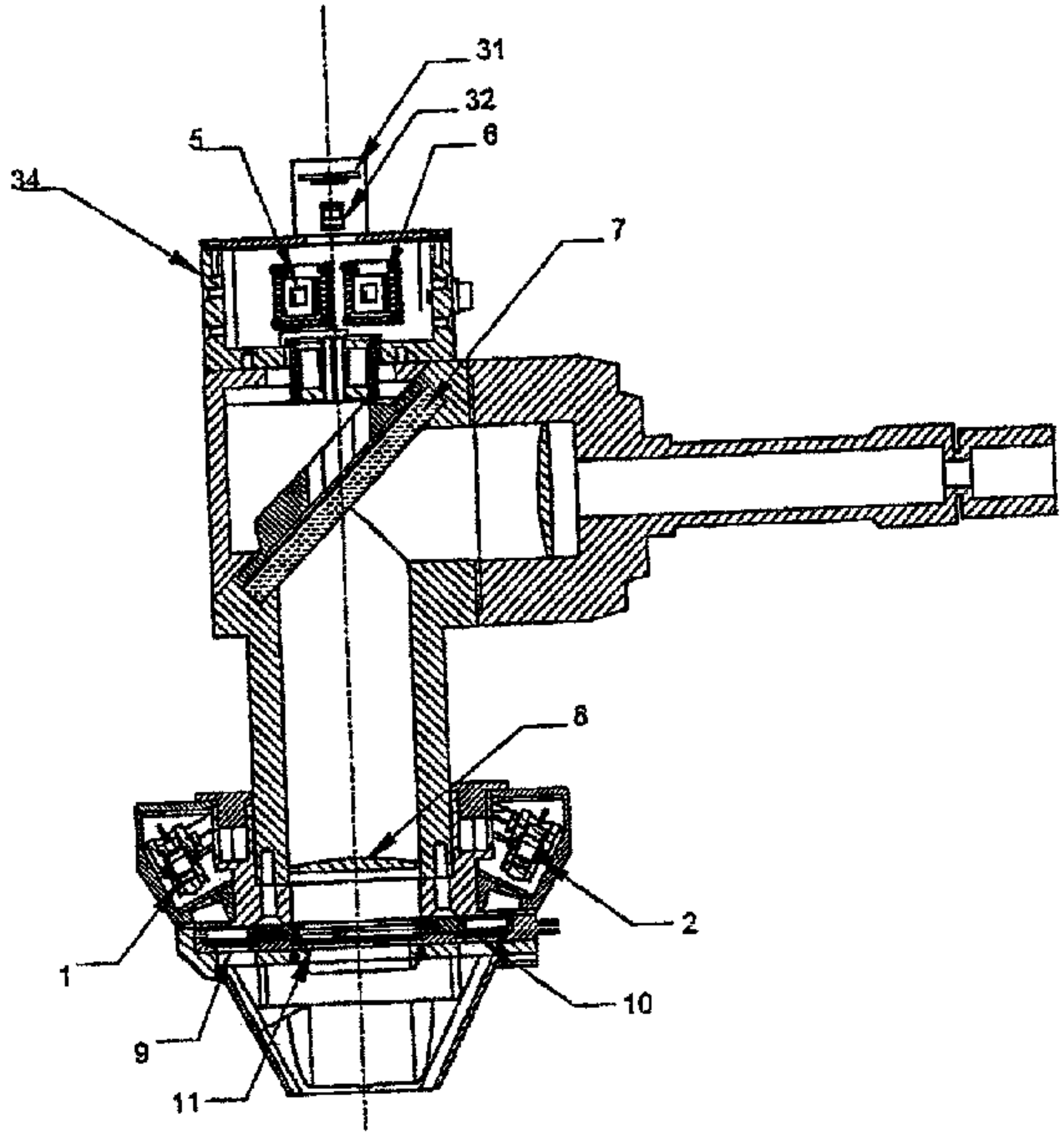
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