**TECHNICAL SOLUTION PROPOSAL** **Reference: J2017-001**

**Title: „Apparatus and method for defusing unexploded ordnance“**

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**Description:**

The proposed technical solution deals with a device and a method for defusing unexploded ordnance. Newly developed fuse concepts are usually tested within the framework of firing tests. It can happen that a fuse of a projectile does not ignite due to a malfunction. Various devices are known from the state of the art for disarming such duds. WO 9424513 A1 describes a device and a method for destroying bodies filled with explosives. In this process, the bodies - such as projectiles - are detonated inside a bursting chamber. DE 199 21 839 A1 describes a similar process: In order to disintegrate ammunition, it is detonated in an enclosed space by firing armour-piercing projectiles at it in a targeted manner. What these approaches have in common is that the projectiles and thus also the detonators are completely destroyed. A subsequent analysis of what led to the malfunction of a detonator is therefore no longer possible. In order to make this possible, up to now personnel equipped with splinter protection suits had to remove the fuze from the projectile by hand, for example by unscrewing it.

**Task**

The task of the proposed technical solution is to specify a method and a device which permits separation of the fuze and the projectile with the greatest possible protection of the personnel. In particular, it is the task of the proposed solution to specify a method and a device which make it possible to subject the fuze of a projectile to a subsequent analysis.

**Solution**

The proposed technical solution proposes to detect the unexploded ordnance in a first step by means of a mining excavator or a mining robot. If a recovery excavator is used instead of a remote-controlled recovery robot, the recovery excavator is preferably equipped with a splinter shield to protect the operator of the recovery excavator from splinters in the event of unintentional ignition of the detonator or the projectile. In a second step, it is intended to insert the projectile with the aid of the excavator or the remotely controllable excavator robot into a holding device of the device according to the proposed solution, which allows an operator to remotely remove the detonator from the projectile in order to be able to examine it afterwards.

The device according to the proposed solution is therefore designed in such a way that it can be operated via a control panel and a remotely readable camera.

The proposed solution is based on the realisation that a control panel can be placed in a safe area, such as a bunker, away from a device to be operated with it. In this way, all the necessary process steps can be carried out by an operator without him having to be in the vicinity of the device and thus possibly putting himself in danger. Furthermore, the proposed solution is based on the realisation that the disarming process and the reliable removal of a detonator from a projectile can be monitored by an operator from a safe environment by means of a remotely readable camera and, in addition, operation of the device by means of the control panel is simplified for the operator, as he can check via the camera whether all process steps are carried out properly.

In one embodiment of the proposed solution, the device comprises a support platform for the unexploded ordnance, on which the projectile can be deposited by means of a recovery excavator or recovery robot. The salvage robot - like the device - can practically be operated via the control panel located in a safe environment. The conveniently replaceable support platform forms a support surface for the projectile and is advantageously located between at least two clamping jaws of the holding device.

In one embodiment, the holding device is designed in the manner of a vice and the two clamping jaws can be provided with spacers adapted to the shape and diameter of the projectile, depending on the type of projectile. Due to the interchangeability of the support platform and the spacers of the clamping jaws, the holding device can be easily adapted to projectiles of different diameters and/or lengths. The clamping jaws and/or the spacers may be made of metal and provided with serrations. Conveniently, at least one of the two clamping jaws can be moved between the at least two clamping jaws by means of a working cylinder in order to fix the projectile, particularly preferably both clamping jaws can be moved symmetrically towards and away from each other by means of the working cylinder. In particular, a pneumatic, hydraulic or electric cylinder is used as the working cylinder, which can be controlled by an operator via the control panel. It is particularly preferred that the working cylinder is a pneumatic cylinder, as it is infinitely adjustable through its control by compressed air and thus allows a simple fixation of projectiles of different diameters.

In one embodiment, the retaining device comprises a guide receptacle for a tail unit of the projectile in an end region. This guide receptacle can have at least two lateral, in particular strut-shaped guide means and/or a plate-shaped end stop which runs essentially perpendicular to the clamping jaws of the holding device. Both the guide means and the end stop can be made of metal.

The device according to the proposed solution further comprises a movable cutting bell for dismantling the fuze from the projectile

In one embodiment, the cutting bell is held in a holder, advantageously in a tube. The cutting tool located in the cutting bell can be activated by a drive, preferably an electric motor. Depending on the diameter of the fuze, an appropriate conical cutting tool is selected. If the mouth hole of the projectile into which the fuze is screwed has a right-hand thread, a cutting tool with a left-hand thread is required; if the mouth hole has a left-hand thread, a cutting tool with a right-hand thread is required.

In order to be able to move the cutting bell along its longitudinal axis towards the projectile and away from it again, it is advantageously mounted on a carriage together with its holder and its drive. The cutting bell, the holder and the drive for the cutting bell can be moved by means of a drive connected to the carriage. Practically, an electric motor with spindle and spindle nut is used as the drive for the slide.

The cutting bell or its holder and the holding device for the projectile are preferably aligned with each other in such a way that the longitudinal axis of the cutting bell is virtually identical in its extension to the longitudinal axis of the holding device for the projectile. This ensures that the cutting bell and the fuze nose are at least roughly aligned with each other when the projectile is placed on the support platform.

Both drives - for the cutting bell or cutting tool and for the carriage - are conveniently designed so that they can be operated by one operator via the control panel.

It is advantageous if there is a compression spring between the cutting bell and the drive or drive motor for the cutting tool. This means that when the cutting bell via the slide towards the projectile, a pre-tension can be created between the fuze nose and the cutting bell via the pressure spring, which ensures better gripping of the fuze nose by the cutting tool of the cutting bell.

In one embodiment, the device according to the proposed solution comprises two clamping jaws which can be moved, preferably by means of working cylinders, and which can be used to fix the ignition booster of a fuze which has been unscrewed from a projectile. The clamping jaws can be made of metal, be provided with toothing and have a shape adapted to the outer contour of the ignition booster. The working cylinders are advantageously pneumatic cylinders and can be operated via the control panel.

In one embodiment, the device according to the proposed solution comprises a cover means movable via a working cylinder for retracting the cover means in front of the mouth hole of the projectile after the fuze has been unscrewed from the projectile. In this way, in the event of unintentional ignition of the fuze or fuze booster, over-ignition of the projectile can be avoided. The covering means may be a steel plate. The working cylinder is preferably a pneumatic cylinder that can be operated via the control panel.

In addition to the two previously mentioned process steps of retrieving the projectile and depositing the projectile in the holding device of the device according to the proposed solution, the process according to the proposed solution preferably also comprises one or more of the following process steps:

- *Moving the carriage by means of its drive in the direction of the projectile placed in the holding device, preferably until the cutting bell engages around the fuze nose and the tail of the projectile rests against the end stop of the guide receptacle. This achieves an adjustment between the cutting bell and the fuze nose.*
- *Closing the clamping jaws of the holding device by means of the working cylinder. This fixes the bullet in the holding device and prepares it for the next process step.*
- *Activation of the drive for the cutting tool of the cutting bell, preferably for at least 1 - 2 revolutions. As a result, the cutting tool cuts into the ogive of the igniter or clasps tightly.*
- *After detection of the start of the detonation process of the fuze from the bullet via the camera, the carriage is moved back/away while the activated cutting tool continues the unscrewing process of the fuze from the bullet until the fuze is completely removed from the bullet. Conveniently, the speeds of the drives for the slide and the cutting tool are coordinated with each other.*
- *Defined movement of the carriage by its drive away from the projectile until the ignition booster of the igniter fixed in the cutting bell is at the level of the two clamping jaws movable by means of working cylinders for fixing the ignition booster and subsequent closing of the clamping jaws by means of the working cylinders for fixing the ignition booster.*
- *The cover is retracted via the working cylinder in front of the mouth hole of the gun.*
- *Re-activation of the drive for the cutting tool of the cutting bell with simultaneous backward/away movement of the carriage in the direction away from the projectile or away from the ignition booster until the ignition booster screwed into the fuze is completely separated from it.*
- *Defined moving away of the carriage by its drive from the ignition booster held in the clamping jaws, gripping of a part of the ignition booster by means of the recovery robot, subsequent opening of the clamping jaws by means of the working cylinders and removal of the ignition booster from the clamping jaws and deposit of the same in a safe container. Since the igniter and the ignition booster are already separated from each other at this point and the danger of an accidental ignition is very low, a manual removal of the ignition booster from the clamping jaws can also be considered. In this case, a person preferably wearing protective gloves removes the ignition booster directly or by means of a gripper.*
- *Gripping of a dummy cover by means of the Berger robot and placing of this dummy cover between the opened clamping jaws for the ignition booster and subsequent closing of the clamping jaws by means of the working cylinders for fixing the dummy cover, subsequent movement of the carriage by its drive in the direction of the clamping jaws until the igniter fixed in the cutting bell is closed by*

*the dummy cover. Here, too, a manual insertion of the dummy cover into the clamping jaws or a manual closing of the igniter with the dummy cover can be considered. For example, the blind cover can be screwed onto the igniter by hand by a person wearing protective gloves.*

Some or all of the process steps are carried out by an operator using the control panel and are advantageously observed and controlled on a monitor via the remotely readable camera and interrupted or corrected if necessary.

**Design example**

An example of a device according to the proposed solution is shown schematically in the attached Figure 1. The attached figures 2 and 3 show photographs of a concrete device according to the proposed solution at different stages of the removal of a detonator from a projectile and figure 4 shows a control panel for operating the device according to figures 2 and 3. Identical or corresponding parts are designated with the same reference signs in the figures.

Figure 1 shows a sketch of a device 2 according to the proposed solution, which is mounted on a table 4. A bullet 6 has already been inserted into a holding device 8 in the form of a vice on a support platform which is not visible, by means of a Berger robot which is not shown. One of the clamping jaws 10 of the holding device 8 can be seen, which can be opened or closed with the opposite clamping jaw, which is covered by the bullet 6 and the clamping jaw 10 in the foreground, by means of a pneumatic cylinder 11, which is not shown. Also visible is a guide receptacle 12 with guide means 14 and a plate-shaped end stop 16 for the tail unit 18 of the projectile 6. The interchangeable support platform was selected so that the extension of the longitudinal axis of a cutting bell 20 with its cutting tool 22 shown in dashed lines coincides with the longitudinal axis of the projectile 6. An electric motor 24, which drives the cutting tool 22, can also be seen. Not shown in Figure 1, but visible in Figures 2 and 3, is a tube 27 in which the cutting bell 20 is held and which surrounds the compression spring 26 between the cutting bell 20 and the electric motor 24. A slide 32, on which the cutting bell 20, tube 27, compression spring 26 and electric motor 24 are mounted, can be moved towards and away from the projectile 6 by means of an electric motor 28 with spindle 30. Also shown is a clamping jaw 34 which can be moved by two pneumatic cylinders (not shown) to fix a firing booster 35 of a fuze 36 of the projectile 6 after it has been unscrewed from the projectile 6 by means of the cutting bell 20.

Figure 2 shows a photograph of a device 2 according to the proposed solution. Compared to the schematic representation in Figure 1, the tube 27 in which the cutting bell 20 is held, the pneumatic cylinder 11 for moving the clamping jaws 10 of the holding device 8 and the pneumatic cylinders 42 for moving the clamping jaws 34 for the subsequent fixing of the ignition booster 35 of the igniter 36 can also be seen. The remotely readable camera 44 can also be seen, with which an operator can carry out, observe and control the process steps for removing the igniter 36.

While Figure 2 shows the phase of the process for removing the detonator 36 in which the cutting bell 20 has cut into the detonator give, Figure 3 shows a partial section of the device 2 in a final phase of the process in which both the detonator 36 has already been unscrewed from the projectile 6 and the ignition booster 35 has already been unscrewed from the detonator 36 but is still held by the clamping jaws 34.

Figure 4 shows a control panel 46 via which the device 2 can be operated by an operator from a safe environment. The switches for closing and opening the clamping jaws 10 and 34 via the pneumatic cylinders 11 and 42 respectively and the switches for activating/deactivating the electric motor 28 for the carriage 32 and the electric motor 24 for the cutting tool 22 of the cutter 20 can be seen.

The procedure for removing the detonator 36 from the projectile 6 and the ignition amplifier 35 from the detonator 36 is essentially carried out in the following steps:

After the projectile 6 has been placed on the exchangeable support platform of the holding device by means of a salvage robot,

adapted to the respective bullet size of the holding device

8 in the form of a vice, which is designed for bullets up to 155mm diameter.

the operator activates the electric motor 28 of the carriage 32 via the control panel 46, so that the carriage the slide 32 so that it moves towards the projectile 6. The corresponding the fuse nose, the conical cutting bell 20 and the cutting tool 22 are tool 22 presses the tail section 18 of the projectile by gripping the rear third of the fuze nose. the tail 18 of the projectile 6 against the end stop 16 of the guide receptacle 12 and thus ensures that the projectile 6 or fuze 36 and cutting bell are adjusted and fixed. the fuse 36 and the cutting bell 20 to each other as well as to a 5 mm pre-tension of the pressure of the compression spring 26 between the cutting bell 20 and the electric motor 24 for the cutting tool 22 inside the tube 27. The operator then deactivates the electric motor 24 again. Before starting the actual release process of the detonator 36 from the bullet 6, the operator uses the control panel 46 to close the clamping jaws 10 of the holding device 8, which should now be at the level of a guide band of the projectile 6. of the projectile 6. The operator then activates the electric motor 24 for the cutting bell 20 via the control panel 46. 24 for the cutting bell 20 for 1 - 2 revolutions, so that the cutting tool 22 cuts into the fuze nose. The operator uses the camera 44 to check whether the release process, i.e. unscrewing the fuze 36 from the mouth hole of the projectile from the mouth of the projectile 6. The operator then slowly retracts the slide 32 via the electric motor 28 and while the electric motor 24 for the cutting bell 20 is activated, until the fuze is completely unscrewed from the bullet 6. Then the operator moves the slide 32 further back until the jaws 34, whose cylindrical recess is adapted to the circumference of the primer 35 of the fuze 36, are level with the primer 35. Now the operator, under observation by means of the camera 44, moves a covering means not shown in the form of a steel plate over a pneumatic cylinder activated via the control panel 46 and also not shown in the figures, in front of the mouth of the projectile 6. Then, by means of the control panel 46 and the pneumatic cylinder 42 activated thereby, the operator closes the clamping

jaws 34, which engage with their teeth in the ignition booster 35. Now the operator activates the electric motor 24 for the cutting tool 22 again to separate the ignition booster 35 and igniter 36 from each other. At the same time, he activates the electric motor 28 for the carriage 32 and moves it away from the jaws 34 to completely rotate the ignition booster 35 out of the igniter 36. Once the ignition booster 35 and igniter 36 are separated, the operator deactivates the electric motor 24 for the cutting tool 22, but moves the carriage 32 back a little further, allowing manual removal of the ignition booster 35 from the clamping jaws 34 or removal by a Bergerobot after opening the clamping jaws 34 via the control panel 46. Subsequently, a dummy cover not shown is inserted into the clamping jaws 34 manually or by means of the salvage robot and these are closed again via the control panel 46. The operator now activates the electric motor 28 for the carriage 32 again and, while observing the carriage 32, lets it camera 44 so far in the direction of the clamping jaws 34 that the blind cover the bottom of the igniter 36 fixed in the cutting bell 20. The operator then opens the clamping jaws 34 and moves the slide 32 away from them again. 32 away from them again. Now a safe handling of bullet 6, 36 and booster 35 by the operator and/or other personnel is possible and the fuze and the fuze 36 can be analysed in more detail.

The speed for the electric motors 24 and 28 has been found to be 50 rpm and 7.6 rpm respectively.

The device 2 is designed in such a way that for the disassembly of projectiles 6 of different diameters and/or lengths only the support plate has to be changed and, depending on the thread of the mouth hole of the projectile 6, a cutting tool with the opposite thread has to be used. In addition to the power supply, a compressor is also required for operation, which supplies the compressed air for the pneumatic cylinders 11, 42.

Fig. 1

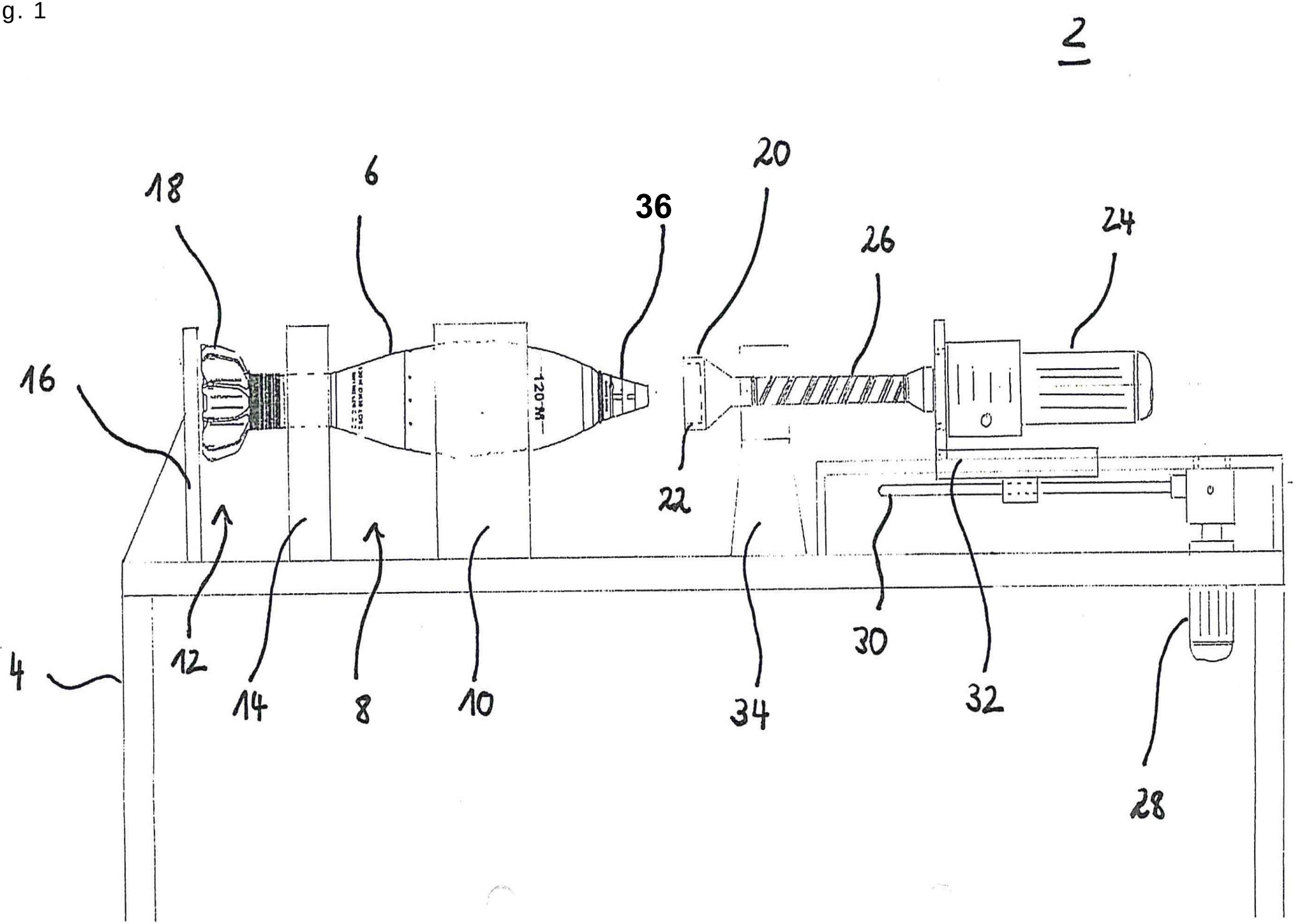

Fig. 2

Fig. 3

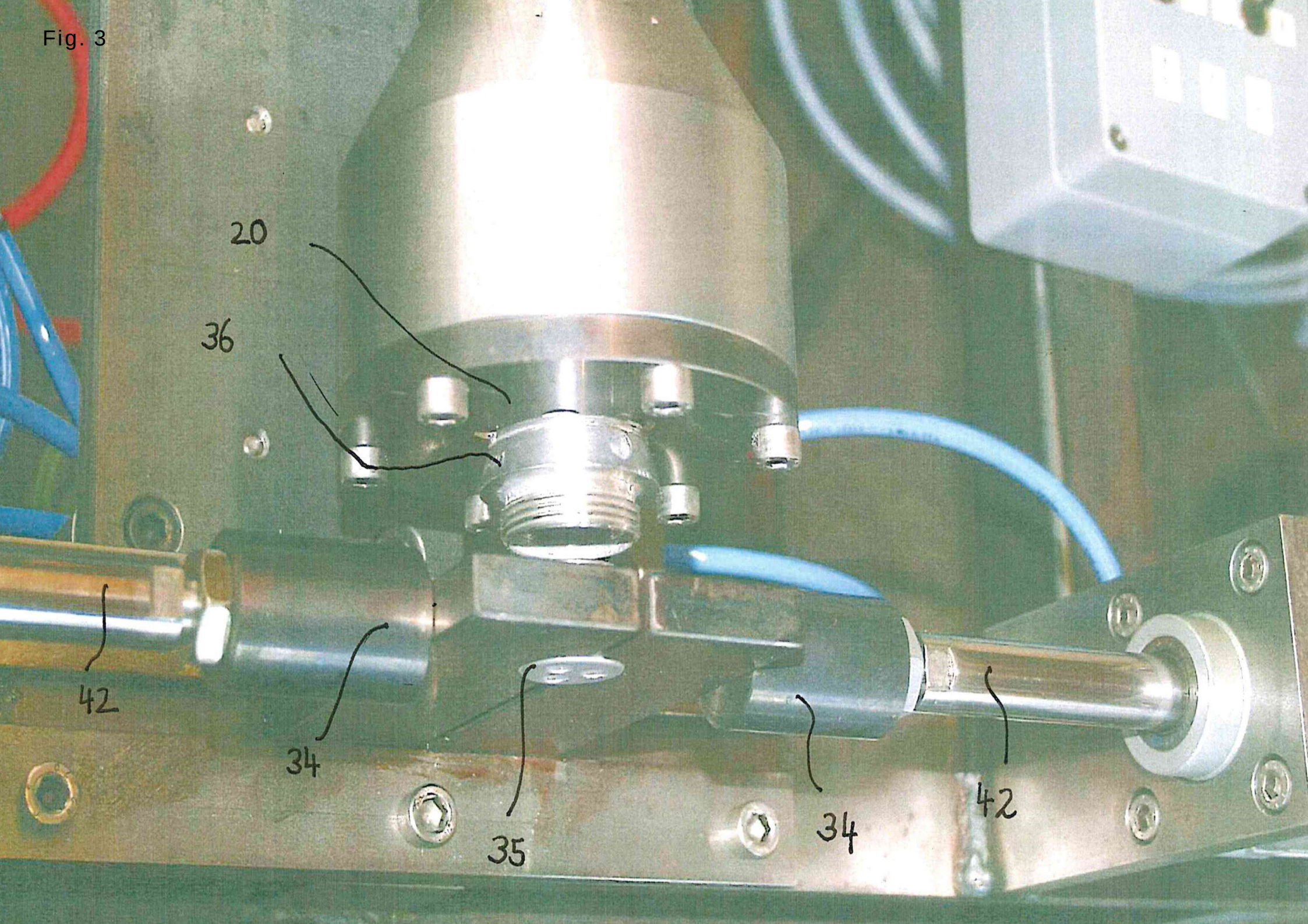

Fig. 4