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(54) Title: MILL FOR GRINDING OF MATERIALS OF DIFFERENT HARDNESS AND GRAIN SIZE

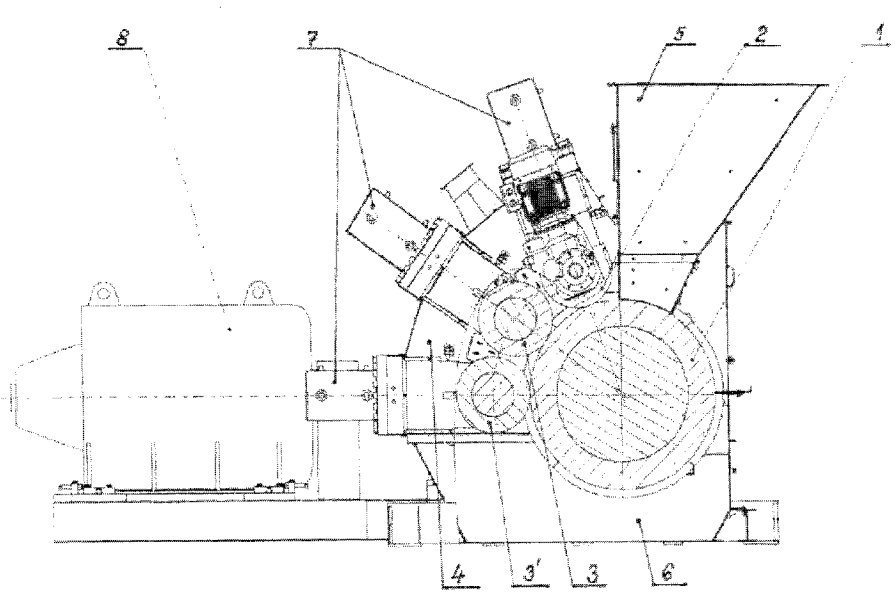

Fig. 1

(57) Abstract: The mill for grinding of materials of different hardness and grain size comprises drives (8, 23) and the body (4), equipped with the hopper (5) and the discharge hopper (6), accommodating the main grinding roller (1), seated in a rotating manner and driven by the main drive (8), equipped with the replaceable abrasion-resistant tire and from both sides fitted with guide rings along the circumference, overlapping its diameter, arranged in a manner to prevent ground stock leakage from the grinding slot. In addition, at least three smaller grinding runners (2, 3, 33, are accommodated in the body (4) of the mill, in a rotating and sliding manner, whose axes are parallel to the axis of the main grinding roller (1), arranged in the direction of its rotation along its circumference between the hopper (5) and the discharge hopper 6. All grinding runners (2, 3, 3') are equipped with compression devices (7) providing their thrust to the main grinding roller (1) and the first grinding runner (2) is fitted with its own drive by means of extended ends of its shaft (9),

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protruding from bearing houses (11), where the driven shaft (9) is seated in antifriction bearings (12). Bearing houses (11) of grinding runners (2, 3, 3') are fitted with guide grooves (13), arranged to fit into the guide in sidewalls of the body (4) of the mill, whereas said guide grooves (13) are fitted with lubrication channels (16) and lined along their circumference with the sliding plates (14) with lubrication grooves (15), whereas bearing houses (11) of the first grinding runner (2) are coupled by the crossbeam (18), to which is leaned the push rod (17) of compression devices (7) via axial ball bearings (19).

Mill for Grinding of Materials of Different Hardness and Grain Size

Field of the Invention

The invention relates to a mill for grinding of materials of different hardness and grain size, such as, for example, materials for production of cement, cement clinker, lime, limestone, ore and pigments, and similar materials.

Background of the Invention

Tube-ball mills and/or vertical disc mills have been used so far to grind the above-mentioned materials of different hardness and grain size. Major disadvantage of tube-ball mills is, however, an asymmetrical process of grinding caused by an indefinable contact between grinding charge and mill armoring, resulting in low energy efficiency of grinding. Existing vertical disc mills also report low grinding efficiency, which may only be improved by repeated supply of ground stock under the grinding disc. Considerable dimensions and weight of said mills are other disadvantages, making their operation energy-demanding with the present long period of grinding.

High-pressure roller presses, comprising two rollers pressed to one another by great force, whereas grinding is completed after one pass of the material between said rollers, are also used for grinding of said materials. Disadvantage of high-

pressure roller presses lies in their high thrust, giving rise to massive wear-and-tear of grinding rollers and other components of presses. In addition, considerable force conditions demand a robust structure of the entire equipment, thus increasing manufacturing costs.

"Medium-Pressure Multi-Roller Press for Grinding of Grained Materials" is known from the CZ patent No. 292 489, comprising one driven roller and at least two grinding rollers, not fitted with their own drives, whereas their axes are parallel to axis of said driven roller. Grinding roller diameter equals, as maximum, to half the diameter of said driven roller and grinding rollers are mechanically seated in a manner that rest gaps, whose height decreases in the direction of rotation of said driven roller, are created between surface of each roller and near surface of said driven roller. Each grinding roller is equipped with devices providing their thrust directed to the driven roller. Longitudinal axes of grinding rollers are on the planes passing through the axis of said driven roller and are diverted from the vertical plane, spaced by the axis of said driven roller, by gradually increasing angles α, β, γ.

In addition, "Mill for Grinding of Grained Materials" is known from the published CZ invention application, file ref. PV 2002-1541, comprising a driven grinding roller and at least two grinding runners, rotating in a parallel way to the grinding roller, whose axes are parallel to the axis of said grinding roller, and which are equipped with devices providing thrust to the grinding roller and which are seated in a sliding manner towards the grinding roller in a way that gaps are created

between their surfaces and near surface of said grinding roller, whose dimensions may radially be adjusted. At least the first grinding runner is equipped with its own drive, whereas grinding runners have identical or different diameter, whose size is, as maximum, ¾ of grinding roller diameter size.

The mentioned cases of "Medium-Pressure Multi-Roller Press" and "Mill for Grinding of Grained Materials" illustrate only conception designs, so far not engineered into a specific implementable form.

Summary of the Invention

To a large extent, the mill for grinding of materials of different hardness and grain size eliminates mentioned weaknesses; the mill comprises drives and a body of the mill, equipped with a hopper and a discharging hopper, housing, in a rotating manner seated, a main grinding roller driven by a main drive, equipped with a replaceable abrasion-resistant tire and from both sides fitted with guide rings along the circumference, overlapping its diameter, arranged in a manner to prevent ground stock leakage from a grinding slot. In addition, at least three smaller grinding runners are incorporated in the body of the mill, in a rotating and sliding manner, whose axes are in parallel to the axis of said main grinding roller, and arranged in the direction of its rotation along its circumference between the hopper and the discharging hopper. All grinding runners are equipped with devices providing their thrust to the main grinding roller and the first grinding runner is equipped with its own drive by means of extended ends of its shaft, protruding from bearing houses,

accommodating said driven shaft in the antifriction bearings. The summary of the invention lies in the fact that said bearing houses of grinding runners are fitted with guide grooves, arranged in a manner to fit into guides in sidewalls of the body of the mill. Guide grooves are fitted with lubrication channels and lined along their circumference with sliding plates with lubrication grooves. Bearing houses of the first grinding runner are coupled by a crossbeam, to which is leaned a push rod of a compression device via an axial ball bearing.

To guarantee correct function of the mill, it is preferable if bearing houses of second and third grinding runners are also coupled, identically to the first grinding runner, to crossbeams to which push rods of compression devices are leaned via axial ball bearings. In contrast to the first grinding runner, compression devices of second and third grinding runners may constitute a part of their bearing houses. Preferably, one antifriction bearing of grinding runners is axially fixed and the other is axially floating. Preferably, drive of the first grinding runner may be provided either by a hydraulic motor or mechanical gearbox or belt or chain gear transmission and its thrust, as well as thrust of other grinding runners, is induced by compression devices, which may be hydraulic and/or pneumatic cylinders or springs. In addition, it also appears preferable if the replaceable tire of runners as well as of the main grinding roller is made of quality abrasion-resistant material, whereas these are forgings from chrome-nickel steel, and, furthermore, this material is fitted with a hard-facing layer for highly abrasive materials.

Overview of Figures on the Drawings

The invention will be explained in more detail by drawings, where Fig. 1 shows a general view of the mill in the partial section perpendicular to axes of the main grinding roller and grinding runners. Fig. 2 shows the first grinding runner in the section taken through the vertical axis of its compression device and perpendicular axis of its roller and Fig. 3 shows the section of the first grinding runner through A-A plane shown in Fig. 2. Fig. 4 shows detail B of Fig 2; Fig. 5 shows detail C of Fig. 3. Fig. 6 clearly shows non-driven second and/or third grinding runner, whose houses are coupled by the crossbeam similarly to the first grinding runner, whereas Fig. 7 shows an alternative embodiment of the second and/or third non-driven grinding runner, where compression devices are integrated directly in their bearing houses without hinged seating of push rods.

Description of the Preferred Embodiments

The mill for grinding of materials of different hardness and grain sizes comprises drives 8, 23 and a body 4 of the mill, equipped with a hopper 5 and a discharging hopper 6, accommodating a main grinding roller 1, seated in a rotating manner, and driven by a main drive 8, the main grinding roller 1 is equipped with a replaceable abrasion-resistant tire and from both sides fitted with guide rings along the circumference, overlapping its diameter, arranged in a manner to prevent ground stock leakage from the grinding slot. In addition, at least three smaller grinding runners 2, 3, 3´, are accommodated in the body 4 of the mill, in a rotating and

sliding manner, whose axes are parallel to the axis of the main grinding roller 1, arranged in the direction of its rotation along its circumference between the hopper 5 and the discharge hopper 6. All grinding runners 2, 3, 3′ are equipped with compression devices 7 providing their thrust to the main grinding roller 1.

The first grinding runner 2 serves, together with the main grinding roller 1, to pull-in ground stock from the hopper 5, providing its distribution across the whole width of the main grinding roller 1 and its pre-grinding. The first grinding runner 2 is fitted with its own drive by means of extended ends 10 of its shaft 9, protruding from bearing houses 11, where one driving device 23 is seated on each extended end 10. The shaft 9 of the first grinding runner 2 is, similarly to other grinding runners 3, 3′, seated in antifriction bearings 12, accommodated in bearing houses 11, fitted with guide grooves 13, arranged to fit into the guide in sidewalls of the body 4 of the mill. Guide grooves 13 are fitted with replaceable sliding plates 14, made of special sliding material, and equipped with lubrication grooves 15, allowing for lubrication distribution. The lubricant is supplied to the friction surface by lubrication channels 16. Bearing houses 11 move in guide grooves 13 together with the entire grinding runners 2, 3, 3′ in radial direction. Grinding runners 2, 3, 3′ are compressed towards the main grinding roller 1 by compression devices 7 (for instance, by linear hydraulic motors), ended with a rod 17. Bearing houses 11 of the first grinding runner 2 are coupled by a cross beam 18, to which mentioned push rod 17 of compression device 7 is leaned while seated in an axial ball bearing 19. The axial ball bearing 19 absorbs compression force and installed

plate springs 21 absorb traction force. The plate spring 21 is pre-stressed, thus also defining clearance in the ball bearing 19. The whole assembly is bolted to the crossbeam 18 by a cover 22. Grinding runners 2, 3, 3′ move in the guide depending on the height of ground stock layer. A replaceable tire 20 is attached to the shaft 9 of the first grinding runner 2, identically to other grinding runners 3, 3′, made of abrasion-resistant material, whereas these are forgings from chrome-nickel steel and, furthermore, this material is fitted with a hard-facing layer for highly abrasive materials.

Second and third grinding runners 3, 3′ are of similar design construction as the first grinding runner 2; however, they are not fitted with drives but may have, as mentioned above, bearing houses 11 coupled also with crossbeams 18, to which push rods 17 of compression devices 7 are leaned while seated in the axial ball bearings 19, see Fig. 6. Said grinding runners 3, 3′ only roll on the layer of ground stock, and grinding itself is effectuated by pressure induced by compression devices 7. In the alternative design embodiment, second and third grinding runners 3, 3′ are not fitted with the crossbeam 18, but said compression devices 7 are directly bolted into their bearing houses 11, without hinged support, see Fig. 7. One antifriction bearing 12 of grinding runners 2, 3, 3′ is axially fixed and the other is axially floating.

As already mentioned, the first grinding runner 2 is driven either by the hydraulic motor and/or mechanical gearbox or by belt or chain gear transmission,

whereas thrust of the first grinding runner 2 as well as other grinding runners 3, 3′ is induced by compression devices 7, comprising hydraulic and/or pneumatic cylinders or springs.

As stress by thrust is by an order of magnitude greater than stress by traction force, said design solution reduces built-in height of the equipment compared to other hinged supports and, at the same time, allows for tilting within limits of clearances in guide grooves 13 of bearing houses 11, thus preventing addition of extra bending load effects to compression rods 17. Bearing areas are sealed against penetration of impurities from grinding area by applied special sealing with high resistance against dust, generated by grinding process.

Grinding of material per Fig. 1 runs between the main grinding roller 1 and three grinding runners 2, 3, 3′. Speed of the first grinding runner 2 may either be controllable or fixed. Speed is selected in a manner that either circumference velocity of the first grinding runner 2 equals to the circumference velocity of the main grinding roller 1, or may be adjusted in a manner that circumference velocity of the first grinding runner 2 and the main grinding roller 1 differs, thus achieving spreading effect on the ground stock. Rotary movement of other two grinding runners 3, 3′ is induced by friction of ground stock between the main grinding roller 1 and said grinding runners 2, 3, 3′. Before attempting to start grinding process, grinding runners 2, 3, 3′ may be lifted to their upper position, thus creating maximum gap between the first grinding runner 2 and the main grinding roller 1.

Ground stock is supplied to the hopper 5, located in the upper part of the body 4 of the mill. Ground stock is drawn from the hopper 5 by the main grinding roller 1 and is delivered to the area of the first slot between the main grinding roller 1 and the first grinding runner 2. Ground stock height is controlled by adjustment of a sliding gate at the outlet surface of the hopper 5. Ground stock is equally distributed across the whole width of the main grinding roller 1 by the first grinding runner 2 by lower grinding pressure, being formed and partially pre-ground at the same time. Grinding pressure of the first grinding runner 2 may also be induced in a manner that the first grinding runner 2, in contrast to other grinding runners 3, 3′, does not vertically move, but rests in stops and the gap between said runner and the main grinding roller 1 is fixed. Subsequently, ground stock is released by slight turning of the main grinding roller 1, and leaves the mentioned area. Additional slight turn of the main grinding roller 1 pushes released and re-arranged ground stock to the second slot, created between the main grinding roller 1 and the second grinding runner 3. In this point, the second grinding runner 3 acts on the ground stock by medium grinding pressure, triggering the second stage of grinding, accompanied with disintegration of ground stock grains. Afterwards, ground stock material is again released by another slight turn of the main grinding roller 1. Ground stock material is delivered to the third grinding slot, created between the main grinding roller 1 and the third grinding runner 3′, in a rather pre-ground condition, while grinding of the material is completed in this point by the highest grinding pressure (by thrust of the third grinding runner 3′). Thrusts of individual

grinding runners 2, 3 and 3′ may be adjusted not only in an ascending order, but arbitrarily depending on the grinding demands. Ground material falls out in the lower part of the mill to the discharging hopper 6, then is transported to other transporting devices. Not shown structural embodiment of covers of the body 4 of the mill allows for complete dust-proof feature of the mill with the possibility of dust exhaust.

Patent claims

1. The mill for grinding of materials of different hardness and grain size comprising drives and the body, equipped with the hopper and the discharging hopper, housing, in a rotating manner seated, the main grinding roller driven by the main drive, which is equipped with the replaceable abrasion-resistant tire and from both sides fitted with guide rings along the circumference, overlapping its diameter in a manner to prevent ground stock leakage from the grinding slot, whereas in addition at least three smaller grinding runners are incorporated in the body of the mill, in a rotating and sliding manner, whose axes are in parallel to the axis of said main grinding roller, and arranged in the direction of its rotation along its circumference between the hopper and the discharging hopper, whereas all grinding runners are equipped with devices providing their thrust to the main grinding roller and the first grinding runner is equipped with its own drive by means of extended ends of its shaft, protruding from bearing houses, accommodating the driven shaft in antifriction bearings, **characterized in that**, bearing houses (11) of grinding runners (2, 3, 3′) are fitted with guide grooves (13), arranged in a manner to fit into guides in sidewalls of the body (4) of the mill, whereas guide grooves (13) are fitted with lubrication channels (16) and lined along their circumference with sliding plates (14) with lubrication grooves (15), whereas bearing houses (11) of the first grinding runner (2) are coupled by said crossbeam (18), to which is leaned said push rod (17) of said compression device (7) via axial ball bearings (19).

2. The mill for grinding of materials of different hardness and grain size according to the claim 1, **characterized in that**, identically to the first grinding runner (2) bearing houses (11) of second and third grinding runners (3, 3´) are also coupled to said crossbeams (18), to which said push rods (17) of said compression devices (7) are leaned via axial ball bearings (19).

3. The mill for grinding of materials of different hardness and grain size according to the claim 1, **characterized in that**, in contrast to the first grinding runner (2) said compression devices (7) of second and third grinding runners (3, 3´) constitute part of their bearing houses (11).

4. The mill for grinding of materials of different hardness and grain size according to the claims 1 to 3, **characterized in that**, one antifriction bearing (12) of grinding runners (2, 3, 3´) is axially fixed and the other is axially floating.

5. The mill for grinding of materials of different hardness and grain size according to the claims 1 and 4, **characterized in that**, the drive of the first grinding runner (2) is provided either by the hydraulic motor or mechanical gearbox or belt or chain gear transmission.

6. The mill for grinding of materials of different hardness and grain size according to the claims 1 to 5, **characterized in that**, said compression devices (7) of

grinding runners (2, 3, 3′) comprise hydraulic and/or pneumatic cylinders or springs.

7. The mill for grinding of materials of different hardness and grain size according to the claims 1 to 6, **characterized in that**, the replaceable tire (20) of grinding runners (2, 3, 3′) is, identically to the main grinding cylinder (1), made of quality abrasion-resistant material, whereas these are forgings from chrome-nickel steel, and, furthermore, this material is fitted with the hard-facing layer for highly abrasive materials.

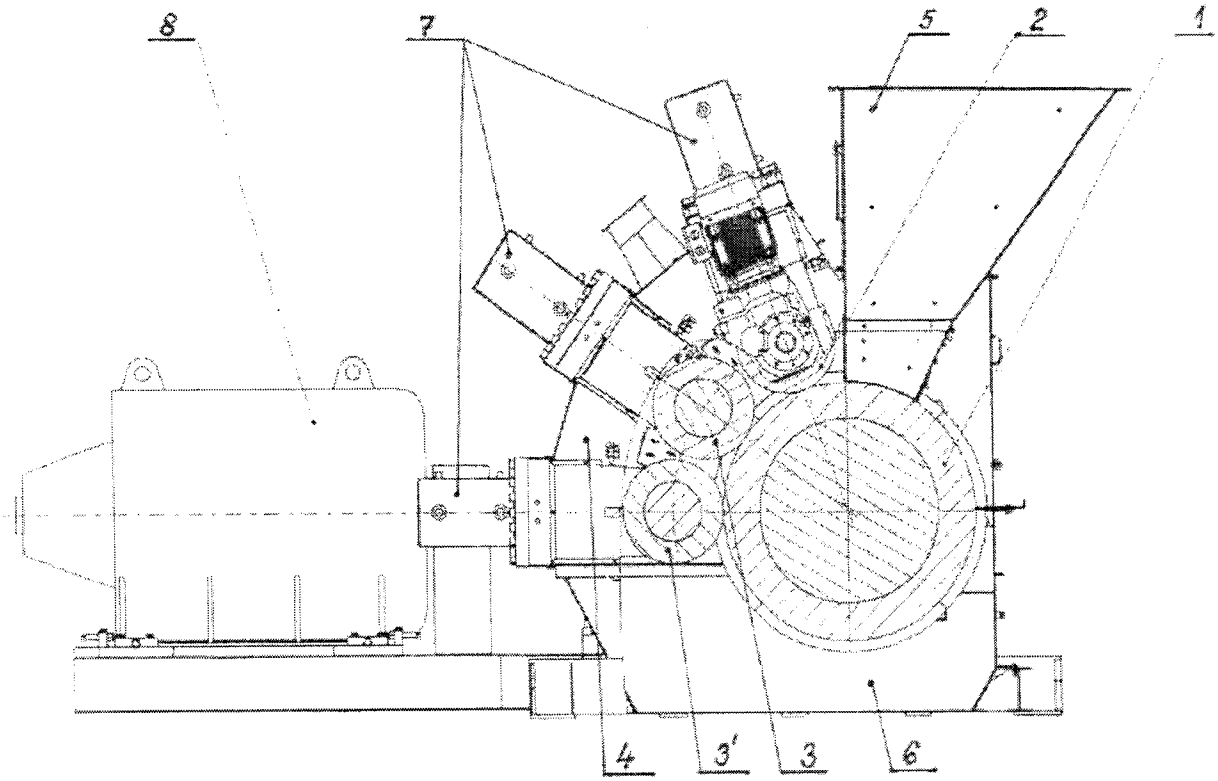

Fig. 1

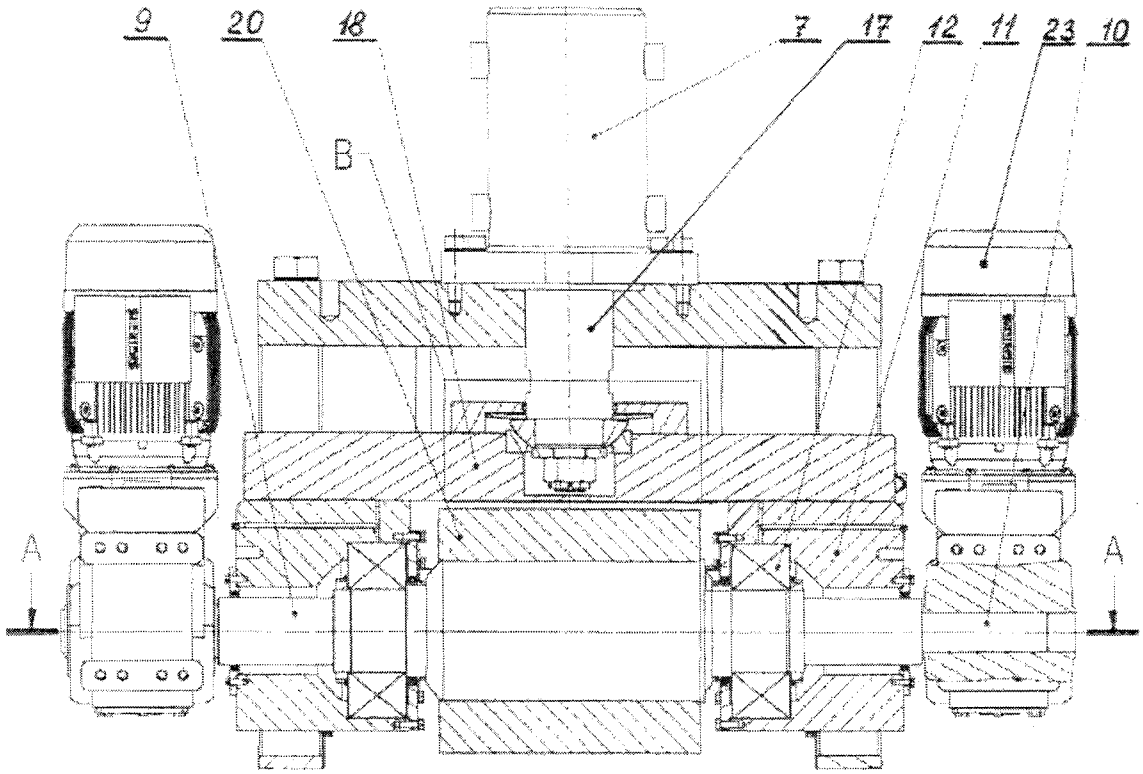

Fig. 2

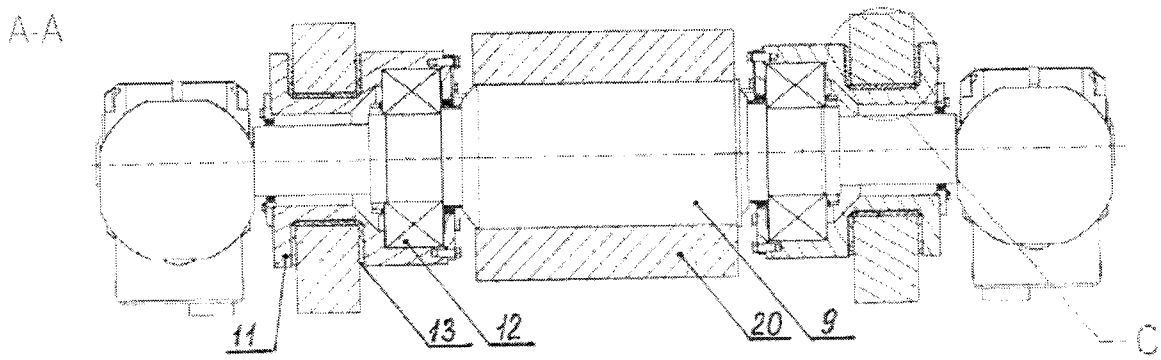

Fig. 3

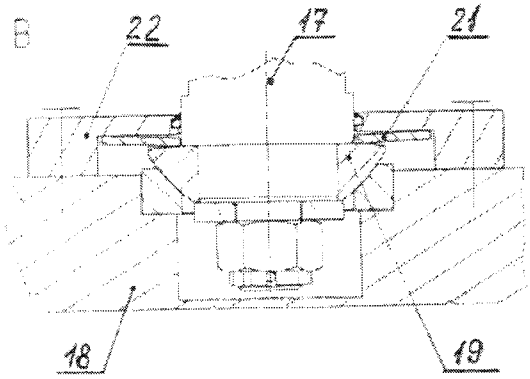

Fig. 4

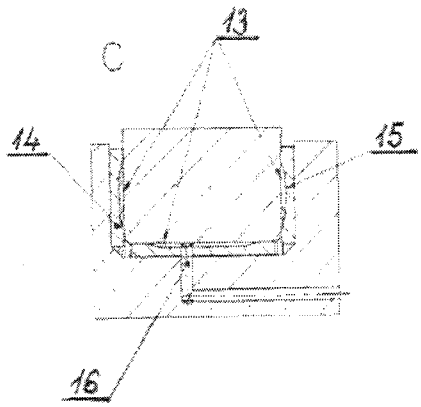

Fig. 5

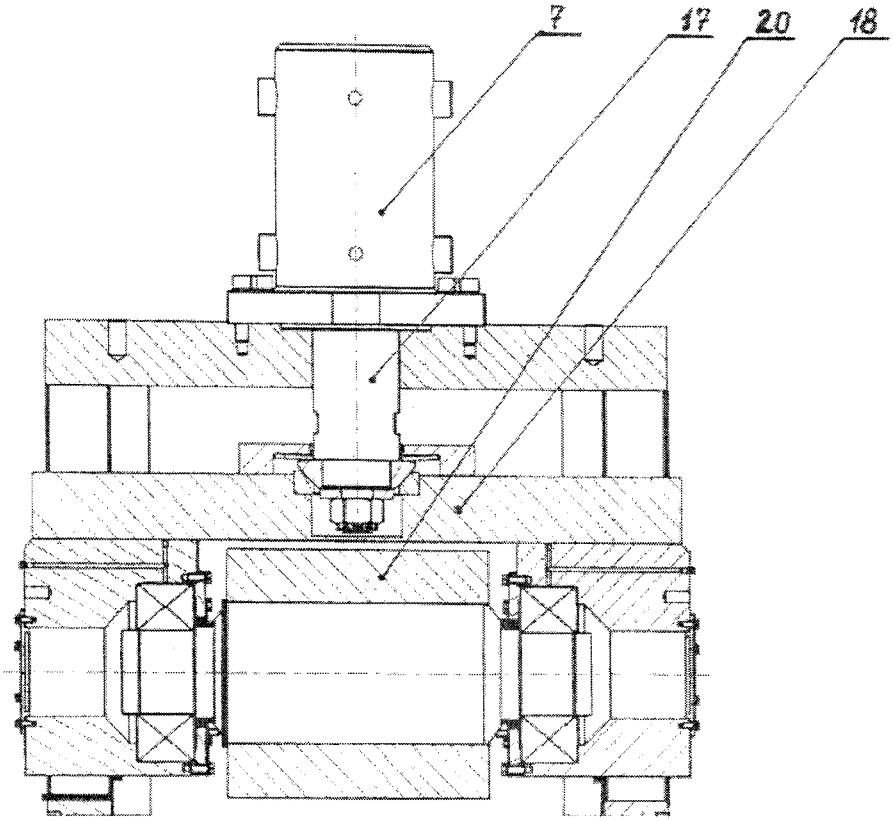

Fig. 6

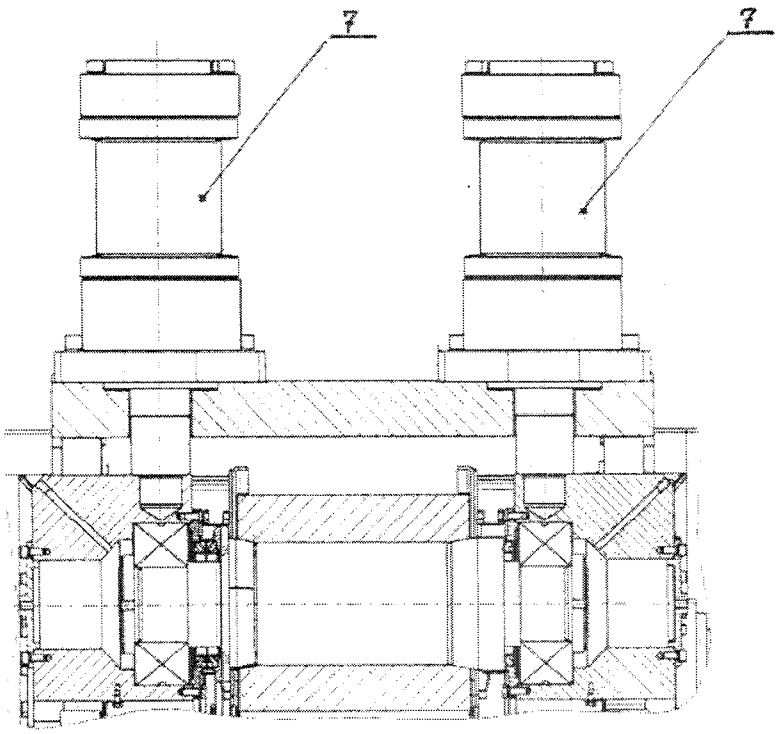

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2019/000027

A. CLASSIFICATION OF SUBJECT MATTER
INV. B02C4/02 B02C4/42 B02C4/28 B02C4/30 B02C4/32
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)
B02C

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010/301145 A1 (MEMARI FARD ALI [DE] ET AL) 2 December 2010 (2010-12-02) paragraphs [0013] - [0042], [0055] - [0057], [0065]; figures 3,7-9	1-7
A	DE 195 14 955 A1 (BUEHLER AG [CH]) 31 October 1996 (1996-10-31) column 4, line 25 - column 5, line 41 column 8, line 44 - column 9, line 16; figures 6,6a,11,12	1-7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
20 September 2019	27/09/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Iuliano, Emanuela

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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