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(54) Device for continuous non-impact pulverisation of accelerated rotated solids

(57) The device for continuous non-impact pulverisation of solids includes: A) a cylindrical container (12) with central input and peripheral output; B) a rotor (68), mounted to turn within the container, made up of a hollow hub (60), two parallel disks (62,64) assembled coaxialy on the hub, and of several flat blades (66) perpendicular to said parallel disks positioned radially between the same from said hub as far as the adjacent point of their external circumference; a front opening (70) in the cavity (12), insulated by a seal from the internal section of the container; several openings (74) linking the central cavity (72) and the area between the blades (66); C) means for driving the rotor. The charger duct (44) of the material to be accelerated is inserted axially as far as the central median point of the rotating cavity (72). The operating and parametric conditions needed for non impact pulverisation, even operating under vacuum, with minimum energy and high producibility are also worthy of note.

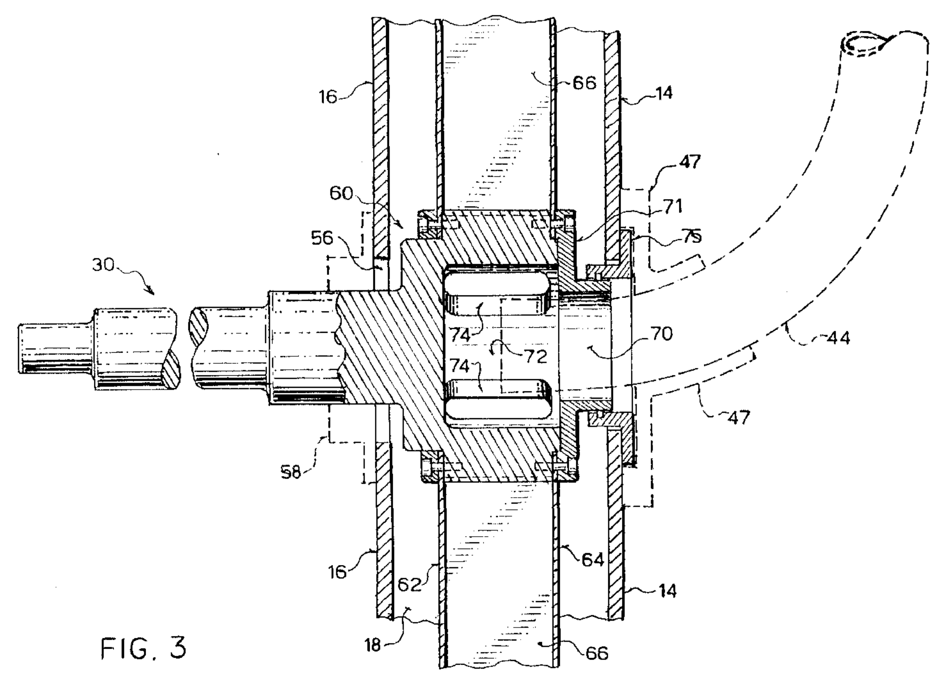

FIG. 3

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Description

FIELD OF INVENTION

The present invention belongs to the pulverisation of various solid materials sector and in particular to a device for non-impact pulverisation of solids accelerated by radial rotation.

TECHNICAL STATUS

A machine with a blade rotor able to pulverise material in general such as carbon fossil, lead, cereals, stones, cement, black sand etc. also working in a vacuum has already been achieved. This machine is the subject of Patent US-A-5392997; in a certain document it is stated that "many alterations and changes are possible without departing from the aim and spirit of the invention", but there is no indication as to the construction parameters and conditions which have to remain unaltered in order to maintain the affirmed pulverisation continuous and without impact. In practice, the machine as indicated in the USA patent has shown to have some faults in terms of production continuity and performance. It has in fact been established that it is not able to maintain for a length of time sufficient delivery of feed material to be used at an industrial level.

After a few minutes of operating, a part of the pulverised material deposits in the container and the machine has to be stopped. Even later attempts to improve the running of the machine did not give better and more reliable results.

The present invention operates basic changes and indicates the necessary conditions and operating parameters in order to avoid the drawbacks in the known machine.

This aim is achieved with a machine for pulverisation of solids without impact.

BRIEF DESCRIPTION OF DRAWINGS

Fig.1 is a front view of the invention with the front removed to reveal the rotor;
Fig.2 is the right side of the invention;
Fig.3 is the rotor in detail;
Fig.4 is an elevation of the central cavity of the rotor.

DESCRIPTION OF INVENTION

With reference to Figs. 1-2, the contrivance 10 for non-impact pulverisation of accelerated solids has a cylindrical container 12 made up of a flat front piece 14 and one at the rear 16 linked by a cylindrical section 18 with a circular flange 20; the internal chamber of container 12 thus forms a cylindrical space free from obstructions on its internal surfaces, the two ends 14-16 are assembled on a base 22 by means of a flange 24. An electric motor 26 is assembled on the base 22 above a narrow vertical frame 28, the motor 26 provides the driving power to turn the shaft 30 which turns on ball bearings 32. A feed duct 44 (held by the circular flange 47 of the front plate 14 of the container 12) exiting from a charging hopper 40 by means of a valve 42, it is inserted axially almost as far as to coincide with the vertical median axis of the internal cavity 72 of the rotor hub 60. The flange 47 supporting the feed duct is hermetically sealed to pipe 44 and the front plate 14 preventing environmental air entering the hollow 72 from the outside of the feed duct. The external duct 50 is connected to the inside of the container 12 by means of a rectangular opening 52 in the cylinder 18; the duct 50, with a circular cross-section (or rectangular), has a larger cross-section than the exit hole 52 and is able to feed directly any equipment using high speed continual flow of the treated material, or can be connected to a suitable eddy chamber (not present in the figure) which slows down the speed to facilitate recovery of the powder. The shaft 30 passes through an air tight chamber 56 on the rear plate 16 which is maintained airtight by rubber sealing rings; at the end of the shaft 30 and inside the cylindrical container 12 there is a cylindrical hollow hub 60 with parallel disks 62-64 assembled axially on the hub; four flat blades 66 are fixed between the disks 62-64, at an equal angular distance one from the other; each flat blade 66 forms a plane which extends perpendicularly to the face of the parallel disks 62-64 as far as the same point on the external circumference of the disks 62-64. The disks 62-64 have a smaller diameter than the cylinder 18. The hub 60 with disks 62-64 and blades 66 form a single body with the rotor 66 which turns freely on shaft 30 inside container 12. Hub 60 has a circular opening 70, at the front of the front flange 71, in connection with the internal cavity of chamber 72; the internal chamber of the centre rotor 72, is in connection with the external section of hub 60 through each space between the blades 66 by means of four rectangular openings 74. The front flange 71 of the hub 60 ends in a ring shape which has a rubber ring seal around its circumference 75; the seal 75 is fixed on the central hole of the front plate 14 of container 12. Therefore the internal hollow 72 of the centre rotor 60 is connected to the internal hollow of the container only through opening 74 between the blades and is connected to the external environment only through valve 42 positioned below the charging hopper at the beginning of the feed duct 44. When valve 42 is closed and the motor 26 is switched on to turn the rotor at a peripheral speed of the blades of at least 90 m/s, the air inside the machine is expelled through the peripheral outlet 52, but a vacuum is also created within duct 44 because the air, previously contained inside it has "dropped" towards the vacuum created in the central cavity 72 of the rotor 68. If at this point, valve 42 is opened and the hopper is empty, the atmospheric pressure feeds air into the centre rotor 72 through the duct 44 at a slower speed than that of the exit from the peripheral outlet 52. The inside of the container 12 remains in a vacuum and "all" the air which continues to enter the machine is regularly expelled at a high speed but without pressure and therefore "rarefied". If, at this stage, the material to be pulverised under the form of pre-ground solids, or as natural pellets, or as an amorphous form such as mud continues to be fed into the hopper, everything which, on occupying the place previously occupied by the air, reaches the inside of chamber 72 in rotor 60, exits through openings 74 between the blades 66, where (if the peripheral speed of the rotor of at least 90 m/s is sufficient in relation to the cohesion energy of the accelerated material)it is immediately pulverised even before it exits from the rotor and turns inside the cylindrical band 18 of the container 12 at a faster rotation speed than the peripheral speed of the blades 66 and, without slowing down the powder it is "all" expelled as soon as it comes in line with the peripheral output opening 52. Differently from the other previously existing machines with blade rotors, this invention does not require air in order to operate. With valve 42 closed the hopper needs to be filled with the material to be pulverised and then hermetically sealed with a cover thus insulating it from atmospheric pressure; the rotor has to reach the peripheral speed which has already been found to be the optimum for the type of material being used and then valve 42 has to be opened: the material and the air contained in the hopper drop into the duct under vacuum and enter the machine at the speed set by the difference in level of the hopper and the machine. The material is instantly pulverised before exiting from the rotor and then expelled as powder from the container at a much higher speed than the peripheral speed of the blades. By substituting the hopper with a suitable silos capable of supporting a vacuum, it is possible to achieve continuous production under vacuum even if limited and subjected to the capacity of the container in use. Following are the parametric and operating conditions which must remain the same so that the non-impact pulverisation operation can take place and be maintained at optimal production and performance conditions, independently of the length and number of blades, the shape of the various openings and ducts, type and positioning of supports, seals and motor, which may be used instead of those indicated in the present description.

A) The feed duct of the material to be accelerated 44 must be inserted axially as far as or very near to the vertical median axis point of the internal cylindrical cavity 72 of the rotor hub 60.

B) This rotating cavity 72 must not be directly connected to the external environment, but only through an open inlet valve, and it must not be directly connected to the internal vacuum of the container 12, but only through the openings 74 between the blades 66.

C) Both the radial peripheral outlet 52 and each opening 74 between the blades must have a larger cross section than the internal cross section of the feed duct 44 of the material to be pulverised.

D) The internal diameter of the container 12 must be 1.3 times less than the external diameter of the blade rotor 68.

E) the feed duct 44 must not have sections which are narrower in diameter to the hopper outlet 40 (or any silos under vacuum) and valve 42 when fully open, and must proceed gradually increasing in diameter to facilitate the passage of the material into the rotating cavity 72, particularly when under vacuum.

F) The peripheral speed of the rotor 69 must not be less than about 90 m/sec: preferably between 90 and 160 m/sec.; a peripheral rotor speed of about 100 m/sec has been found during tests to be suitable for the non-impact pulverisation of some of the most heterogeneous solids which may be fed together into the machine in different proportions, sizes and shapes, such as for example: carbon fossils, iron, other metals, mine dust, perlite minerals, granite, various cereals, mud, some plastic materials and others. They are however mixtures of materials whose components have previously been tested in individual pulverisation tests which have shown them to be compatible with an equal peripheral operating speed. For example aluminium accelerated at a peripheral rotor speed of 100 m/sec, exits from the container at a faster speed than the peripheral speed of the blades, but still unchanged from how it was fed in; its non-impact pulverisation was reached however using a rotor peripheral speed of about 155 m/sec! It is necessary to avoid critical speeds, those falling between normally valid speeds, where for example the grains of different cereals, such as rice and maize are split into two instead of being pulverised.

G) The maximum sizes of the solids which can be accelerated by the machine together with smaller sizes depends on the width of the blades between the parallel disks, in that given that the feeder duct must reach as far as the centre line of the blades, the bodies to be accelerated must be much smaller than half the width of the blades themselves.

H) At the same blade width it is worthwhile assigning the rotor with large diameters in order to reach the same rotor peripheral speed with less angular speeds, producibility remaining the same. For example the rotor may have an external diameter from between 400 to 4000 mm.

I) The internal cross section of the outlet duct 50 must be larger than the cross section of outlet 52 in order to proceed without narrowings as far as the collection eddy chamber of the powder produced.

The same machine can also vaporise liquids: 80 Kg of ground ice was transformed into a continuous jet under vacuum of saturated vapour at 36°C at a higher speed than the peripheral speed of the blades; from mud polluted with chemical agents containing 40% water a dehydrated and 100% clean powder was had. Given that radial acceleration by rotation under vacuum does not depend on the mass of the accelerated bodies performance and the negligible wear indexes on the internal parts of the machine which were held to be impossible up to now have become possible with the present invention. Up to now the physical explanation for the pulverisation action of the machine remains completely unknown.

Claims

1. Accelerating device for the continuous non-impact pulverisation of materials such as carbon fossils, cereals, metals, rocks and similar made up of:

   - a hollow cylindrical container with peripheral axial feeder and radial output duct,
   - a cylindrical rotor mounted for rotation in said container made up of a hollow hub, two parallel circular disks mounted coaxially on said hub and of several flat blades perpendicular to said parallel disks positioned radially between the same from said hub as far as the adjacent point of their external circumference, said hub, having an axial elongation orientated towards its own internal cavity and several openings which connect the internal cavity of the hub with the space between the blades.
   - a motor to turn the rotor; and where
   - the material is loaded into the internal hollow of said hub while the rotor is driven to turn,

   characterised by the fact that said rotor is driven at a peripheral speed of not less than 90 m/sec; so that the material is immediately pulverised without impact and flows out of said duct at a speed greater than the peripheral speed of the blades.

2. Device according to claim 1, where said rotor is driven at a peripheral speed from between 90 to 160 m/sec., preferably at about 100 m/sec depending on the material to be pulverised.

3. Device according to claim 1 where the internal diameter of the container is at least 1.3 times the external diameter of the rotor positioned and turning in said container.

4. Device according to claim 3 where the rotor has an external diameter of between 400 and 4000 mm depending on the width of the rotor blades.

5. Device according to any of the previous claims where the charger duct to load the material to be pulverised enters the central cavity of the hub as far as the centre line of said cavity without connecting to the internal section of said container.

6. Device according to any of the previous claims where said charger duct is equipped with means of preventing air entering the internal section of the container.

7. Device according to any of the previous claims where said central cavity of the rotor hub is insulated towards the internal cavity of the container by an hermetic seal.

8. Device according to any of the previous claims where the charger duct is equipped with a valve fixed below the output opening of the hopper for charging the material to be pulverised, said valve is closed during starting up and setting at work of the rotor or when the continuous feed of material is interrupted and is open during functioning at full production.

9. Device according to any of the previous claims where said charger duct has a wider cross section than the output opening of said hopper.

10. Device according to any of the previous claims where each of the radial openings of the hub are rectangular, as long as the width of the blades and half as large at least so that they have a cross section longer than the internal one of said charger duct.

11. Device according to claim 10 where the peripheral radial exit duct connects up to the inside of the container through a rectangular opening wider than any one of the radial openings of the hub between the blades.

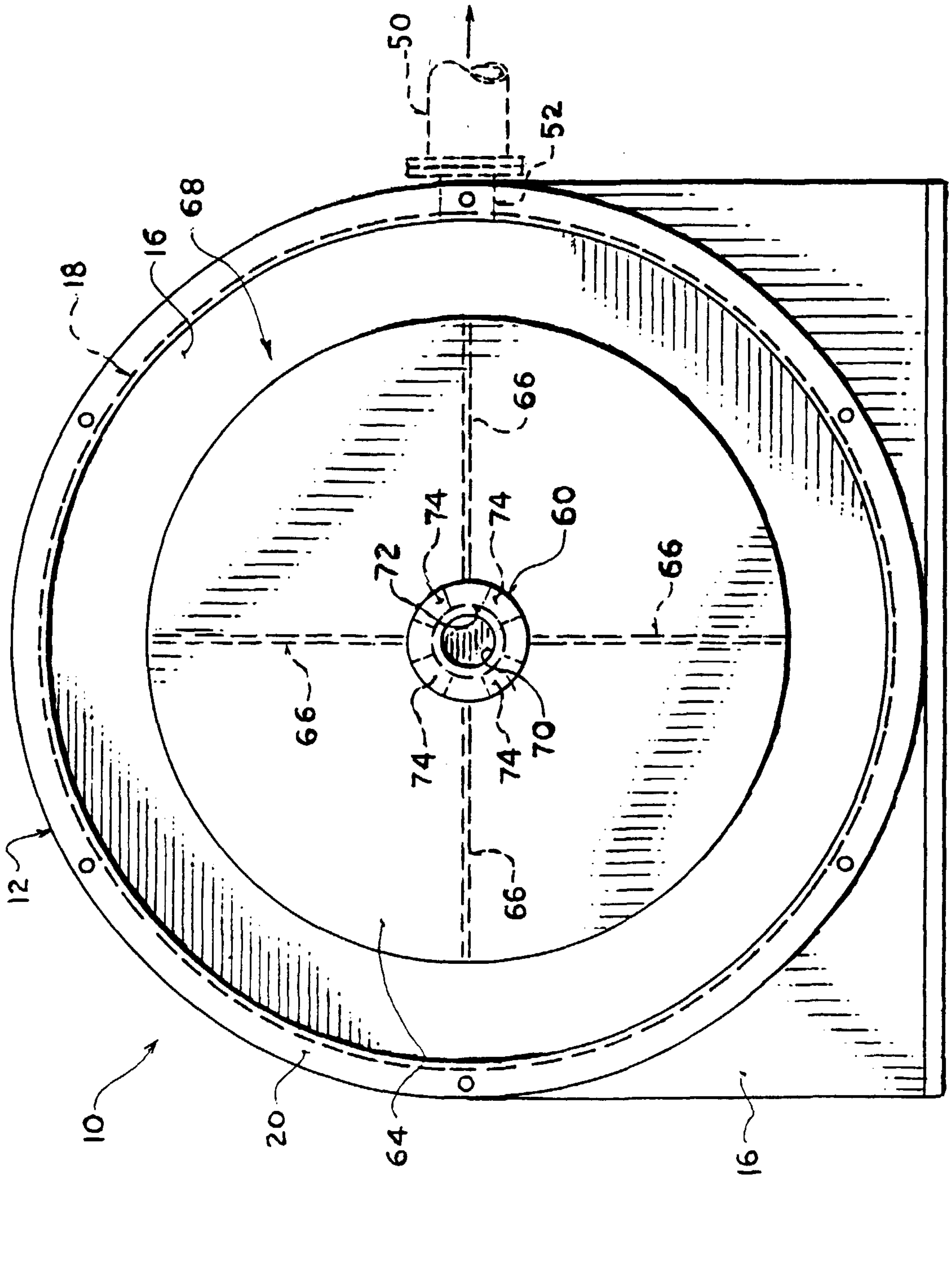

FIG. 1

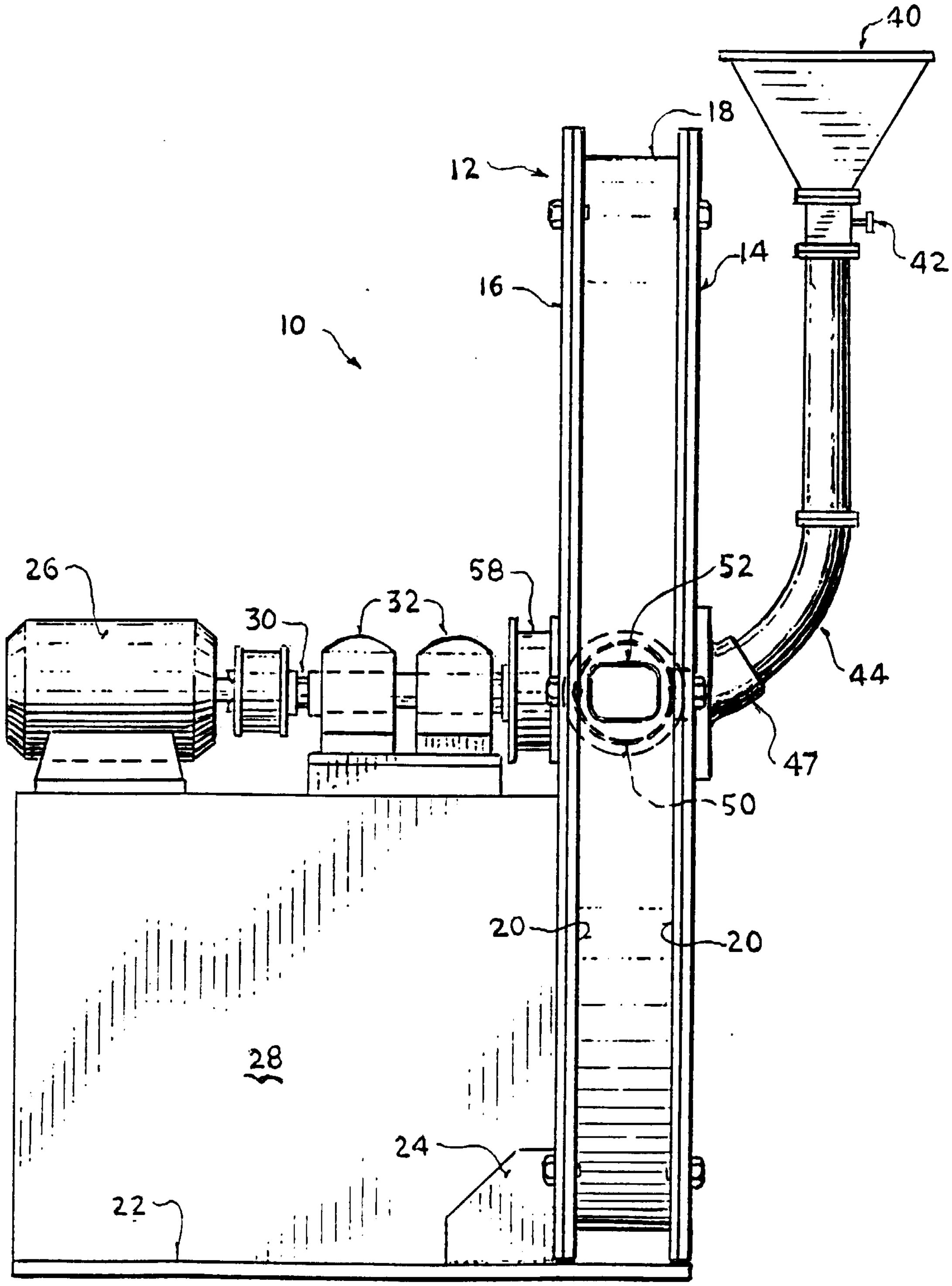

FIG. 2

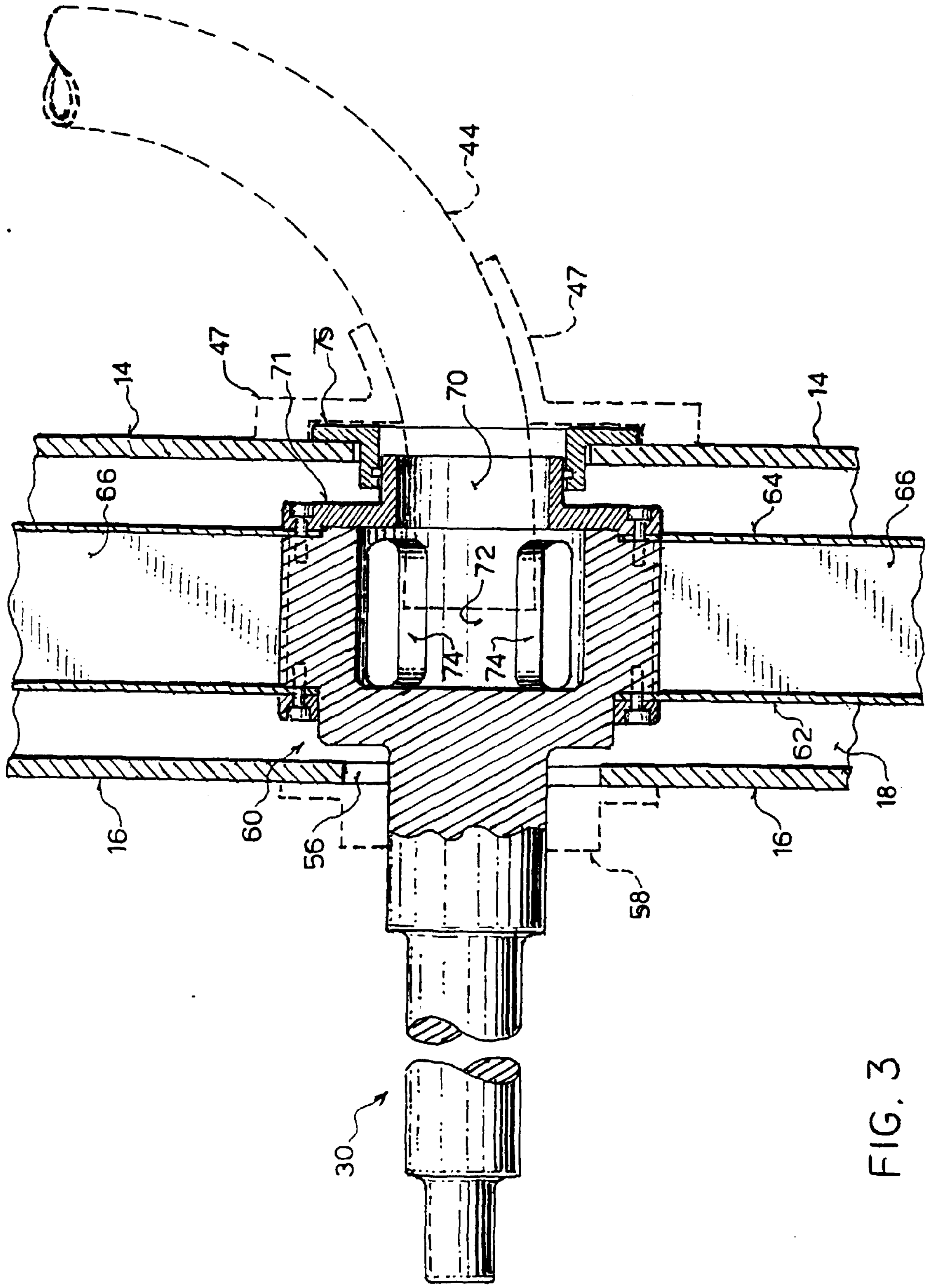

FIG. 3

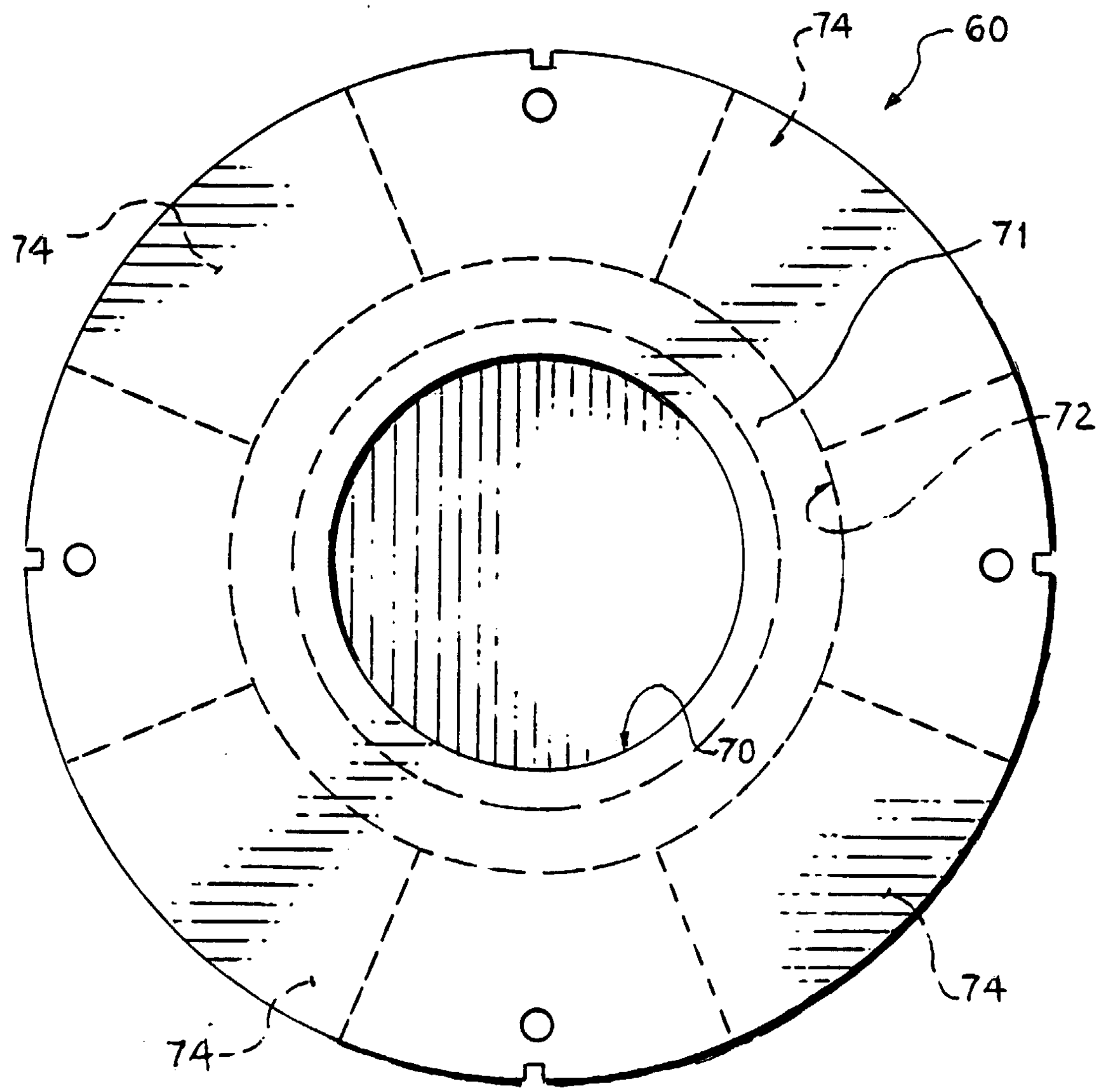

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 97 83 0437

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X,D	US 5 392 997 A (I. COMENSOLI)	1,2,4,6, 8	B02C1/00 B02C13/06 B02C13/288 B02C19/00 B02C13/286
	* the whole document *		
A		3,5,7, 9-11	
A	GB 939 206 A (SOC. ULTRAFINE DE L'UNION FRRANÇAISE) * page 2, line 21 - line 27 *	1	
A	US 3 028 106 A (R.P. FISHER) * the whole document *	1	
A	FR 1 570 346 A (MANUEL DIAS VALENTE DE ALMEIDA) * page 2, line 3 - line 16; figure 2 *	1,5	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B02C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 December 1997	Verdonck, J

CATEGORY OF CITED DOCUMENTS

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