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(71) Applicant : **Ente per le nuove tecnologie, l'energia e l'ambiente (ENEA)**
Viale Regina Margherita 125
I-00198 Roma (IT)

(72) Inventor : **Floris Francesco**
Via Dante 254 M
It-09128 Cagliari (It)
Inventor : **Partesotti Corrado**
Via Nirano 43
It-41040 Spezzano (It)

(74) Representative : **Sarpi, Maurizio**
Studio FERRARIO Via Collina, 36
I-00187 Roma (IT)

(54) Automatically operated burner of coal dust or any other solid fuel.

(57) A burner of coal dust or any other powdery solid fuel includes a powder fuel metering device and an enbloc combustion head having horizontal axis which is supplied by said metering device and includes a plurality of tubular coaxial ducts, i.e. a central cylindrical duct for supplying coal dust mixed with air which is provided with an atomizing nozzle, a concentric tubular duct for the swirling air, a duct for the air-gas mixture which is provided with a ring of auxiliary firing holes, and a duct for the combustion air surrounding the whole assembly and provided at its end with a ring of holes converging to the axis and axially misaligned so as to cause the air to swirl.

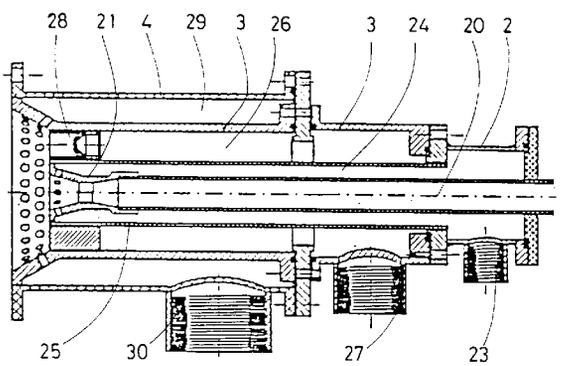

FIG.4

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The present invention relates to a burner designed in particular to be supplied with coal dust, solid fuels from urban solid refuses, industrial waste, also referred to RDF (Refuse Derived Fuel), or any other solid fuel which can be turned into dust.

The burner is of the self-contained enbloc type and can operate automatically.

At the present status of art devices are used which can be operatively referred to coal dust blowers rather than burners. Such known devices need suitable combustion chambers and starting pre-heaters causing the system to be considerably "rigid", which makes the control thereof very hard, the automatic operation quite complicated, the fire control very difficult, the flow rate control insufficient, the capability of adaptation to other fuels very short, and the rate of the carrier gas rather low with deposition problems.

This invention aims at providing a burner of the mentioned kind which has the following advantages over the known systems:

a) capability of burning any fuel which can be powdered;

b) ease of installation at any furnace, high operating flexibility due to the modular regulation, use of automatic controls, automatic firing and re-firing;

c) good combustion efficiency such as high thermal efficiency, complete combustion with spent residual dusts, and high combustion temperature.

According to the invention it is provided a self-contained burner of dusts from any solid fuels having an auxiliary pre-firing or pre-heating flame located in the same combustion head for the combustion of solid fuels derived from industrial wastes which are poor or can be hardly burnt. Such auxiliary flame which also starts the combustion is produced by a burner of premixed gas which is integral with the combustion head of the burner so that the device thus formed is a self-contained, automatically operating, enbloc burner.

The invention will now be described with reference to the accompanying drawings which show by way of a non-limitative example a preferred embodiment of the invention.

In the drawings:

Fig. 1 is a side elevation view;

Fig. 2 is a front elevation view of Fig. 1 seen from the flame;

Fig. 3 shows in detail the meter of the dust in several. section views;

Fig. 4 shows schematically an axial section view of the burner;

Fig. 5 is a front view corresponding to Fig. 4;

Figs. 6 and 7 are views in enlarged scale corresponding to Figs. 4 and 5.

With reference to Figs. 1 and 2 the invention provides a metering device 1 and a burner supplied by such metering device and formed of four coaxial bodies, namely cylindrical body 2 in which the dust is conveyed along with the carrier air, body 3 conveying the swirling air as better described afterwards, body 4 for the air-gas mixture feeding the auxiliary flame to fire the dust, and the outer sleeve 7 in which the combustion air is conveyed. There is also a fitting 5 provided with flange 6 for the connection of the whole device to the furnace (not shown), as well as a nozzle ejecting the flame 8.

The metering device (Fig. 3) includes a hopper 9 receiving the powdery fuel with the desired granulometry. At the base of the hopper a pair of rotors 10 turn in the direction indicated by the arrows. Such rotors carry radial vanes 11 which form compartments or pockets having an essentially constant volume together with the seats formed in the stationary casing 12.

Radial vanes 11 are offset so that the dust from the hopper is mixed and supplied to the feeding chamber 13 under rotors 10. A disc 14 rotating within hopper 9 is provided with tangential studs 15 and radial studs 16 having the function of avoiding dust cloggings. All of such rotating members are driven by gearmotor 17 through gears 18 and 19. It is evident that the flow rate of the dust can continuously be varied from zero to the predetermined maximum value by varying the speed of rotors 10.

From the feeding chamber 13 the dust along with the carrier air is fed through the axial pipe 20 of the burner head shown in Figs. 4 to 7.

Pipe 20 ends at the front side in a Venturi tube nozzle 21 carrying a ring of holes 22 converging to the axis of pipe 20 and misaligned sideways so as to cause air flowing from inlet 23 through the annular room 24 about pipe 20 defined by sleeve 25 to swirl.

Another annular room 26 is provided coaxially to the axis of the ejecting pipe 20, in which room an air-gas mixture flows from inlet 27. Such room 26 ends at the front side in a ring of nozzles 28 angularly spaced and intended to eject a plurality of flames surrounding the outlet of nozzle 21. A further annular room 29 defined by sleeves 3 and 4 conveyes the combustion air from inlet 30 which is generated by a known electric fan not shown.

The annular room 29 of the combustion air ends at the front side in a frusto-conical "horn" fitting 31 carrying a double ring of holes 32 converging to the axis of pipe 20 and misaligned so as to cause the combustion air to swirl in the opposite direction of rotation of the dust ejected by nozzle 21.

The operation of the device is apparent from Figs. 6 and 7: the dust swirls out of nozzle 21 and is fired by the surrounding ring of auxiliary flames ejected by nozzles 28. Once the predetermined conditions of the thermal rate are reached, the auxiliary flames can be blown out (by shutting off only the gas) so that the combustion is supported only by the dust.

As mentioned above the operation of the dust burner is completely automatic, including firing which is provided by a little blowing air burner (drive burner)

having a low thermal value, for example 7000 kcal/h. The drive burner is automatic and provided with electric firing means and flame control means. The combustion air to be supplied to the drive burner is fed by the electric fan also supplying the auxiliary burner associated to the dust burner with the combustion air.

The firing steps are as follows:

– pre-washing the combustion chamber for eliminating any gas residue;

– firing the drive burner and waiting for the fire stabilization;

– repeating in succession the above steps of the firing cycle of the dust burner.

The drive burner operates as long as the dust burner is under operating conditions and even as the latter is blown out due to the reaching of the maximum temperature.

After the drive burner is fired, the auxiliary pre-firing gas burner formed of the nozzle ring 28 is fired. The latter burner has a prefixed thermal value of 30.000 to 60.000 kcal/h.

After the pre-firing burner is fired, a certain time is needed so that the combustion chamber can reach the requested minimum temperature; once the desired temperature is reached, the combustion air, the swirling air, the dust atomizing carrier air, and the dust at the minimum flow rate arm let in. After the dust is fired with the aid of the auxiliary flame, the flow rate of the fuel is automatically adjusted to the desired value.

After the flame has settled and a further increase in the temperature of the combustion chamber is achieved, the gas of the auxiliary burner is shut off and the combustion is supported only by the dust fuel, as previously mentioned.

The blowing out of the auxiliary burner is provided only if a good combustion can be self-sustained by means of the fuel being used; in case of a poor, hardly burning fuel, the auxiliary burner is kept fired. In any case the drive burner is kept in operation.

After the temperature or the pressure adjusted in the automatic modulation regulators located by the user to be supplied is reached, the thermal value of the burner is settled to the actual requirement of the user; if also the minimum flow rate is overflowing, the whole burner is blown out except for the drive burner. The whole burner assembly will be fired again when believed it necessary by the control means. The re-firing steps are the same as those already described.

The present invention has been illustrated and described with reference to a preferred embodiment thereof, however, it should be understood that construction modifications can be made by those skilled in the art without departing from the scope of the present invention.

Claims

1. A burner of coal dust or any other solid fuel of the enbloc type having a horizontal axis characterized in that it includes:
   – a metering means provided with charging hopper to supply dust to an underlying mixing chamber where the dust is mixed with the carrier air; and
   – a combustion head comprising a plurality of coaxial cylindrical ducts including a sleeve carrying the dust from said mixing chamber and ending in an atomizing nozzle, a duct of the swirling air, a duct to let in an air-gas mixture ending in a pre-firing hole for the auxiliary flame, and a duct of the combustion air.

2. The burner of coal dust of claim 1, characterized in that said metering unit includes a pair of rotors having parallel axes and opposite directions of rotation which are provided with vanes defining a plurality of little compartments or pockets which are externally closed by the lining of the stationary casing of said rotors and communicates at the upper side with the exterior through the charging opening at the bottom of the hopper and at the lower side with a chamber at the base of the metering unit.

3. The burner of coal dust of the preceding claims, characterized in that the two rotors are offset by half compartment in order to cause the dust to be continuously transferred into the underlying chamber of the metering unit.

4. The burner of coal dust of the preceding claims, characterized in that in said chamber at the base of the metering unit two Venturi tube nozzles are provided, the first of which injects the atomizing carrier air necessary to carry the coal dust from the metering unit to the atomizing nozzle in the combustion head, the second collects the air-dust mixture and conveyes it through said transfer sleeve up to the atomizing nozzle.

5. The burner of coal dust of the preceding claims, characterized in that a rotating disc with horizontal axis is provided within said charging hopper, at the periphery of which radially protruding studs interleaved with tangential protruding studs parallel to the axis of the disc are provided, said studs having the function of avoiding cloggings.

6. The burner of coal dust of the preceding claims, characterized in that the metering unit is controlled by an electromechanical gearmotor arranged for the automatic control.

7. The burner of coal dust of claim 1, characterized in that the atomizing nozzle at the front end of the sleeve transferring the air-dust mixture includes a first converging, frusto-conical input length, a second cylindrical length and a third diverging frusto-conical output length to slow down the rate of the mixture and at the same time to spread the jet, in the conical portion of the third length a plurality of cylindrital holes being provided, said holes having sloping axes with regard to the longitudinal axis of the burner and being misaligned with regard to the central axis of the nozzle, said holes communicating with the swirl air inlet duct coaxially surrounding the nozzle, thus providing that the air flowing through said holes be caused to swirl and be conveyed to the jet of the atomized dust.

8. The burner of coal dust of claim 7, characterized in that the swirl air duct is completely separated from the other air ducts, and the flow rate of the inlet air can be proportioned through a controlling shutter so as to let air in the nozzle at optimized pressures, flow rates and temperatures without affect the other regulations.

9. The burner of coal dust of claim 1, characterized in that the atomizing nozzle is provided at the centre of a pre-firing and/or auxiliary ring-shaped burner adapted to provide a flame ring surrounding said nozzle ejecting the dust.

10. The burner of coal dust of the preceding claim, characterized in that said pre-firing and/or auxiliary burner is formed of a ring in which a plurality of cylindrical, equally spaced holes are provided, in which as many nozzles of frusto-conical form are provided having output holes with axis parallel to that of the dust inlet duct and all connected to the duct of the air-gas mixture surrounding said dust inlet duct.

11. The burner of coal dust of the preceding claim, characterized in that said nozzles of the prefiring and/or auxiliary burner are provided with secondary holes formed in the conical wall and sloped with regard to the longitudinal axis of the burner, said holes being adapted to eject little flames in order to avoid any flame breakdown.

12. The burner of coal dust of claims 10 and 11, characterized in that said prefiring and/or auxiliary burner has also the function of air ejector coaxial to the burner operating when the gas is shut off upon reaching the thermal rate of the flame.

13. The burner of coal dust of the preceding claims, characterized in that outside the pre-firing and/or auxiliary gas burner a frusto-conical annular body diverging to the outside is provided, in the wall of which two parallel rings of cylindrical holes supplied by the combustion air duct are formed.

14. The burner of coal dust of the preceding claim, characterized in that the axes of said cylindrical holes are sloped with regard to the longitudinal axis of the burner, said holes being misaligned from the central axis of said combustion head, thus providing that the air conveyed through said holes swirls in the opposite direction of that of rotation in the atomizing nozzle in order to cause the combustion air to cross the fuel atomized in the combustion head.

15. The burner of coal dust of the preceding claim, characterized in that the dust carrier air, the swirling air, the combustion air, and the air of the auxiliary burner are supplied by only one electric fan.

16. The burner of coal dust of claims 1 to 15, characterized in that several flow rates can be independently adjusted so as to provide optimum combustion conditions as a function of the required thermal value.

17. The burner of coal dust of claims 1 to 16, characterized in that the whole operating cycle including the firing, the setting up, and the operation is completely automatic, and the initial firing is provided by a conventional drive burner with blown in air and little thermal value.

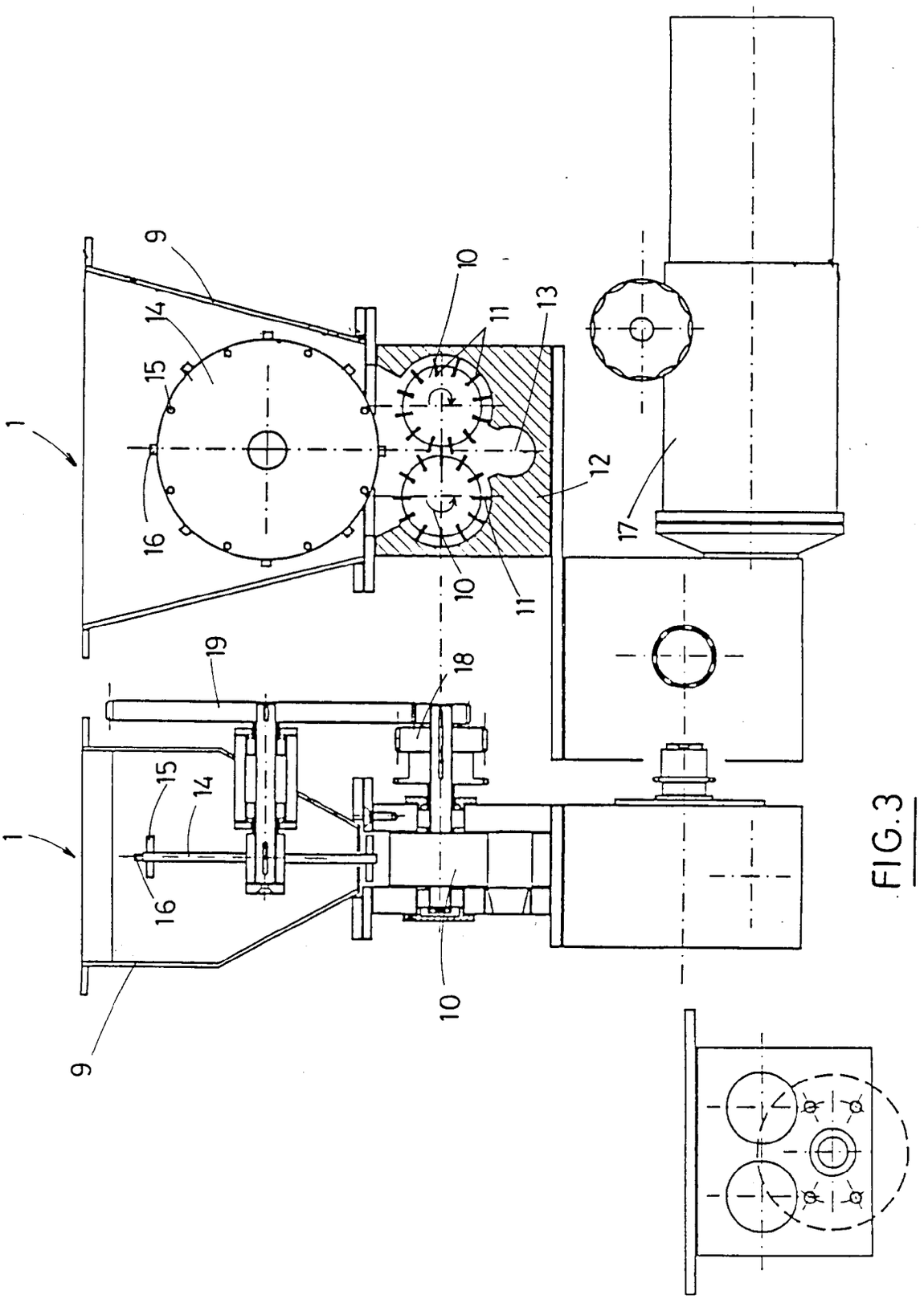

FIG.3

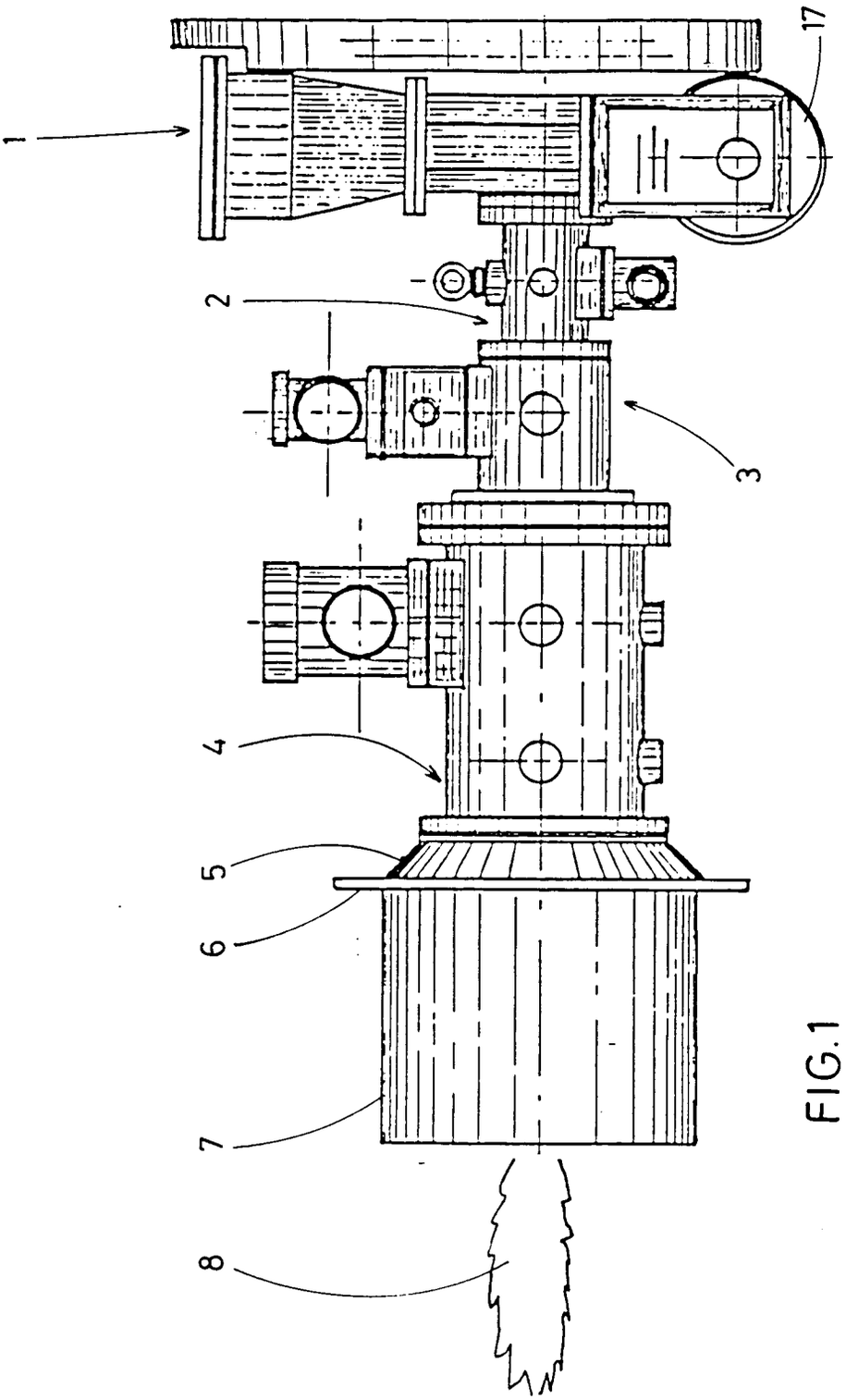

FIG.1

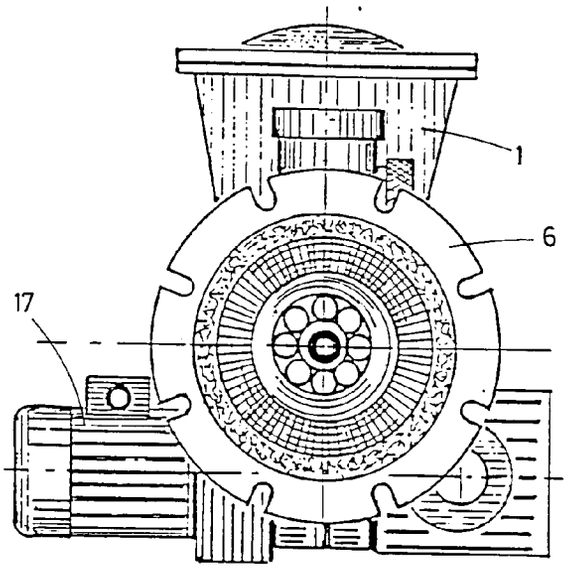

FIG.2

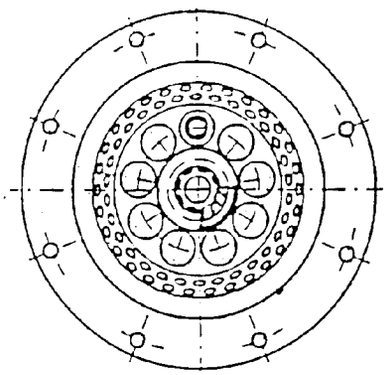

FIG.5

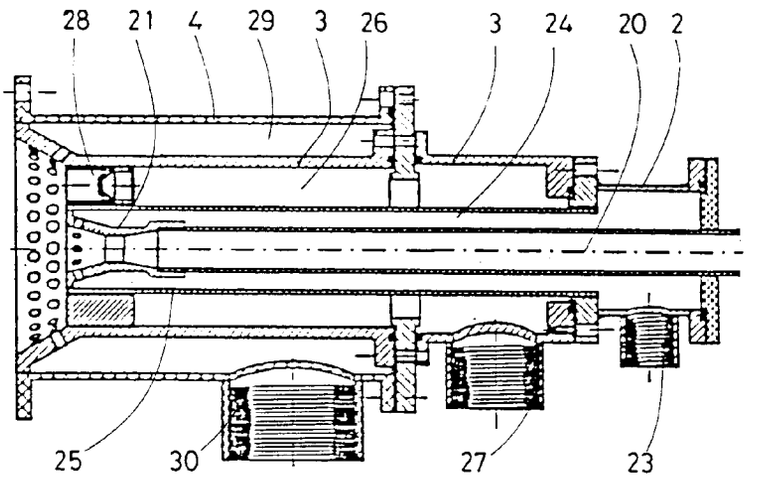

FIG.4

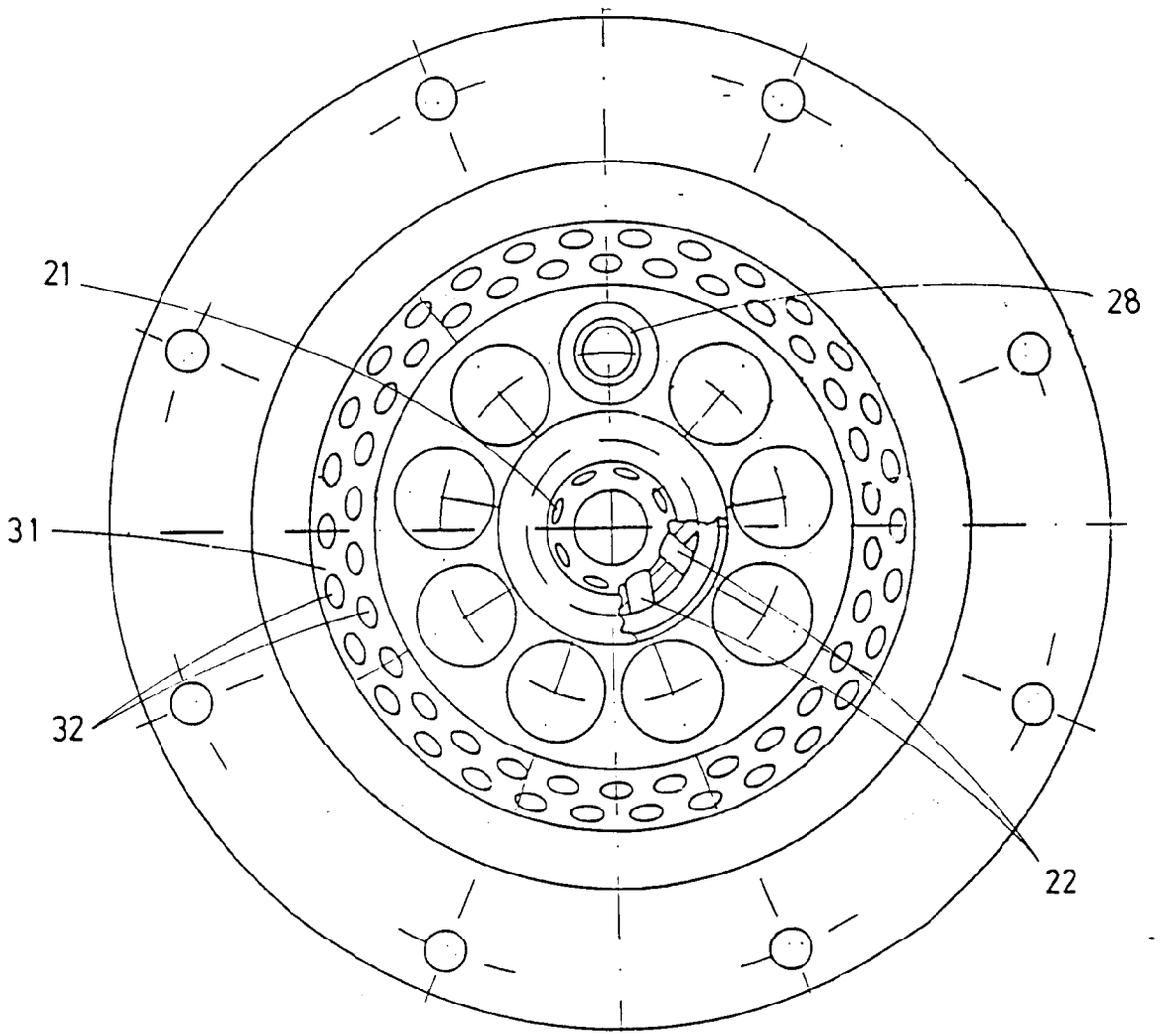

FIG. 7

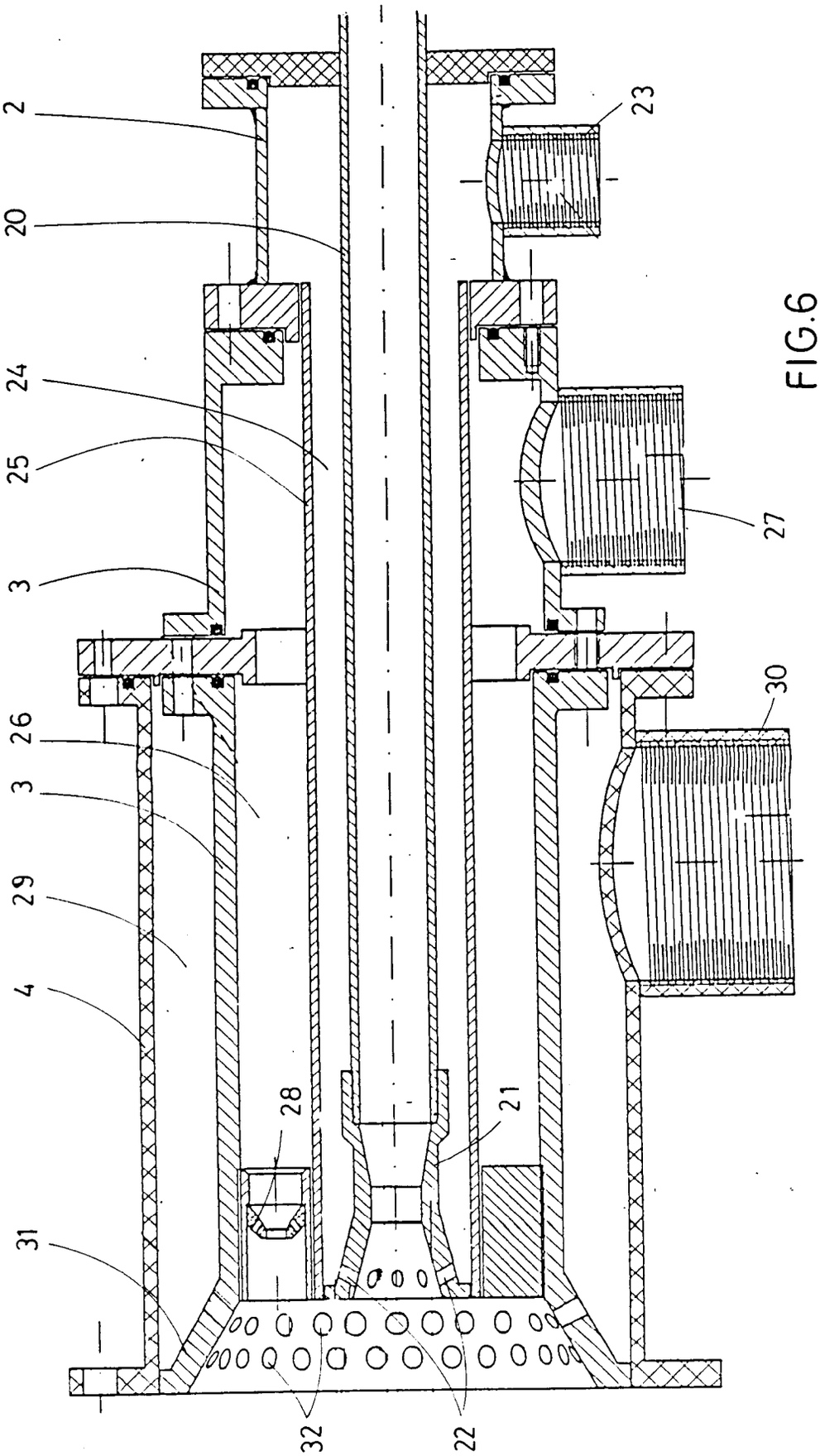

FIG.6