# United States Patent [19]

**Carrasse et al.**

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[54] **GAS HEAT EXCHANGER UNIT**


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[51] **Int. Cl.** ............................................ **F28d 19/00**

[58] **Field of Search** .................... 165/6, 5, 10, 9, 95



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[57] **ABSTRACT**

Compact dedusting heat exchanger, characterized in that the heat exchange unit consists of a superimposing of a certain number of metal lattices, the assembly having the form of a metal conveyor in a closed loop moving continuously, passing through a hot gas compartment then a cold gas compartment.


**11 Claims, 8 Drawing Figures**

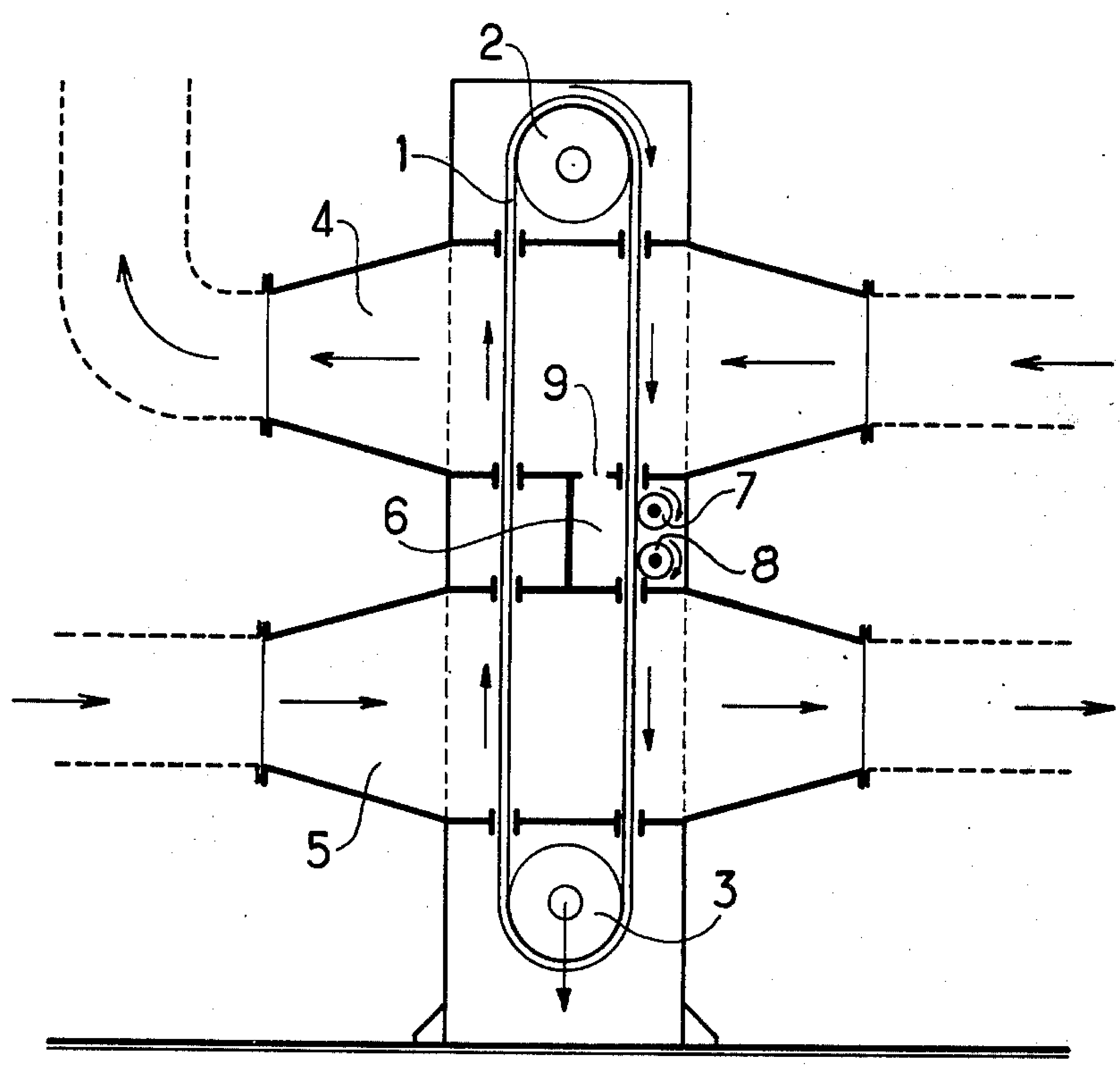


FIG. 1

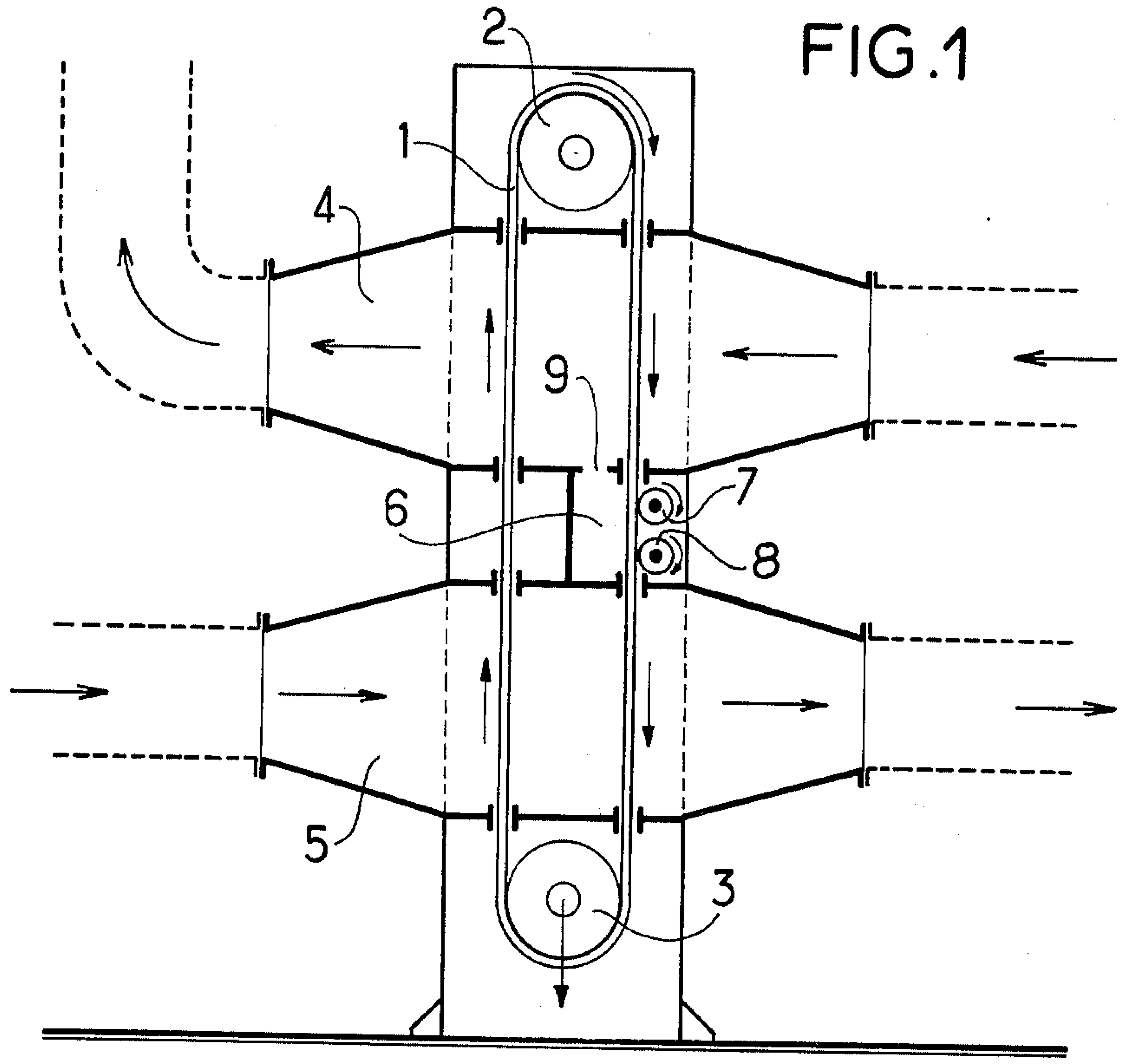
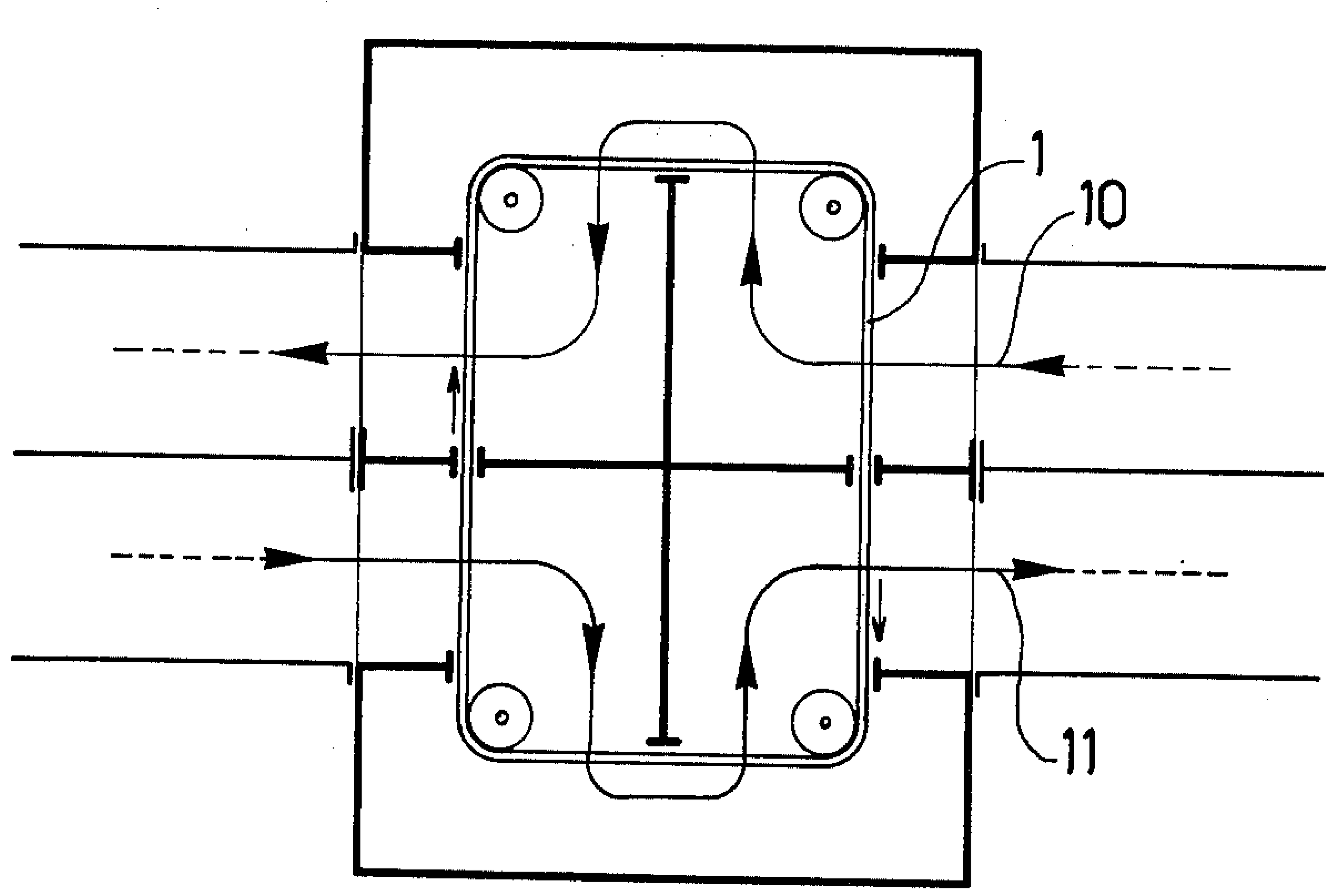



FIG. 2



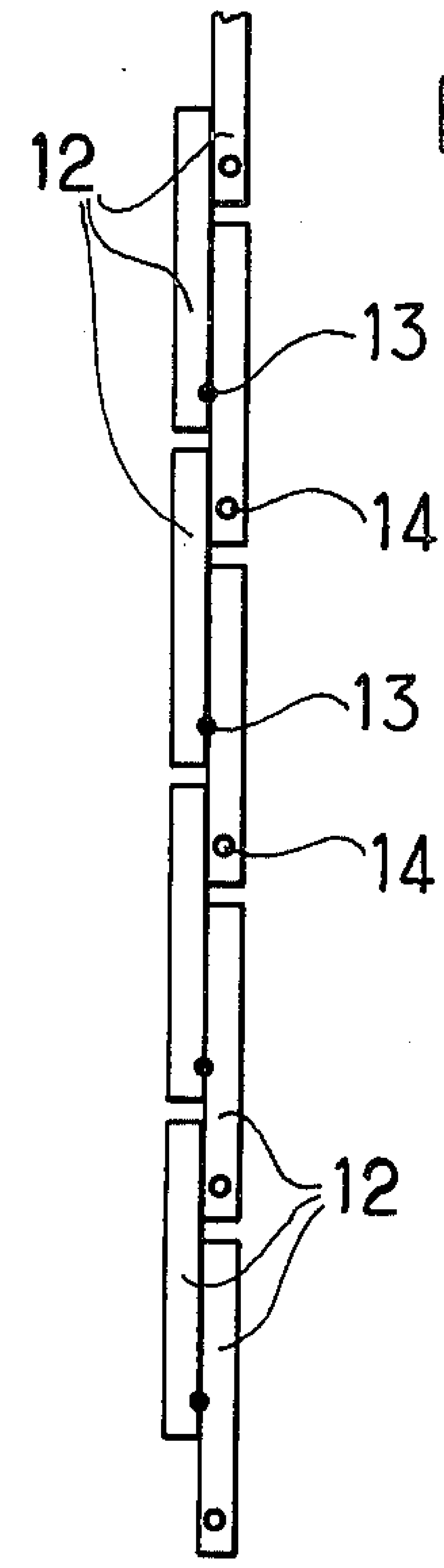



FIG.3

FIG.4

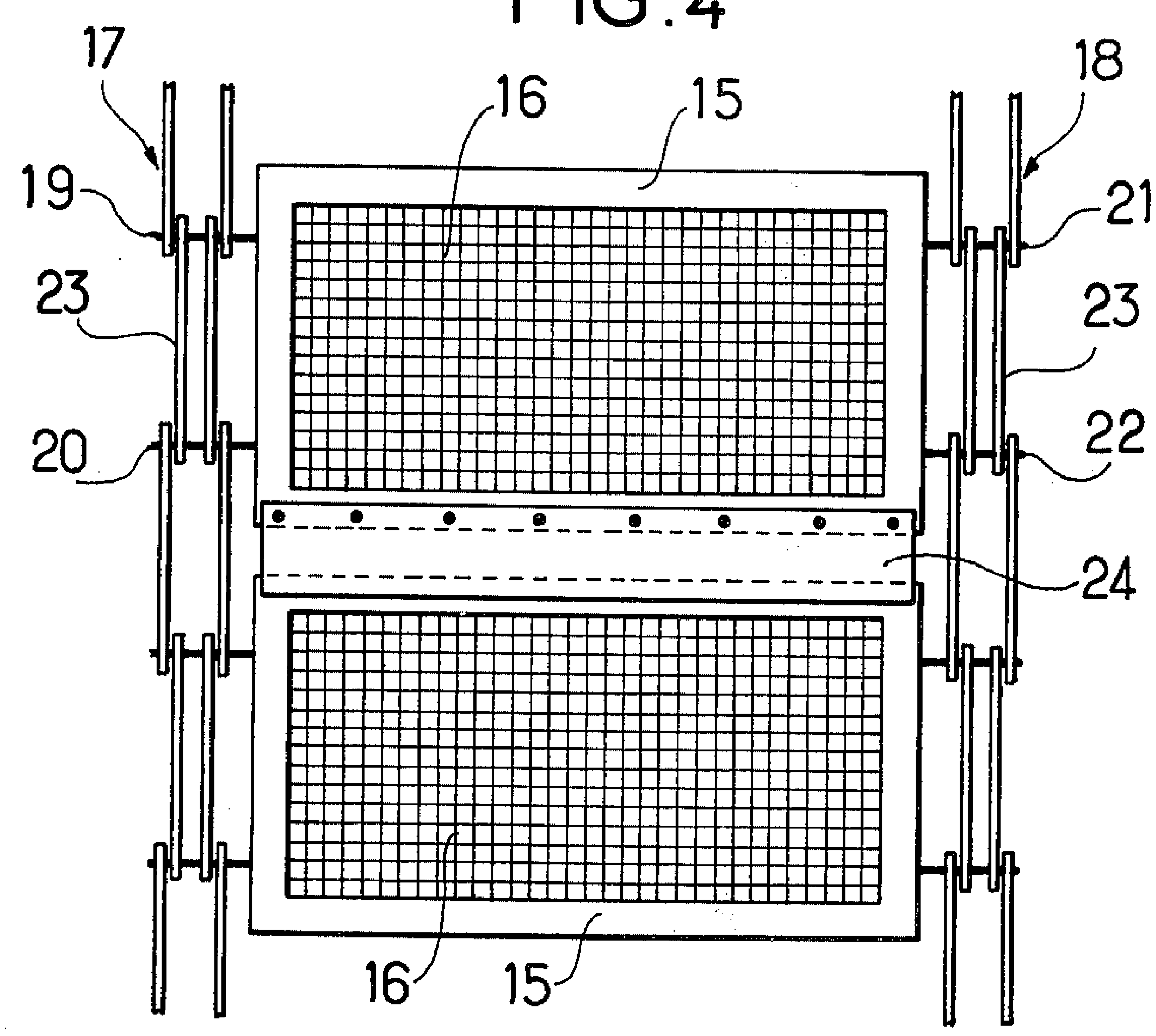


FIG. 5

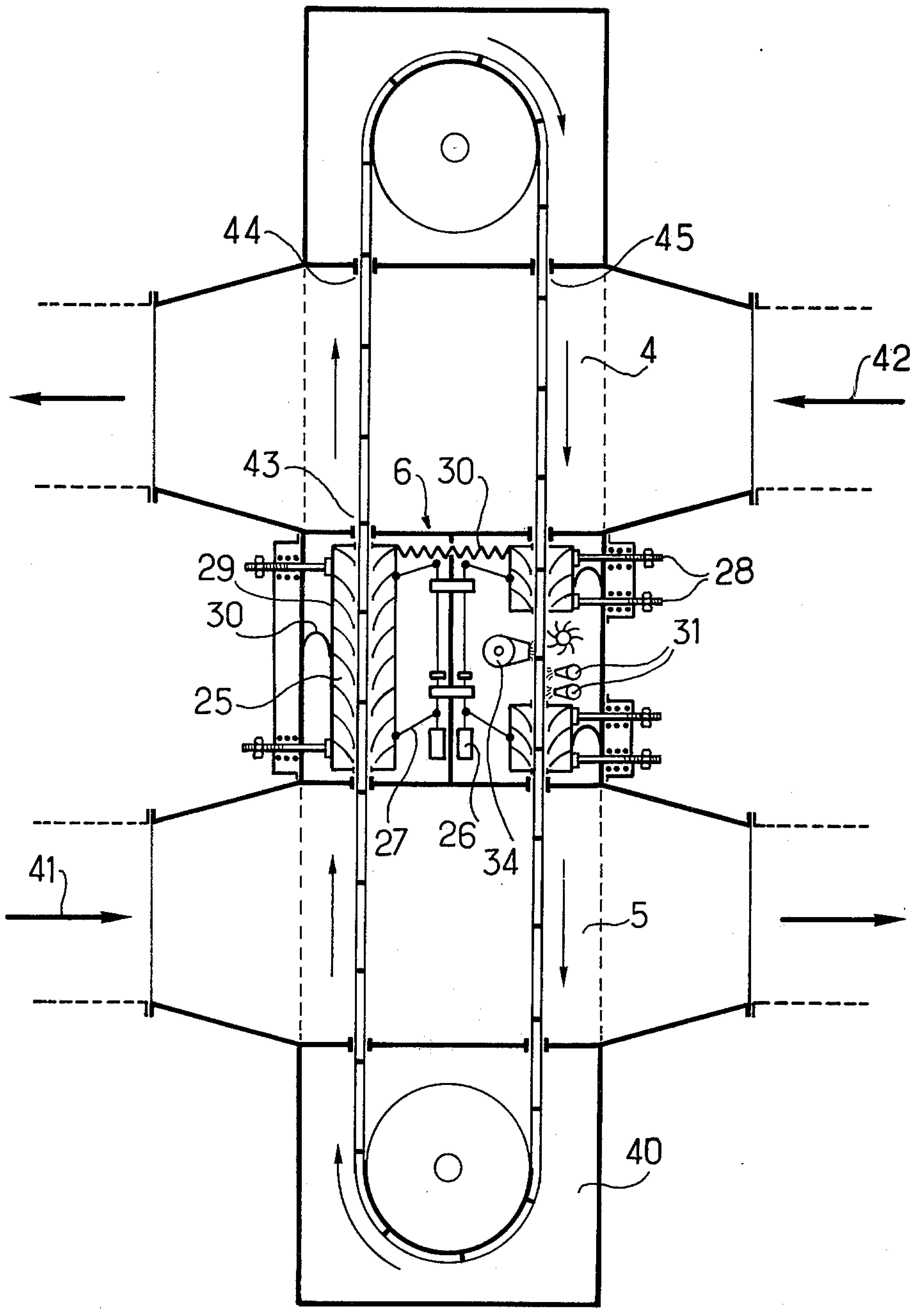


FIG. 6

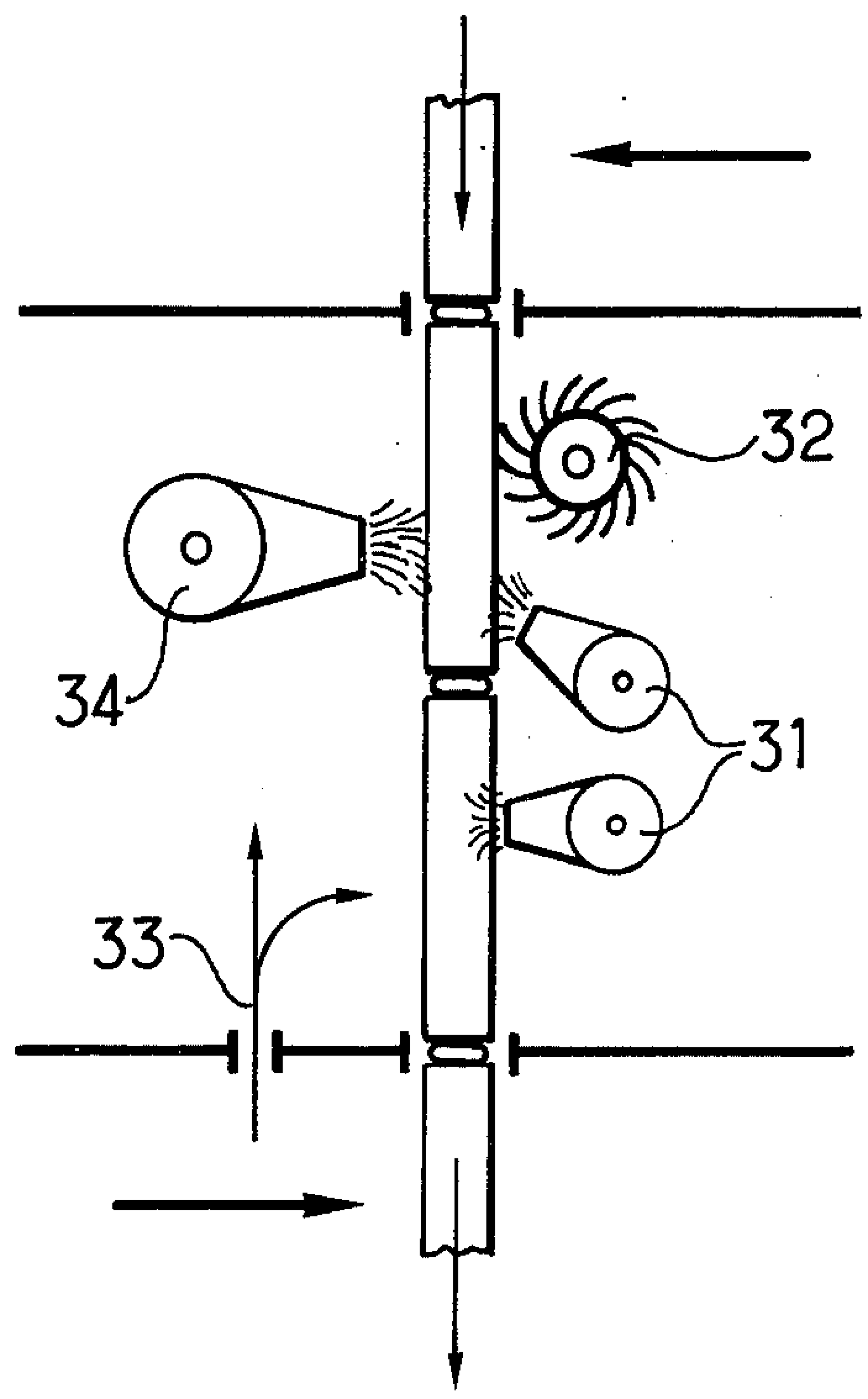



FIG. 7

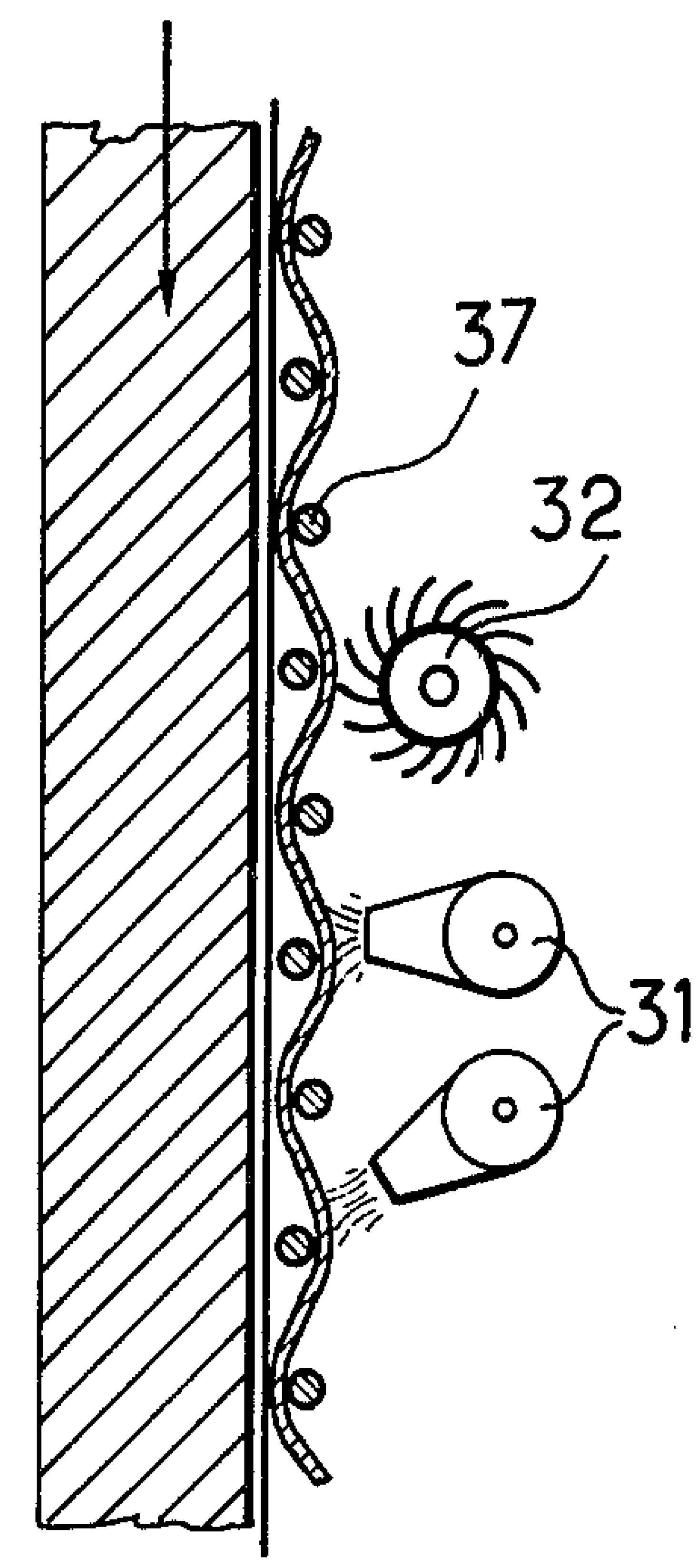
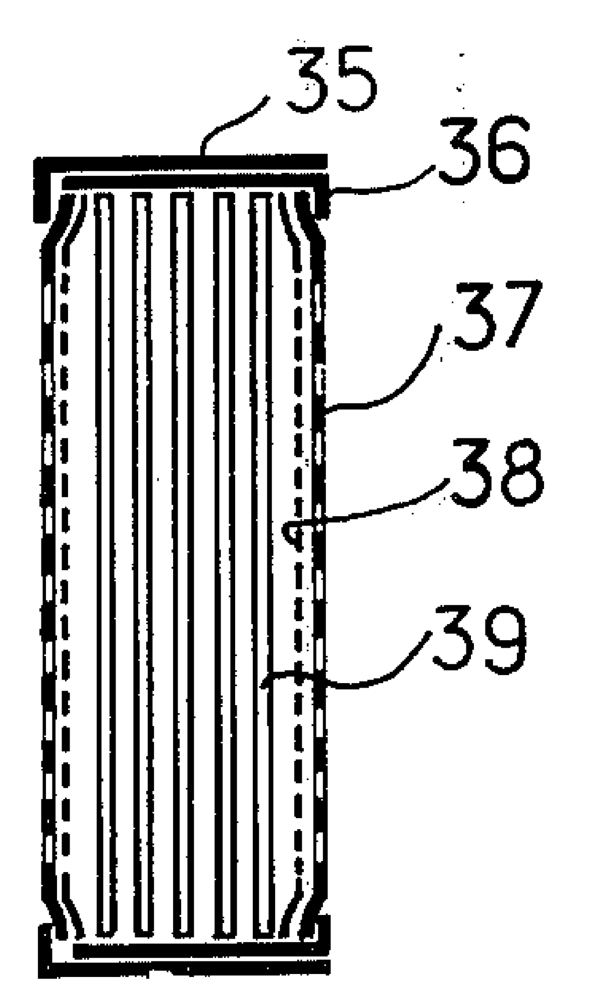



FIG. 8



## GAS HEAT EXCHANGER UNIT

The object of the present invention is a compact gas heat exchanger and heater unit in which the very structure of the heat exchange unit enables the dedusting of the gases passing across it, for example, hot smoke coming from a power station boiler. Moreover, the cleaning of the heat exchange unit itself is easy and may be effected continuously. Furthermore, the invention also allows the removal of sulphurous products from smoke.

More particularly but not exclusively, the object of the invention is an air heat exchanger and heater unit for a boiler in a large power station.

There exist, at present, heat exchangers ensuring that function, for example, LJUNGSTROM and ROTHEMUHLE rotating heat exchangers, but their dimensions limit the use thereof; furthermore, heat exchange takes place over a great length, for example two meters, as does the depositing of soot, this making cleaning of the metal sheets difficult; moreover, the mobile unit is subjected to numerous differential expansions which lead to difficulties in manufacturing and operating. Likewise, a part of the metal sheets is constantly damp and subjected to the combined action of the soot deposits and of the condensing of sulphuric acid coming from the water vapour and the $SO_3$ of the smoke. Despite the use, in the low and cold part of the heat exchanger, of enameled metal sheets, or metal sheets made from special steel which resist acid corrosion, the replacing of the heat exchange units, or at least the cleaning thereof, makes frequent and relatively long stoppages of the installation compulsory. Another disadvantage is that it is not possible to inspect the heat exchanger, for example, to clean the plates or change them without stopping the boiler.

The aim of the present invention is to overcome these disadvantages and, more particularly, it enables good dedusting of smoke, maintenance, inspection or replacement of wear elements without stopping the boiler, detection in various zones of soot deposits, on the one hand, and damp sulphuric acid deposits on the other hand, thus avoiding the forming of smoky charcoal.

Another advantage resides in the fact that the wear elements are independent from one another and that each of them is subjected, at a given instant and as a whole, to the same temperature conditions and also to the same dampness conditions, contrary to the case of aforesaid rotating exchangers, having a constantly dry zone and a constantly damp zone. Moreover, in these aforesaid exchangers, the heat exchange takes place in the volume, as does the depositing of soot; in the case of the invention, the heat exchange takes place in a volume, which is, moreover, much shorter, whereas the depositing of soot or dust is effected mainly at the surface, thus making the cleaning of the heat exchange unit easier.

The gas heat exchanger and heater unit according to the invention comprises at least one heat exchange unit in the form of a closed loop metal conveyor moving continuously or in jerks crossing successively, in two crossed passes and against the gas current, each of the hot gas and cold gas compartments, and is characterized in that the said metal conveyor consists of a set of independent elementary sieves each constituted by the superimposing of a great number of layers of metal lattices, in that the hot gas and cold gas compartments are separated by an intermediate compartment in which are installed cleaning and dust-removing devices. Two compartments, the one placed at the upper part of the heat exchanger, the other at the lower part, both separated from the smoke and air compartments, contain at least a part of the mechanical drive and rolling means of the conveyor, in that these compartments are accessible during the operation of the installation, and in that, in the compartments, the sieves may be inspected and dismantled separately.



The number of layers of metal lattices may be very great, this increasing the heat exchange surface by the crossing of the conveyor and enables the number of passes of the conveyor in each compartment to be limited. The separation into independent solid elements connected to one another in the form of an articulated conveyor enables, despite the great number of layers of metal lattices, the driving of the unit by simple means and avoiding any mechanical or thermic stresses which might otherwise result from the accumulation in relatively thick layers of moving metallic masses subjected to the action of heat.

According to a particular embodiment of the present invention, the said elementary sieves are each constituted by solid frames enclosing the said superimposing of metal lattices, the said conveyor being constituted by a succession of these said frames, which are each fixed laterally to two drive chains, each frame being fixed to each chain at the two ends of a same chain link, thus enabling rapid dismantling of the frames for repairs, replacements or more thorough cleaning.

According to a particular form of that embodiment, and to make fluid-tight sealing between the various compartments easier, the drive links are fast with the frames in their lateral faces, the chain links being articulated between two successive frames on these same faces.

In the case of independent chains, an upper shaft provided with two cog wheels enables simultaneously the supporting of the conveyor and the driving thereof, by means of chains, an identical device in the lower part simply guided vertically enables the mobile unit to be sent back and subjected to tightening, taking into account the expansion of the conveyor.

In the case of integrated links, an upper drum and a lower drum only fulfill the functions of a support and a bearing, drive being provided by independent means, for example, cog wheels or lateral worm screws placed either in a mechanical compartment, or in the air compartment, and coming into gear in lateral openings of the frames forming links as stated above.

Preferably, the first and second layers of metal lattices of each frame are constituted by a metal lattice having finer meshes than the inside layers, and, moreover, either a perforated metal sheet whose holes are larger than the meshes of the inside metal lattices, or a solid grid having large meshes, are arranged on each side of the assembly thus formed.

Cleaning and dedusting devices are arranged in the intermediate compartment; to great advantage, it is possible, for example, to place means for sending, with an adjustable speed and direction, one or several jets of gas or steam against the face of the metal conveyor on which dust is deposited. It has indeed been observed that this method affords a greater advantage than sending the jet(s) in the reverse direction to the path of the hot unclean gases; this comes from the very structure of the metal conveyor; the first layer of metal lattices being very fine, the dust remains on the surface against that first layer and also in the holes of the perforated metal sheet placed on the outside, without penetrating deep into the inside layers; moreover, the known dust precoating effect occurs, improving the filtering qualities of the metal conveyor, and experience shows that by blowing on the dust deposit side, a good result is obtained without forasmuch destroying that filtering precoating. This action may be combined with brushing and also with blowing at low speed in the reverse direction, the aim of this being not so much to clean but by blowing in the reverse direction, to remove dust already knocked away by jets blowing in the normal direction in the direction of the dust deposit.

The direction and the speed of the steam or gas jets against the conveyor, on the dust deposit side, evidently depends on the grain size of the dust or soot, or their adhering power, on the temperature, etc.

It is also possible, besides blowing in the reverse direction, to remove dust already knocked off, to arrange, moreover, high gas or steam pressure jets for intermittent deep cleaning, or when, for example, the above-mentioned precoating becomes too thick. Indeed, a small amount of dust always penetrates into the deep layers.

According to another particular embodiment of the present invention, the said elementary sieves are constituted by a set of elementary transversal strips each constituted by a stack of metal lattices, the said transversal elementary strips being arranged on at least two superimposed layers, each layer being constituted by a succession of the said elementary strips placed end to end, the elementary strips of the top layer being staggered in relation to the elementary strips of the bottom layer, each elementary strip of the top layer being fixed along one of its edges to the top elementary layer placed on that edge. Each elementary transversal strip of the lower layer is fixed to two drive chains, at a point of two of its opposite sides.

Other characteristics and advantages of the present invention will become apparent from the following description with reference to the accompanying drawings.

FIG. 1 is an air heat exchanger and heater unit for a boiler according to the invention;

FIG. 2 shows diagrammatically a heat exchanger according to the invention, in which the gases cross the metal conveyor four times;

FIG. 3 gives an example of the assembling of elementary transversal strips;

FIG. 4 shows diagrammatically an embodiment of the metal conveyor formed by frames installed between two chains;

FIG. 5 shows an air heat-exchanger and heater unit according to the invention, showing the fluid-tight sealing and cleaning devices;

FIGS. 6 and 7 are enlarged views of the intermediate compartment showing the cleaning devices; and

FIG. 8 is a cross section of a frame enclosing the metal lattices.

The air heater unit in FIG. 1 is composed essentially of a heat exchanger unit 1 in the form of a closed loop conveyor, constituted by the superimposing of metal lattices; that heat exchanger unit is driven in a continuous or jerky movement in the direction shown by the arrows, by means of a motor unit 2 and comprises, at its lower part, an idle pulley 3 provided with a device which provides a constant tension of the heat exchanger unit 1, despite variations in temperature. That heat exchanger unit 1 passes through a compartment 4 crossed in the direction of the arrows by hot smoke coming from the boiler and a compartment 5, crossed by the air supply of the boiler in the direction of the arrows.

On passing through the heat exchanger unit 1, the hot smoke cools down, heating the heat exchanger unit 1, and in the compartment 5, the air supply is heated by absorption of the calories which the heat exchanger unit has received from the hot smoke.

In an intermediate compartment 6, the cleaning of the heat exchanger unit 1 by permanent brushing by means of brushes 7 and 8 takes place.

An opening 9 in the intermediate compartment 6 makes it possible to sample, in the compartment 4 a part of the clean hot smoke which has already passed once across the heat exchange unit 1 and to send it back against the current into the intermediate compartment through the heat exchanger unit 1 to remove the soot which has been knocked off by the brushes 7 and 8. In that heat exchanger and air heater unit, the smoke released into the atmosphere is clean, for it has been rid of its soot on passing across the heat exchanger unit 1 which has a meshed structure. That heat exchanger and air heater unit has, moreover, the advantage, compared with the conventional devices mentioned above, such as LJUNGSTROM or ROTHEMUHLE, of being much more compact and lighter, due to that meshed structure of the heat exchange unit, which, for a same volume, has a much greater heat exchange surface because it is more finely divided.

Fluid-tight sealing devices, not shown in the figure, are provided between the various compartments; these latter do not, moreover, need to be perfect; indeed, a certain leakage may be tolerated. Furthermore, the fluid-tight sealing is greater than that of the other types of heat exchangers because of the great reduction in the length of the leakage lines. One advantage is the considerable reduction in the danger of fire subsequent to the permanent cleaning of the heat exchanger unit. In order to make the dedusting more efficient, the first layer in contact with the smoke may have finer meshes than those of the following layers. Another advantage of the system in the present invention is its corrosion characteristic, which distributes the corrosion evenly throughout the heat exchange surface due to the fact that the latter moves.

In the heat exchanger in FIG. 1, the smoke and the air pass twice across the heat exchanger unit, but it is possible either to have two or several heat exchanger units in succession, or to adopt the arrangement in FIG. 2, in which four passes are shown by the arrow line 10 for the smoke and by the arrow line 11 for the air.

The order of magnitude of the moving speed of the metal conveyor 1 is a few tens of centimeters per second and depends on the air flow.

Another advantage of the present invention is that it is possible to install, in the intermediate compartment 6 and/or in the hot gas compartment, a desulphurization system. The situation of the condensation zone makes it possible to proceed with the neutralizing of the sulphurous compounds by injecting a neutralizing gas or solid. The movement of the heat exchanger unit, which passes from a cold zone to a hot zone makes drying by evaporation of that mass possible. The sulphurous products, in the dry form, may then be recuperated in the dedusting zone which follows the hot zone.

FIG. 3 gives an example of a structural arrangement of the metal conveyor 1; it is made of elementary strips 12; each one is constituted by a stack of metal lattices. These elementary strips 12 are arranged in two superimposed layers. Each element is fixed to a bottom element by spot welding 13. The figure shows that the elements of the top layer are staggered in relation to the elements of the bottom layer. The conveyor thus formed is fixed by the bottom layer, at 14, to two parallel drive chains. This fragmentary structure of the metal conveyor and the way in which the elements 12 are assembled and fixed to the chains enables the conveyor to follow the curves of the loop closed, for example, at the idle pulley 3 and at the drive pulley 2, without damaging the metal lattices.

This fragmentary arrangement also enables the rapid dismantling of the elements, either to replace them, or to clean them more thoroughly.

Preferably, in heat exchangers for a high air flow, the metal conveyor 1 is constituted by a succession of rigid frames 15 (FIG. 4) which enclose a stack of metal lattices 16. Each frame 15 is fixed to two drive chains 17 and 18 at two points 19, 20 and 21, 22, of two of the sides of the frame, at the ends of two chain links 23. Fluid-tight sealing is provided at 24 between each consecutive frame.

FIG. 5 shows a heat exchanger similar to that in FIG. 2, in which fluid-tight sealing means and cleaning and blowing means in the intermediate compartment 6 have been shown. The fluid-tight sealing means are constituted by mobile boxes 25, suspended by counterweights 26 and articulated by parallelograms 27 enabling movements, limited by flexible suspension means 28. These boxes 25 comprise sealing rings 29 forming break joints, for example, for the flexible metal sheets. There are, moreover, flexible fluid-tight partitions 30.

In the case of a drive by independent chains, these horizontal fluid-tight sealing means are completed by vertical lines of seals pressing against the lateral edges of the frames preventing air from passing in the chain pass funnels.

In the case of a drive by links fast with the frames, horizontal means are also installed on the lateral edges of the frames forming a continuous barrage at the level of the crossing of the conveyor from one compartment to the next.

Cleaning and dedusting devices which have been shown on an enlarged scale in FIGS. 6 and 7 have also been shown in that figure. In these figures, cleaning is effected by blow nozzles 31 which may be directed, blowing on the face of the conveyor 1 on which the dust has been deposited; a brush 32 may also be provided. The dust knocked off is then removed, for example by sampling the air across the conveyor over all the face of the compartment. (see the arrows 33, FIG. 6).

Deep periodic cleaning may also be effected by means of a blow nozzle system 34 for steam or compressed air at a high pressure, lasting a short while.

FIG. 8 shows a cross section of a frame of the metal conveyor comprising the actual metal frame 35, a cover 36, two perforated metal sheets or else two large-mesh grids 37, as will be seen in an enlarged illustration in FIG. 7, two metal lattices or fine-mesh sieves 38 and lastly, two layers of metal lattices or medium-mesh sieves 39.

Another advantage of the present invention is that the conveyor may be inspected in a compartment 40 (FIG. 5) without stopping the device, and that it is even possible, by then stopping the conveyor, but without stopping the boiler, that is, while continuing to supply the boiler with air, in the direction of the arrows 41, and while providing the removal of the hot gas in the direction of the arrows 42, to dismantle the frames of the conveyor for cleaning, repair or even changing. The possibility of dealing with the heat exchanger without stopping the boiler and without forasmuch there being any danger of damaging the heater exchanger unit permanently, on account of its independent element structure, constitutes a great advantage of the invention compared with known devices having compact heat exchanger units with large dimensions.

A great advantage of the invention is that there is never a combination of soot and liquid sulphuric acid. Indeed, at the input of the hot gas in the compartment 4, the conveyor is at high temperature, and there is no condensation of sulphuric acid, but only a deposit of soot; on the other hand, when the conveyor arrives at 43 in the compartment 4 after having left the fresh air compartment 5, that cold heat exchanger unit below dew point meets the gas which is already partly cooled and charged with $SO_3$; there is then a condensation of sulphuric acid, but on a clean conveyor, for it has been cleaned in the intermediate compartment 6. Then the conveyor continues its travel and is heated on rising from the point 43 to the point 44 and when it reaches 45, the temperature is higher than the dew point of sulphuric acid. Moreover, a neutralizing substance which will form a solid compound which at first is wet at 43 and 44, becoming completely dry during its transfer through 45 and beyond so that it may be removed in a dry form in the same way as the soot in the intermediate compartment 6, may be injected at the point 43.

It must be understood that certain technological elements could be substituted for others described above which fulfill the same function, without forasmuch departing from the general idea of the invention, nor going beyond the scope thereof.

What is claimed is:

**1.** A gas heat exchanger unit comprising, a hot gas compartment and a cold gas compartment, at least one heat exchanger unit in the form of a closed loop metal band mounted for movement through both of said hot and cold gas compartments along first and second paths transverse to the gas flow therethrough, said metal band being formed by a plurality of independent elementary sieves interconnected to form the band and constituted by a plurality of layers of metal lattices, and intermediate compartment disposed between said hot and cold gas compartments traversed by said metal band, cleaning means disposed in said intermediate compartment for removing dust from the band passing therethrough, and means for driving said band along a closed loop path, wherein said cleaning means includes means for intermittently directing jets of gas at high speed onto the band against the opposite surface from the dust deposit.

**2.** A gas heat exchanger unit as defined in claim 1, further including first and second outer compartments disposed adjacent said hot and cold gas compartments on the sides thereof opposite said intermediate compartment in which said means for driving said bank are disposed, at least one of said first and second outer compartments being provided with means for permitting inspection of said band.

**3.** A gas heat exchanger unit as defined in claim **1** wherein said elementary sieves are each formed by solid frames enclosing said plurality of layers of metal lattices, said driving means including a pair of drive chains to which each frame of the elementary sieves is fastened in succession to form the metal band.

**4.** A gas heat exchanger unit as defined in claim **3** wherein said driving means further includes first and second sets of sprocket wheels engaging said pair of drive chains for driving said band, the links of said drive chains being articulated between successive frames of said sieves.

**5.** A gas heat exchanger unit as defined in claim **3** wherein the outer layers of metal lattices of each sieve have a finer mesh than the inner layers, and further including a metal sheet having holes larger than the holes in said metal lattices disposed outside of said lattices on respective sides of the frame of each sieve.

**6.** A gas heat exchanger unit as defined in claim **1** wherein said cleaning means further includes means for directing at least one jet of gas against the face of said metal band in an adjustably variable direction.

**7.** A gas heat exchanger unit as defined in claim **1** wherein said cleaning means further includes brush means for mechanically brushing the surface of said metal band.

**8.** A gas heat exchanger unit as defined in claim **7** wherein said cleaning means further includes means for directing at least one jet of gas against the face of said metal band in an adjustably variable direction.

**9.** A gas heat exchanger unit as defined in claim **1** wherein said elementary sieves are formed by a set of transverse elementary strips each constituted by a plurality of metal lattices arranged in at least two superimposed layers, each layer being constituted by a succession of said elementary strips placed end-to-end, the elementary strips of the top layer being staggered in relation to the elementary strips of the bottom layer, each elementary strip of the upper layer being fixed along one of its edges to the bottom elementary layer situated under that edge.

**10.** A gas heat exchanger unit as defined in claim **9** wherein each elementary strip of the bottom layer of each sieve is fixed to a pair of drive chains forming part of said drive means.

**11.** A gas heat exchanger unit as defined in claim **1** wherein said intermediate compartment includes movable boxes suspended flexibly surrounding the metal band and sealing rings for sealing the entrance and exit openings for the band in said boxes.

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