



(51) International Patent Classification:

B28D 1/26 (2006.01)

E02D 3/046 (2006.01)

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(21) International Application Number:

PCT/BG2019/000012

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(22) International Filing Date:

14 June 2019 (14.06.2019)

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

112750

15 June 2018 (15.06.2018)

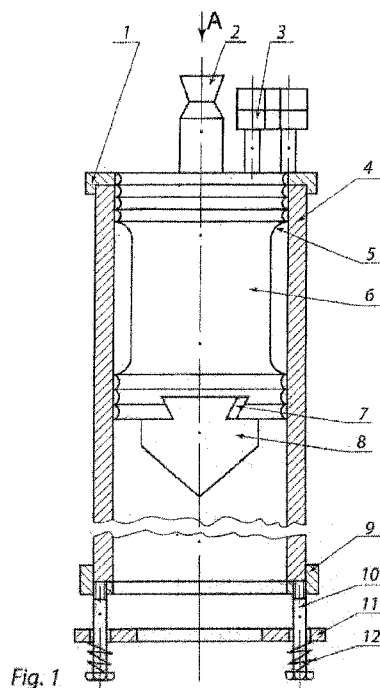
BG

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(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

(54) Title: ROCK BREAKING HAMMER



(57) Abstract: The invention relates to a hammer that breaks rocks which have a large size in open pit mines and quarries. This hammer can also be used for breaking boulders in rock slides in mountains presenting a risk for people and roads. These huge rock blocks must be broken into small pieces to be convenient for further mechanical treatment or for removal. Another application of this hammer is compacting soils to develop a solid earth surface as for a base for roads, airstrips or construction sites by a tamping operation in civil engineering activities. Both applications of this hammer will be put into effect by high speed impact parts which will increase the efficiency of operation. The driving system of the ram uses a solid fuel jet engine (2) which allows to handle a hammer with minimal mass, which can be delivered to place inaccessible by heavy transport equipment. The solid fuel jet engine (2) also provides the ability to strike at any angle in space.

GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
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Declarations under Rule 4.17:

- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

ROCK BREAKING HAMMER

Technical field to which invention relates

The invention related to a rock-breaking hammer, which has a mechanical structure and driving system that allow efficient breaking of large rock blocks from blasting activities in open pit mines and quarries. It also can be used for demolition of boulders from landslides in mountains that present a risk for local roads and people. These rock blocks must be broken in pieces in order to be convenient for further mechanical treatment or removal. Other application of this hammer is for compacting soils to develop a solid earth surface as for a base for roads, airstrips or construction sites by a tamping operation in civil engineering activities. Both applications of this hammer will be put into effect by high speed impact parts which will increase multifold the efficiency of operation.

Relevant prior art

There are two types of breaking hammers – one-shot and multi-shot. Multi-shot hammers use hydraulic or pneumatic unit for driving the impact part and perform multifold shots. These hammers are suitable for breaking artificial materials like concrete, brickwork and asphalt, but are not effective against massive boulders with high impact strength like granite, andesite, etc.

Technical problem to be solved

One-shot hammers break rocks with one or two blows of the impact part, which is raised vertically by hydraulic unit and at its free fall vertically hits the rock block. It is obvious that the higher power of this hammer is connected with its high mass. The significant mass of this hammer require heavy transport equipment, for example chain machinery, weighing several tonnages. These requirements not only make this hammers expensive, but also render them unusable for non-accessible places. Moreover, they may execute a breaking shot only vertically which is not always convenient or possible.

A common disadvantage of multi-shot and one-shot hammers is the low speed of their impact parts which reduces their overall efficiency.

Disclosure of the invention

The purpose of this invention is to engineer a hammer for breaking rocks with high speed of the hammer ram plus making shots at any angle in space while having a light construction. Its light weight construction should make easier to operate with this hammer and should allow the use of ordinary transport equipment. For difficult of access places the above hammer may be delivered by truck crane with very long arrow, by truck with hydraulic system used for concrete transport, by helicopter or by drone.

Advantageous effects of invention

The task has been solved by designing a hammer with impact part driven by repeatedly usable reactive engine with hard fuel, as well as by reactive engine with liquid fuel. The hammer is housed in the hammer structure, which is comprised of a guiding tube reinforced with a top and a bottom plate. A rigid n-shaped brace is provided along the length of the pipe, which provides for the orientation of the hammer-edge that is attached to the hammer ram by means of a "swallow tail" and a wedge. The n-bar is made up of a rod which at its lower end has a movable stop with a roller that moves on the inside of the n-bar. At its upper end, this rod is connected by a console with the piston rod to a hydraulic cylinder located on the outside of the guide tube. The hydraulic

cylinder is fixed together with a hydraulic station to the bottom plate of the guide tube. Below the bottom plate there is a limiter, which is a plate with an opening through which the hammer-edge (attached under the hammer ram) pass freely. Around the hole of the limiter there are circumferential bolts with strung pressed springs that rest on the limiter. The Reactive Engine is mounted fixed to the upper face of the hammer ram by means of two pins fixed opposite to its lower part which engage in a groove of the engine bed in the impactor. The Reactive Engine is charged before each impact with solid fuel, most commonly in the form of hollow cylindrical checkers. The combustion of solid fuel is electric. The reactive engine performs a rapid and effective acceleration of the impact part at a high impact rate of up to several times higher than that of the multi-shot and one-shot hammers. High impact velocity provides very effective fragmentation of rock blocks including rocks with the highest strength. The combined action of the inertial forces of the accelerated to high velocity hammer ram and the thrust of the jet-powered engine creates a rock-breaking effect that is not matched by existing hammers. The Reactive Engine also provides the ability to strike at any angle in space. The reactive drive provides a small mass of the hammer and its convenient operation. At the lower part of the hammer ram is mounted a hammer-edge by a "swallow-tail" and a wedge. The shape of the hammer-edge is formed by two flat sides, the striking edge being sharp or rounded. The hammer is mounted vertically, inclined or horizontally fixed on a metal platform (frame), which is fixed, for example, to the place of the bucket of a wheel loader.

In other embodiments the hammer is mounted to the arm of a chain or wheel excavator.

In other embodiments the hammer is mounted to the arm of a truck crane.

In another embodiment, the hammer is attached to the hydraulic system of the concrete pump truck.

In another embodiment, the hammer with two hooks and ropes is hinged horizontally under a transport helicopter, airship or drone.

In another embodiment, the hammer-edge is a wedge with protruding arcuate sides. The arcs may be parts of a circle, spiral, parabola, or other geometric curve.

In another embodiment, the hammer-edge has a wedge with inwardly arched edges.

In another embodiment, the hammer-edge is in the shape of a straight-forming cone.

In another embodiment, the cone of the hammer-edge is spheroidal, i. e. with a curved protruding arc forming.

In another embodiment, the cone of the hammer-edge has an inward concave arc forming.

In another embodiment, the hammer-edge has the form of a triangular pyramid with three flat triangular sides.

In another embodiment, the hammer-edge has the shape of a spheroidal tetrahedron with protruding sides.

In another embodiment, the hammer-edge has the shape of a spheroidal tetrahedron with protruding sides.

In another embodiment, the hammer-edge has the shape of a spheroidal tetrahedron with inwardly concave sides.

In another embodiment, the hammer-edge is formed as a cylinder whose upper end has a convex spherical surface, and below it has an anvil consisting of two cylinders, the upper cylinder having a diameter greater than the diameter of the hammer-edge and its face having a concave spherical surface. The diameter of the spherical surfaces of the hammer-edge and the anvil is the same or different. The lower part of the anvil is a short cylinder with a diameter larger than that

of its upper part, with ribs fixed around it with holes in them. The anvil is placed on a land surface.

Description of at least one way of carrying out invention with reference to drawing(s)

A preferred embodiment of the invention is shown in the accompanying drawings, wherein:

- FIG. 1 is sectional view E-E in FIG. 2 rock-breaking hammer.
- FIG. 2 is a top view A in FIG. 1.
- FIG. 3 is a partly sectioned view B-B in FIG. 2.
- FIG. 4 is a partly sectioned view C-C in FIG. 2.
- FIG. 5 is a somewhat schematic section view of a stop in the position to start lifting the ram in an upper starting position
- FIG. 6 is a somewhat schematic section view of a stop in the position after the ram is in a position to strike.
- FIG. 7 is a view of hammer-edge shaped as a wedge with two flat sides.
- FIG. 8 is a view of a hammer-edge shaped as a wedge with two curved protruding sides.
- FIG. 9 is a hammer-edge shaped as a wedge with two concave inwardly arched edges.
- FIG. 10 is a view of a hammer-edge shaped as a right circular cone.
- FIG. 11 is a view of a hammer-edge shaped as a cone with an outwardly arcuate formation.
- FIG. 12 is a view of a hammer-edge shaped as a cone with an inward concave arc forming.
- FIG. 13 is a view of a hammer-edge shaped as a triangular pyramid with three flat triangular sides.
- FIG. 14 is a view of a hammer-edge shaped as a spheroidal tetrahedron with three protruding sides.
- FIG. 15 is a view of a hammer-edge shaped as a spheroidal tetrahedron with three concave sides.
- FIG. 16 is a view of a hammer-edge shaped as a cylinder with a convex spherical surface and an anvil against it, the upper part of which has an inwardly spherical surface.
- FIG. 17 is a sectioned view of a section of the upper part of the ram with a jet engine housed therein.
- FIG. 18 is a top view in Fig. 17 of the upper part of the ram with a jet engine housed therein.

Embodiments of the invention

The rock-breaking hammer is better illustrated by the following examples. The hammer structure includes a guide tube 4 which is reinforced at both ends by an upper plate 1 and a bottom plate 9, Fig. 1. The hammer ram 6 is housed in the tube 4, with a solid fuel jet engine 2 disposed at its upper end, and at its lower end fixed to the cylinder 8 by means of the "sword tail" and a wedge 7. The hammer-edge 8 has an edge which is formed from two flat sides 34 and which may be sharp or rounded. In its middle part, the hammer ram 6 is narrowed with a curvature 5 formed over the entire circumference of the hammer ram 6 without the flat chamfering 17. A fixed double-bend iron bar 15 is provided along the guide tube 4 which serves as a orientation of the edge of the hammer-edge 8, for which purpose the hammer ram 6 is flatly sloped along its full length by a plate 17, Fig. 2. Below the bottom plate 9 a limiter 11 which is a plate with an opening large enough to pass through the hammer-edge 8 is fastened by means of circumferential bolts 10 with spring-loaded springs 12. To the upper plate 1 are fixed two plates 19 for which

two tubular housings 14 are fixed with bottoms in which bolts 13 are screwed. Cranks 21 are mounted in the housing 14 and the freewheel cylindrical rollers 20 are mounted on the forks 21. The radii of the rollers 20 are the same as the radius of the curvature 5 of the hammer-edge 6. Against the housings 14 in the guide tube 4 there are cut openings 24 through which the rollers 20 reach friction-tight contact with the curvature 5 of the hammer-edge 6. The cups 14 are also provided with cups 23 in which the bolts 13 abut, and between the cups 21 and cups 23 there are arranged springs 22, Fig. 3. Hydraulic station 16 and hydraulic cylinder 27 are mounted on the bottom plate 9 on the outside of the guide tube 4, and Fig. 4. The piston rod 26 of the hydraulic cylinder 27 ends at its upper end with a bracket 3 for which a rod 25 fixed to the double-bend bar 15 is secured. The abutment 28 is supported at the lower end of the rod 25. The support 28 is pivoted around an axle 29, which is mounted at the lower end of the rod 25, Fig. 5. At the other end of the support 28, a roller 31 is mounted which rotates about an axle 30 also mounted on the support 28. For the support 28 adjacent to the roller 31, one end of the spring 32 is engaged and the other end of the spring 32 is secured to the ring 33 mounted on the rod 25.

In another embodiment, the hammer-edge 35 is a wedge formed by two arcuate outwardly projecting sides 36, Fig. 8.

In another embodiment, the hammer-edge 37 is a wedge of two recessed inwardly arcuate sides 38, Fig. 9.

In another embodiment, the hammer-edge 39 is a cone-shaped form, Fig. 10.

In another embodiment, the hammer-edge 40 is a spherical cone formed by an outwardly arcuate formation 41, Fig. 11.

In another embodiment, the hammer-edge 42 is a cone with an inwardly concave arcuate form 43, Fig. 12.

In another embodiment, the hammer-edge 44 is in the form of a triangular pyramid with three flat triangular sides 45, Fig. 13.

In another embodiment, the hammer-edge 46 is in the form of a spheroidal tetrahedron with outwardly projecting sides 47, Fig. 14.

In another embodiment, the hammer-edge 48 is in the form of a spheroidal tetrahedron with inwardly concaved sides 49, Fig. 15.

All hammer-edges may have sharp or rounded edges and peaks.

In another embodiment, the hammer-edge 50 is formed as a cylinder whose face has a convex spherical surface 51, and below the hammer-edge 50 there is an anvil consisting of two cylinders, the upper cylinder 56 having a diameter larger than the diameter of the hammer-edge 50 and its face has a concave spherical surface 57. The spherical surfaces 51 and 57 are of the same or different radius. The lower part of the anvil is a short cylinder 53 with a diameter greater than the diameter of the upper cylinder 56. Ribs 55 with holes 54 are arranged circumferentially. The upper cylinder 56, the lower cylinder 53 and the ribs 55 are fixed to one another and form the anvil which is placed on the ground 52, Fig. 16. The openings 54 are for facilitating the removal of the anvil with a truck crane when there is sinking into unstable soil.

Two identical cylindrical pins 18 are oppositely attached to the casing of the jet engine 2, Fig. 17. In the upper part of the hammer ram 6 there is a blind opening 60 in which part of the jet of the jet engine 2 is located. A circular ring 58 is formed around the deeper opening 60. The two pins 18 enter the ring-shaped channel 58 through both grooves 59, Fig. 18.

The rock-breaking hammer works in the following way:

Hydraulic unit 16 is supplied with an electric current through a cable. The hydraulic cylinder 27 drives the piston rod 26 upwards. The console 3 also drives the rod 25 upwards. The roller 31,

which pivots on the axle 30 secured to the support 28, meets the end of the double-bend bar 15 and starts to rotate about its middle plane.

By moving the roller 30, the support 28 is pivoted about the axle 29 which is attached to the lower end of the rod 25. The support 28 raises the ram 6 together with the hammer-edge 8 and the wedge 7 mounted thereto to reach the rollers 20 which are fastened to forks 21. The force of the springs 22 is overcome and the upper part of the ram 6 extends over the rollers 20.

At that moment, the movement of the piston rod 26 and the associated rod 25 stops, and the rollers 20 pass through the holes 24 in the guide tube 4 to a tight contact with the curvature 5 of the ram. The springs 22 between the forks 21 and the cups 23 are tightened by the bolts 13, so as to retain the mass of the mass 6 with all the elements attached to it. The piston rod 26 is returned to the hydraulic cylinder 27 and the rod 25 is returned to it again. At the end of the rod 25, the roller 30 comes out of contact with the center plane of the double-bend bar 15 and under the action of the spring 32, the support 28 stands vertically. The Reactive Engine 2 is charged with solid fuel and an electric igniter not shown in the figures and placed in the blind hole 60 in the upper portion of the ram 6.

Upon insertion of the engine 2, its two pins 18 enter the grooves 59 and reach the ring-shaped groove 58 and the bottom of the engine 2 reaches the bottom of the blind hole 60. The reactive engine 2 is rotated manually about 90 degrees and thus secures its attachment to the ram 6. The electric igniter is connected to an electrical power source with an electrical cable. For example, with the help of a crane, the hammer is placed on the rock block, that is selected for breaking.

Electric current is supplied to the electric igniter and the solid fuel is ignited. In combustion of the solid fuel a reactive thrust is created which overcomes the force of the two springs 22 and the rollers 20 extend out of the holes 24 in the tube 4. Then, under the action of the reactive force of the motor 2, the ram 6 is driven by the pipe 4 and reaching a high speed it strikes destructively on the rock block.

The limiter 11 prevents the ram 6 from coming out of the tube 4. The solid fuel charge provides the reactive thrust of the engine 2 and during the impact on the rock block itself. This results in a unique combined impact that is very effective in breaking down rocks. For the next impact on a rock block repeat the described actions. For various materials and minerals of the broken rock blocks there are various options of the described forms of the bottle 8, Fig. 7, Fig. 8, Fig. 9, Fig. 10, Fig. 11, Fig. 12, Fig. 13, Fig. 14, Fig. 15.

For the stabilization of unstable soil there are two options of the proposed hammer. In the first embodiment, an impact by hammer ram 6 is applied to the soil 52 and a hammer-edge 50 mounted thereon, whose face 51 has a spherical surface convex outwardly. In the second embodiment, an anvil consisting of cylinders 56 and 53 is provided on the soil 52, the upper cylinder 56 having a concave spherical surface 57. The hammer is placed by a truck crane on the anvil and is struck by the hammer-edge 50 on the anvil. In the second option, a larger surface area is expected to be stabilized.

Claims

What is claimed is:

1. A rock-breaking hammer comprising:

a hammer ram with a flat chamfering (17) along the entire length and assembled with a hammer-edge (8) with a wedge (7) is housed in a guide tube (4) with a rigidly mounted double-bend bar (15) and reinforced with an upper plate (1) and a lower plate (9) mounted on a limiter (11) with circumferentially spaced bolts (10) with spring (12);

a solid fuel jet engine (2) is mounted at the upper part of the guide tube (4) the engine being mounted with two pins (18) fixed to the housing ; the fixed pins (18) which enter the grooves (59) to the ring-shaped groove (58) and are rotated by 90 °;

also in the upper part of the ram (2); a circumferential curvature (5) is formed in which two opposing rollers (20), which are fastened to the forks (21), which together with cups (23) two housings (14), which are fastened to plates (19);

between the forks (21) and cups (23) there are springs (22) which are tensioned by bolts (13), a rod (25) being provided in the double-bend bar (15), which in the lower part reach a support (28) with a roller (31) that rotates on an axle (30), and the support (28) itself rotates on an axle (29) located on the rod (25);

support (28) is connected with a spring (32) to a ring (33) mounted on the rod (25), in the upper end the rod (25) is fastened to a bracket (3) to the piston rod (26) of the hydraulic cylinder (27); the hydraulic cylinder (27) is assembled with the hydraulic unit (16) over the lower plate (9).

2. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (8) is wedge-shaped with two flat sides (34).

3. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (35) is a wedge formed by two arcuate protruding outward sides (36).

4. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (37) is a wedge of two concave inwardly arcuate sides (38).

5. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (39) is in the form of a right cone.

6. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (40) is a spherical cone formed by an outwardly arc-formation (41).

7. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (42) is a cone with an inwardly concave arc-formation (43).

8. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (44) is in the form of a triangular pyramid with three flat triangular sides (45).

9. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (46) is in the form of a spheroidal tetrahedron with protruding outward sides (47).

10. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge(48) is in the form of a spheroidal tetrahedron with inwardly concaved sides (49).
11. A rock-breaking hammer according to claims 1 to 10, characterized in that all the edges and tips of the hammer-edges are sharp or rounded.
12. A rock-breaking hammer according to claim 1, characterized in that the hammer-edge (50) is formed as a cylinder where its face has a spherical surface (51) and under the hammer-edge there is an anvil formed by two cylinders, the upper cylinder (56) having a diameter greater than the diameter of the hammer-edge (50) and its face having a concave spherical surface (57), as the spherical surfaces (51) and (57) are of the same or different radius, and the lower part of the anvil is a short cylinder (53) with a diameter larger than the diameter of the upper cylinder (56), on which there are circumferentially made ribs (55) with openings (54).

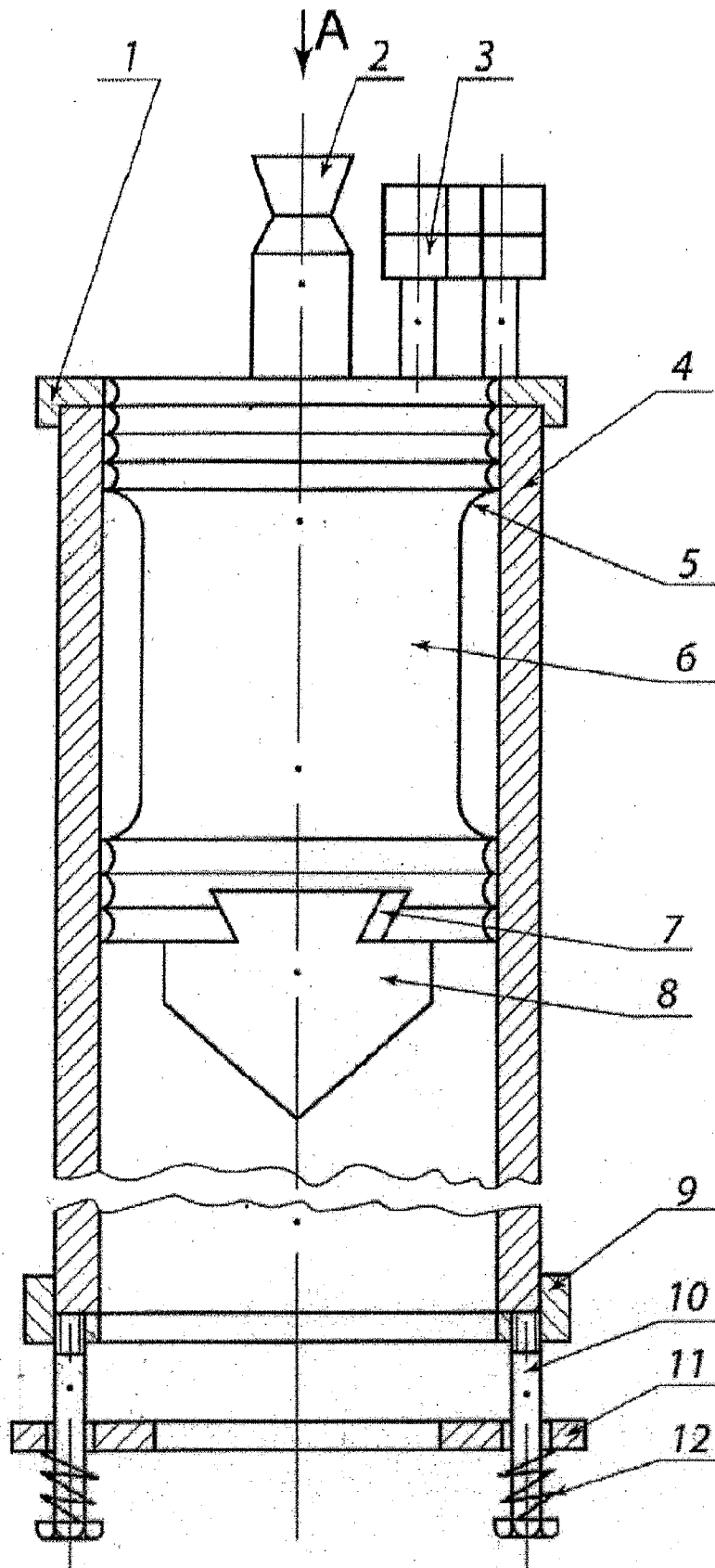
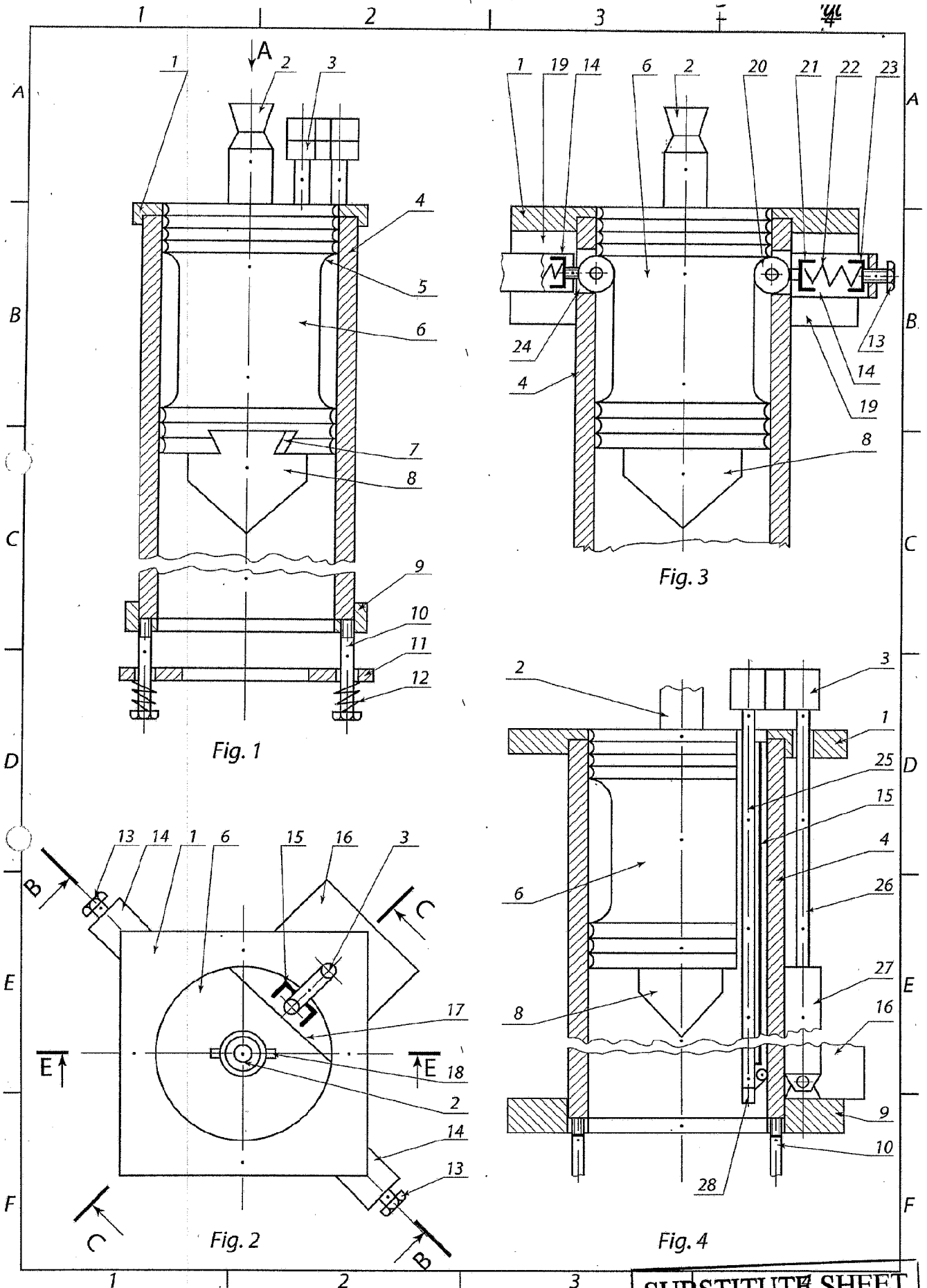


Fig. 1

SUBSTITUTE SHEET



SUBSTITUTE SHEET

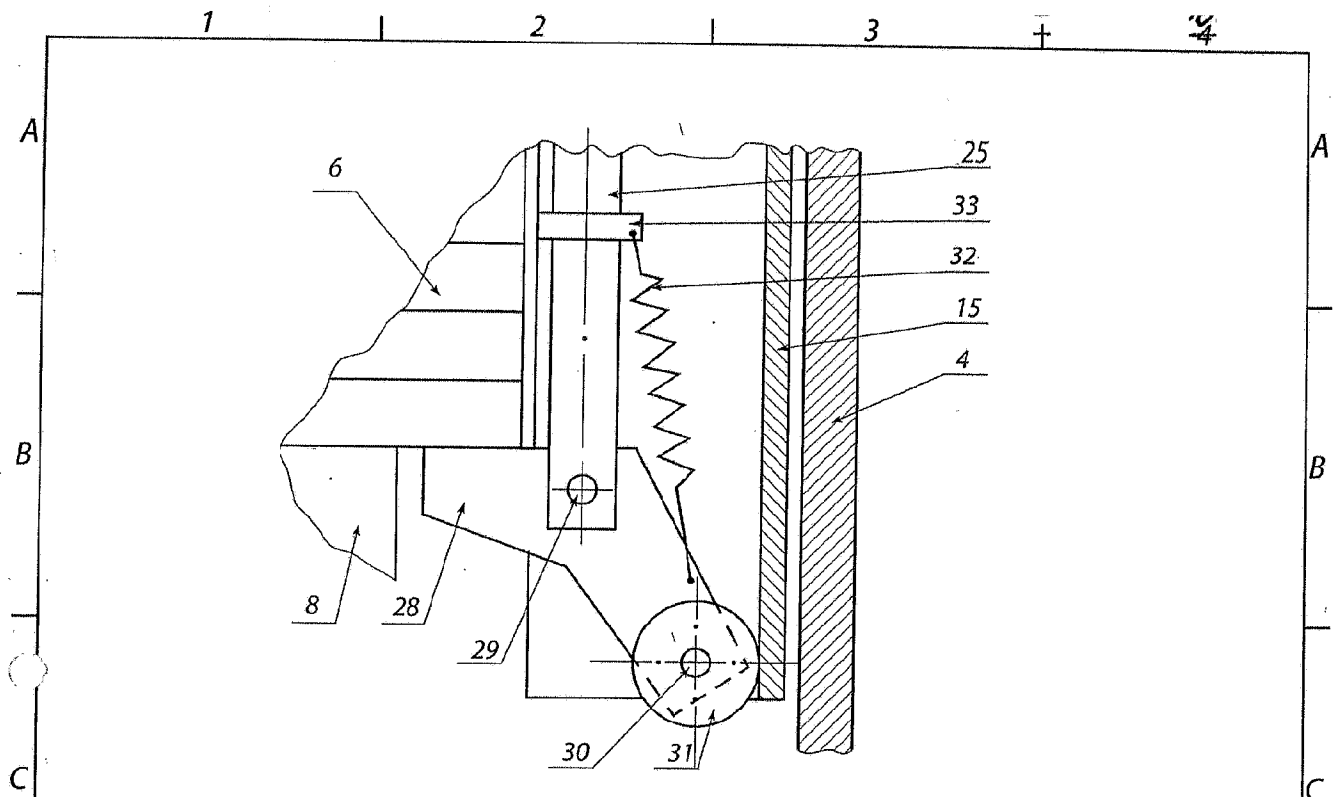


Fig. 5

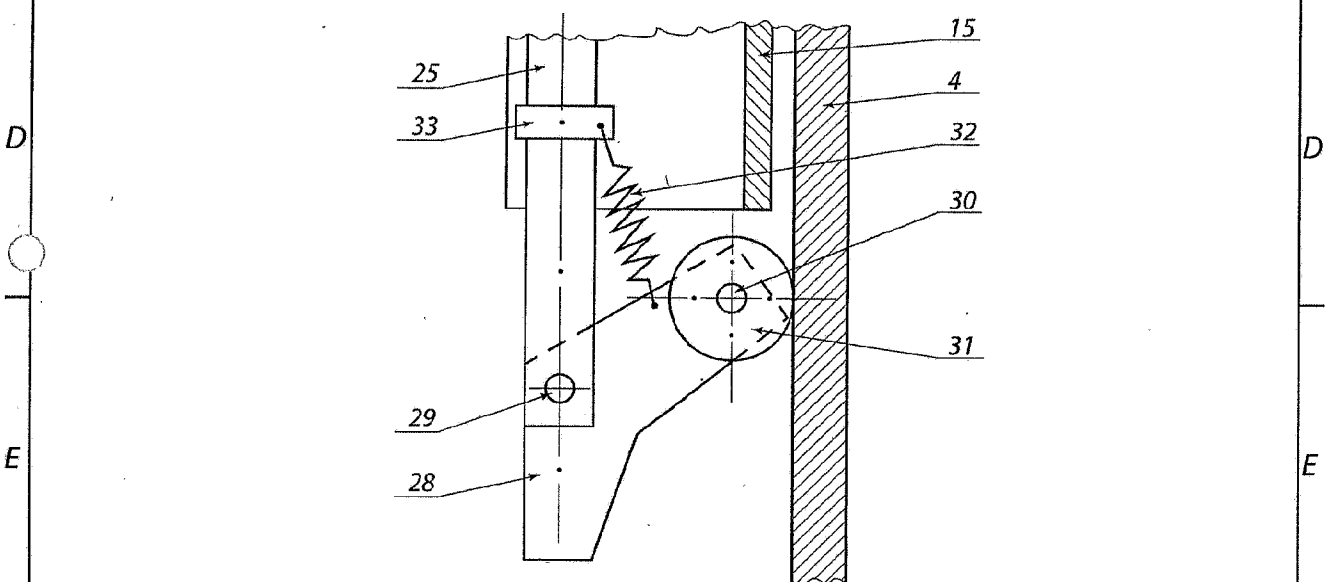
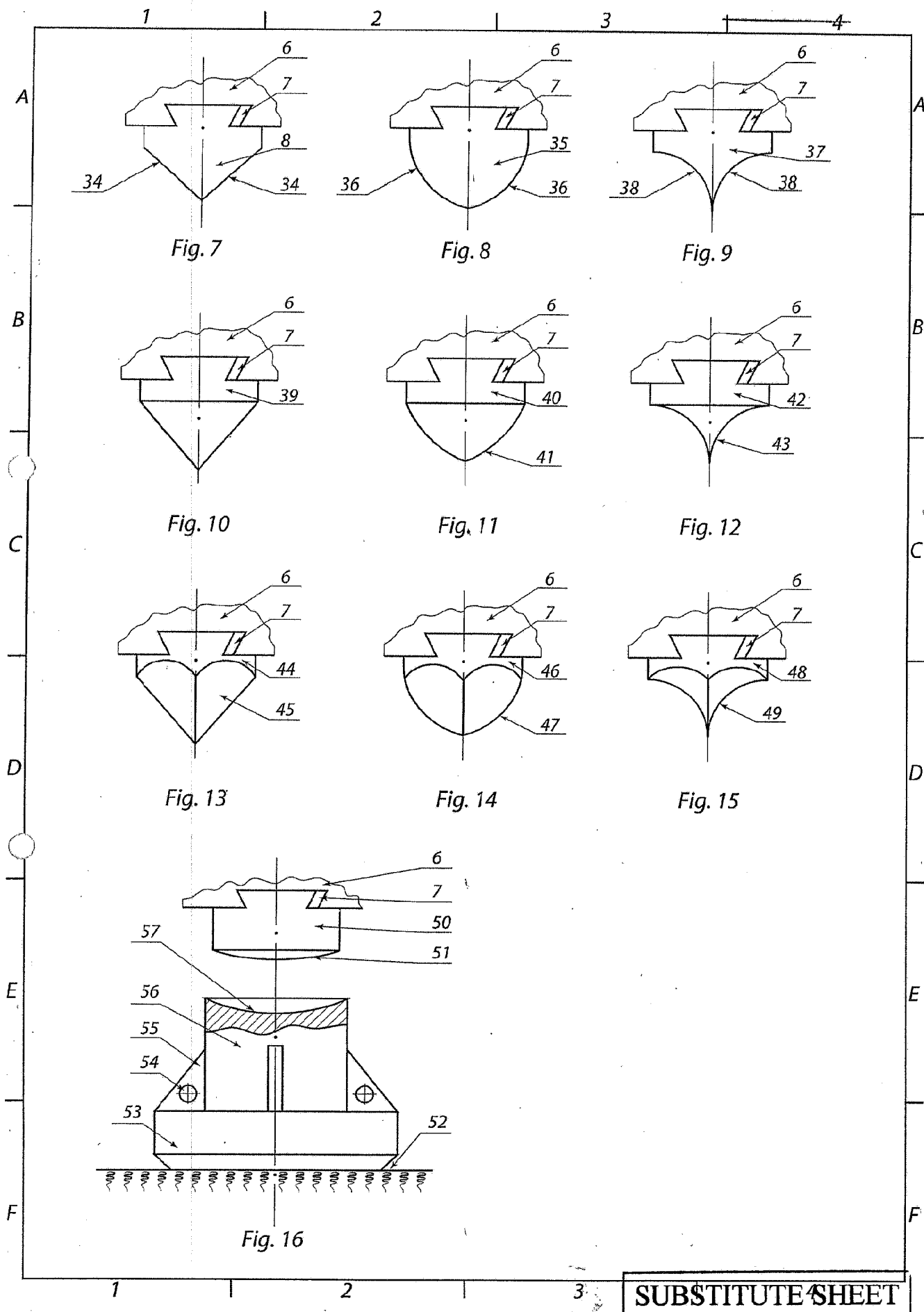


Fig. 6



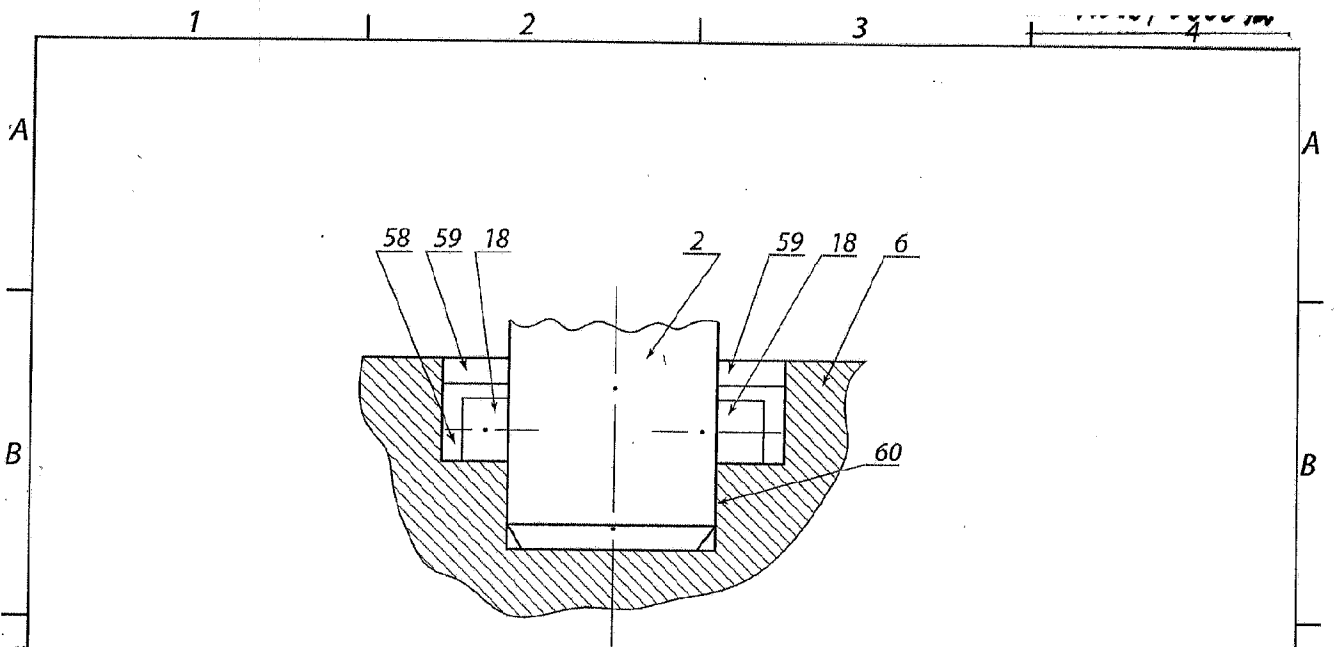


Fig. 17

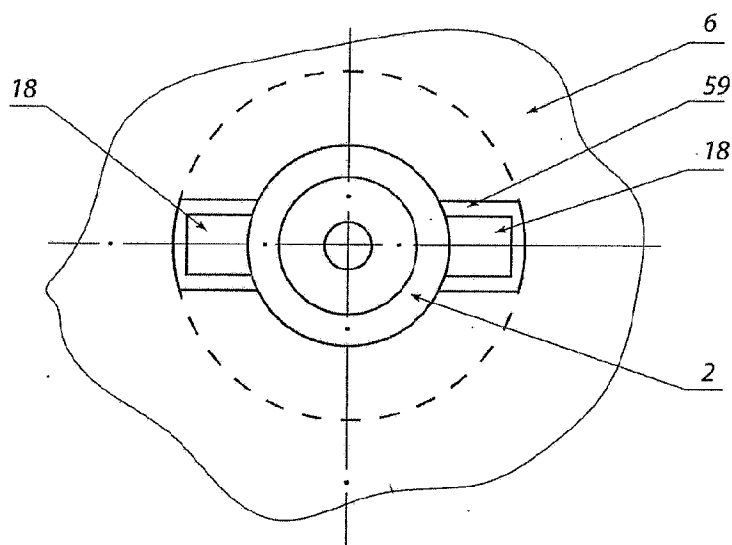


Fig. 18

INTERNATIONAL SEARCH REPORT

International application No
PCT/BG2019/000012

A. CLASSIFICATION OF SUBJECT MATTER

INV. B28D1/26 E02D3/046
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B28D E02D E21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 86/06672 A1 (PEINER MASCH SCHRAUBEN [DE]) 20 November 1986 (1986-11-20) page 1, paragraph 1 page 3, last paragraph - page 5, last paragraph figure 1	1-12
A	WO 2013/075181 A2 (RELO BG LTD [BG]; BODUROV PETAR [BG]; GENCHEV VASIL [BG]) 30 May 2013 (2013-05-30) page 8, line 33 - page 9, line 27 figure 8	1-12
A	BG 98 688 A (BODUROV [BG]; KUMANOV [BG]; NIKOLOV [BG]) 29 September 1995 (1995-09-29) the whole document	1-12
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

18 September 2019

Date of mailing of the international search report

09/10/2019

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/BG2019/000012

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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