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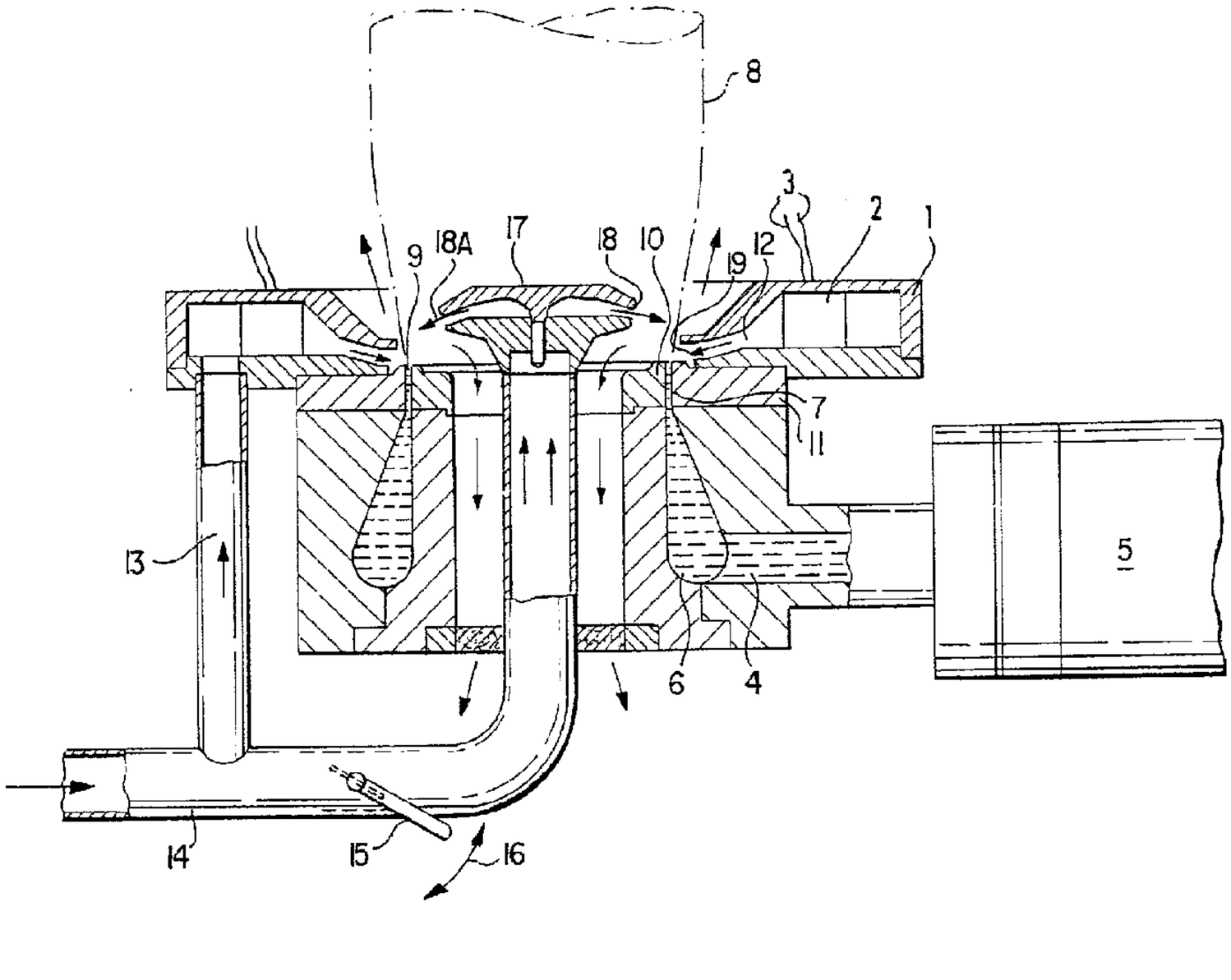
(54) Title: BLOW HEAD FOR THE MANUFACTURE OF TUBULAR FILM FROM THERMOPLASTIC SYNTHETIC RESIN



(57) Abrégé/Abstract:
A blowing head is provided for the manufacture of tubular film from thermoplastic synthetic resin. The blowing head includes a supply of molten synthetic resin through an annular extrusion orifice for producing a tube of resin film; ducts for the supply and exhaust of cooling air applied to the interior of the extruded tube; and an external cooling ring surrounding the extruded film provided with air which can be varied in temperature at different points around the periphery of the film. Greater control over the final thickness of the film is achieved through the provision of an external cooling ring in which sections around the periphery of the tubular film can be differentially heated or cooled. A compact design for the external cooling ring includes lamellar guide bodies, electrical heating rods or alternately arranged vortex nozzles radially positioned within the cooling ring which are independently controlled to produce differential temperature gradients around the tubular film. Additional air currents may be provided around the external periphery of the film which are also independently controllable regarding temperature and air flow.

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ABSTRACT

A blowing head is provided for the manufacture of tubular film from thermoplastic synthetic resin. The blowing head includes a supply of molten synthetic resin through an annular extrusion orifice for producing a tube of resin film; ducts for the supply and exhaust of cooling air applied to the interior of the extruded tube; and an external cooling ring surrounding the extruded film provided with air which can be varied in temperature at different points around the periphery of the film. Greater control over the final thickness of the film is achieved through the provision of an external cooling ring in which sections around the periphery of the tubular film can be differentially heated or cooled. A compact design for the external cooling ring includes lamellar guide bodies, electrical heating rods or alternately arranged vortex nozzles radially positioned within the cooling ring which are independently controlled to produce differential temperature gradients around the tubular film. Additional air currents may be provided around the external periphery of the film which are also independently controllable regarding temperature and air flow.

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A BLOW HEAD FOR THE MANUFACTURE OF TUBULAR FILM FROM THERMOPLASTIC SYNTHETIC RESIN

The present invention relates to a blowing head for the manufacture of tubular film from thermoplastic synthetic resin. The blowing head includes a supply of molten synthetic resin through an annular extrusion orifice for producing a tube of resin film; ducts for the supply and exhaust of cooling air applied to the interior of the extruded tube; and an external cooling ring surrounding the extruded film provided with air which can be varied in temperature at different points around the periphery of the film.

Several heads of this type have been proposed, having different designs. The internal cooling air supplied and removed in the axial direction through the film blowing head serves for the cooling of the extruded tubular film and for the inflation of the tubular film to form a tubular film bubble stretching out the molten synthetic resin tubular film. The external cooling ring has an annular nozzle gap directed towards the extruded tubular film through which the cooling air is caused to impinge on the film so that the film is rapidly cooled down creating the lowest possible so-called frost line in order to increase the output rate.

In accordance with the prior art, it is possible to heat and/or cool the tubular extruded molten synthetic resin differentially in sections of the periphery in order to influence the thickness gradient and to control the final thickness of the film. The final thickness is dependent to a large part on the fact that the hotter regions flow more easily and the cooler regions flow less easily.

A film blowing head as described in German patent 2,658,518 has a plurality of correcting air nozzles arranged around the external air blowing ring in a circle surrounding

the tubular film for influencing the extruded tubular film to be at different peripheral temperatures. Adjustment valves, which are suitably controlled, are associated with the individual correcting air nozzles. However, this known film blowing head is comparatively complicated in design due to the necessity of having a plurality of radial air nozzles directed towards the extruded tubular film to blow air at different temperatures onto it.

Accordingly, the invention seeks to provide a compactly designed film blowing head of the type initially mentioned.

In accordance with the invention this is to be attained by subdividing the external cooling ring into sectors, in which the air directed onto the extruded tubular film is able to be differentially cooled and/or heated. The film blowing head in accordance with the invention consequently has a compact design, because the elements for differential heating of the air blown onto the extruded tubular film are directly integrated within the external cooling ring.

In accordance with an advantageous embodiment of the invention radial lamellar guide bodies are arranged in the external cooling ring between the outer part of the annular space and the inner nozzle-like outlet part, such bodies being able to be cooled and/or heated independently of each other, and through which heated or cooled air may be blown, if desired at different rates. In accordance with the invention, the cooling air supplied to the external cooling ring is differently cooled as necessary within the external cooling ring without additional air nozzles having to be provided.

It is convenient if the guide bodies extend through the annular space vertically, so that the cooling ring is more or less divided into sector-like air cells. The guide bodies may be designed so as to be streamlined in horizontal cross-section, for instance as radial foils. The guide bodies may be arranged to be heated or alternatively cooled by different means. It is convenient for the guide bodies to be furnished with electrical heating elements.

An alternative advantageous feature of the invention provides electrical heating rod elements instead of guide bodies, arranged in the external cooling ring extending radially inwards. The electrical heating rods may be secured on the outer peripheral wall surface of the cooling ring.

In accordance with a further advantageous embodiment of the invention, additional air nozzles are arranged in the cooling ring, which may be utilized for changing the temperature of the blowing air supplied into the cooling ring. The direction of flow of these additional air nozzles is conveniently radial toward the extruded synthetic resin tubular film.

A further advantageous feature of the invention provides that the air nozzles are in the form of a ring of vortex nozzles directed radially on the extruded synthetic resin tubular film. Such vortex nozzles are supplied by the Dutch company Simco and they have a central annular plenum into which compressed air is supplied radially, or tangentially through a duct. On the one side cooled air and on the other side heated air then emerges from axial nozzles arranged perpendicularly to the direction of air injection. If for instance compressed air is injected into the central plenum at a temperature of 21°C, then on the one side cold air at -46°C will emerge and on the other side heated air at a temperature of 100°C will emerge.

It is convenient furthermore if the vortex nozzles are arranged in the interior of the external cooling ring so that the ducts supplying the compressed air extend through the upper walls of the external cooling ring and a proportion of the outlet nozzles are directed onto the synthetic resin tubular film, while the remaining outlet nozzles open towards the outside.

Some of the outlet nozzles of the vortex series may furthermore be arranged to extend through the outer peripheral wall surface of the outer cooling ring.

Additionally, the vortex nozzles may be arranged in the cooling ring to alternately direct cold or hot air onto the film so that it is possible to produce different temperature gradients.

The compact manner of construction provided in accordance with the invention renders it possible to arrange the elements for heating or cooling the blown air inside the eternal cooling ring.

In accordance with a further working embodiment the external cooling ring is provided with multiple nozzles or with a single slot-like nozzle directed onto the film. Furthermore, the ring constituting the external lip of the outlet nozzle is provided with a plurality of adjacently arranged holes or ducts directed approximately parallel to the emerging synthetic resin tubular film, from which additional air currents may be blown which may also be differentially heated and/or cooled. By means of the holes or ducts extending through the external nozzle ring it is accordingly possible to modify the temperature gradient of the external nozzle lip with the result that a more intensive action may be produced on the emerging molten synthetic resin. The additional air currents may flow more slowly than the main outlets. In accordance with

requirements it is possible for the flow velocity to be uniformly increased or reduced or for the flow velocity of individual holes or ducts to be differently selected.

Thus in a first embodiment this invention seeks to provide a blowing head for the manufacture of tubular film from thermoplastic synthetic resin comprising:

ducts for supplying and removing internal cooling air,
at least one duct for supplying fused synthetic resin, wherein said duct opens into an annular outlet nozzle defined by an internal ring and an external ring between which the blown tubular film emerges,
an external cooling ring encircling the extruded synthetic resin film,
and means for supplying air heated to different temperatures to sections, which are distributed over the periphery of the extruded tubular film, wherein:
the external cooling ring is subdivided into sectors, wherein air directed onto the extruded tubular film is differentially cooled and/or heated,
wherein the external cooling ring comprises nozzles for air directed onto the extruded synthetic resin tubular film or a nozzle gap directed onto the tubular film, and
wherein the external ring of the annular outlet nozzle is provided with a plurality of adjacently arranged elongated holes, each hole extending directly adjacent to and with its length approximately parallel to the emerging synthetic resin tubular film and then opening into a hole which leads radially outward, from which holes additional air currents are blown in a direction approximately parallel to the emerging synthetic resin tubular film, and
the elongated holes extend over a sufficient length that the air currents blown through the holes in the external ring influence the temperature of the tubular film both along the

length of hole before extrusion and also, in combination with air from the external cooling
ring, after extrusion of the tubular film, and wherein air from the elongated holes and air from the nozzles or nozzle gap impinge upon one another at the same location at which air emerges from holes and nozzles or nozzle gap, respectively.

In a second embodiment this invention seeks to provide a blowing head for the manufacture of tubular film from thermoplastic synthetic resin comprising:
ducts for supplying and removing internal cooling air,
at least one duct for supplying fused synthetic resin, wherein said duct opens into an annular outlet nozzle defined by an internal ring and an external ring between which the blown tubular film emerges,
an external cooling ring encircling the extruded synthetic resin film,
and means for supplying air heated to different temperatures to sections, which are distributed over the periphery of the extruded tubular film, wherein:
the external cooling ring is subdivided into sectors, wherein air directed onto the extruded tubular film is differentially cooled and/or heated,
wherein the external cooling ring comprises nozzles directed onto the extruded synthetic resin tubular film or a nozzle gap directed onto the tubular film, and wherein the external ring of the annular outlet nozzle is provided with a plurality of adjacently arranged elongated holes, each hole extending through the external ring directly adjacent to and with its length approximately parallel to the emerging synthetic resin tubular film and then opening into a hole which leads radially outward, from which holes additional air currents may be blown,

wherein said additional air currents for blowing air from the holes are differently heated and/or cooled and extend in the external ring approximately parallel to the emerging synthetic resin tubular film directly adjacent thereto, and the elongated holes extend over a sufficient length that the air currents blown through the holes in the external ring influence the temperature of the tubular film both along the length of hole before extrusion and also, in combination with air from the external cooling ring, after extrusion of the tubular film, and wherein air from the elongated holes and air from the nozzles or nozzle gap impinge upon one another the same location at which air emerges from holes and nozzles or nozzle gap, respectively.

Working embodiments of the invention will now be described in the following with reference to the accompanying drawings.

Figure 1 is a vertical cross section taken through a first working embodiment of a film blowing head.

Figure 2 is a vertical cross section taken through a second working embodiment of a film blowing head.

Figure 3 is a vertical cross section taken through an external cooling ring with a vortex cooling nozzle therein.

Figure 4 is a vertical cross section taken through a cooling ring in which the vortex cooling nozzle is incorporated in the external wall surface.

Figure 5 is a cross section taken through the annular outlet nozzle with the external cooling ring therein.

The film blowing head depicted in Figure 1 is supplied with molten synthetic resin 4 from a diagrammatically indicated extruder 5 through a connection union. The molten synthetic resin 4 is then supplied for distribution to an annular manifold duct 6, which opens into the annular outlet nozzle 7. The tubular film 8 as shown in broken lines emerges from the annular extrusion orifice 9 which is defined by two annular orifice rings 10, 11. On the external orifice ring 11 the cooling ring 1 is arranged, which directs the cooling air through the preferably downwardly inclined annular gap 12 towards the extruded tubular film 8 directly above the orifice rings 10, 11.

The cooling air, which is supplied, all comes from a blower, not illustrated for internal and external cooling is supplied through a connection tube 13 to the external cooling ring and, respectively, is supplied through a tube

14 with a throttle flap 15 movable through an arc 16, for control of the ratio of the impinging air currents, to the internal cooling ring 17, the outlet gap 18, like that of the external cooling ring, being preferably inclined downwards or arranged for simply blowing radially outwards so that the tightly paralllelized air jet 18A impinges on the internal side of the tubular film generally at the same level as the external air jet 19. The basic construction or design of the film blowing head shown in Figure 1 may be in accordance with the German patent publication 1,960,962 A.

In the case of the film blowing head in accordance with the invention lamellae 2 are arranged in the external cooling ring 1 with equal spacing from each other around the periphery in a circle. Such lamellae 2 are able to be heated via electrical connections 3 independently of each other.

In the case of the working embodiment in accordance with Figure 2, instead of the lamellae, electrical heating rods 20 are arranged evenly around the periphery in the external cooling ring, and they extend radially inwards. The heating rods 20 are, as shown in Figure 2, positioned in the vertical outer wall of the external cooling ring 1. The heating rods 20 are provided with heating cartridge elements, which, like the lamellae in Figure 1, may be operated independently of each other via electrical connection leads 21.

Furthermore, in lieu of the heating rods 20, it is possible for air nozzles to be arranged in the wall 35 as shown in Figures 3 and 4, so as to have a radial direction of blowing and through which, in accordance with requirements, hot or cold air may be injected in different zones.

Preferred designs of such air nozzles are shown in Figures 3 and 4 utilizing vortex nozzles 30 into which, if for instance compressed air 31 is fed in at 21°, then the air current is divided up in the central plenum 32 so that hot air at 100° flows from the outwardly directed part 33 while from the inwardly directed nozzle 34 cold air at -46° emerges.

In the illustrated working embodiment of the invention of Figures 3 and 4 the vortex nozzles are installed so that the nozzles for the cold air are directed radially inwards. In a further working embodiment it is possible for the nozzles to be alternately arranged to blow cold air from some nozzles and hot air from others in a radially inward direction.

Figure 5 shows a further embodiment of a film blowing head, in which the external ring 11 which defines the annular extrusion orifice 9 of the annular molten plastic outlet nozzle 7 and which constitutes an external annular nozzle lip 36 is provided with holes 37 which extend along a certain distance generally parallel to the emerging molten synthetic resin tube 8 and includes an opening 38 which leads radially outwards (below the cooling ring). The holes 37 are arranged with generally equal spacing on a circle concentric with the annular extrusion nozzle 7 between the internal and external rings 10, 11. Through the holes 37 and the connecting openings 38 it is possible to supply a further heated, or cooled, air 39 in a controlled manner, which air then impinges on the cooling air current 19, as shown in the Figure emerging from the nozzle gap 12 of the external cooling ring 1.

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A blowing head for the manufacture of tubular film from thermoplastic synthetic resin comprising:

ducts for supplying and removing internal cooling air,

at least one duct for supplying fused synthetic resin, wherein said duct opens into an annular outlet nozzle defined by an internal ring and an external ring between which the blown tubular film emerges,

an external cooling ring encircling the extruded synthetic resin film,

and means for supplying air heated to different temperatures to sections, which are distributed over the periphery of the extruded tubular film, wherein:

the external cooling ring is subdivided into sectors, wherein air directed onto the extruded tubular film is differentially cooled and/or heated,

wherein the external cooling ring comprises nozzles for air directed onto the extruded synthetic resin tubular film or a nozzle gap directed onto the tubular film, and

wherein the external ring of the annular outlet nozzle is provided with a plurality of adjacently arranged elongated holes, each hole extending directly adjacent to and with its length approximately parallel to the emerging synthetic resin tubular film and then opening into a hole which leads radially outward, from which holes additional air currents

are blown in a direction approximately parallel to the emerging synthetic resin tubular film, and

the elongated holes extend over a sufficient length that the air currents blown through the holes in the external ring influence the temperature of the tubular film both along the length of hole before extrusion and also, in combination with air from the external cooling ring, after extrusion of the tubular film, and wherein air from the elongated holes and air from the nozzles or nozzle gap impinge upon one another at the same location at which air emerges from holes and nozzles or nozzle gap, respectively.

2. A blowing head for the manufacture of tubular film from thermoplastic synthetic resin comprising:

ducts for supplying and removing internal cooling air,

at least one duct for supplying fused synthetic resin, wherein said duct opens into an annular outlet nozzle defined by an internal ring and an external ring between which the blown tubular film emerges,

an external cooling ring encircling the extruded synthetic resin film,

and means for supplying air heated to different temperatures to sections, which are distributed over the periphery of the extruded tubular film, wherein:

the external cooling ring is subdivided into sectors, wherein air directed onto the extruded tubular film is differentially cooled and/or heated,

wherein the external cooling ring comprises nozzles directed onto the extruded synthetic resin tubular film or a nozzle gap directed onto the tubular film, and

wherein the external ring of the annular outlet nozzle is provided with a plurality of adjacently arranged elongated holes, each hole extending through the external ring directly adjacent to and with its length approximately parallel to the emerging synthetic resin tubular film and then opening into a hole which leads radially outward, from which holes additional air currents may be blown,

wherein said additional air currents for blowing air from the holes are differently heated and/or cooled and extend in the external ring approximately parallel to the emerging synthetic resin tubular film directly adjacent thereto, and

the elongated holes extend over a sufficient length that the air currents blown through the holes in the external ring influence the temperature of the tubular film both along the length of hole before extrusion and also, in combination with air from the external cooling ring, after extrusion of the tubular film, and wherein air from the elongated holes and air from the nozzles or nozzle gap impinge upon one another the same location at which air emerges from holes and nozzles or nozzle gap, respectively.

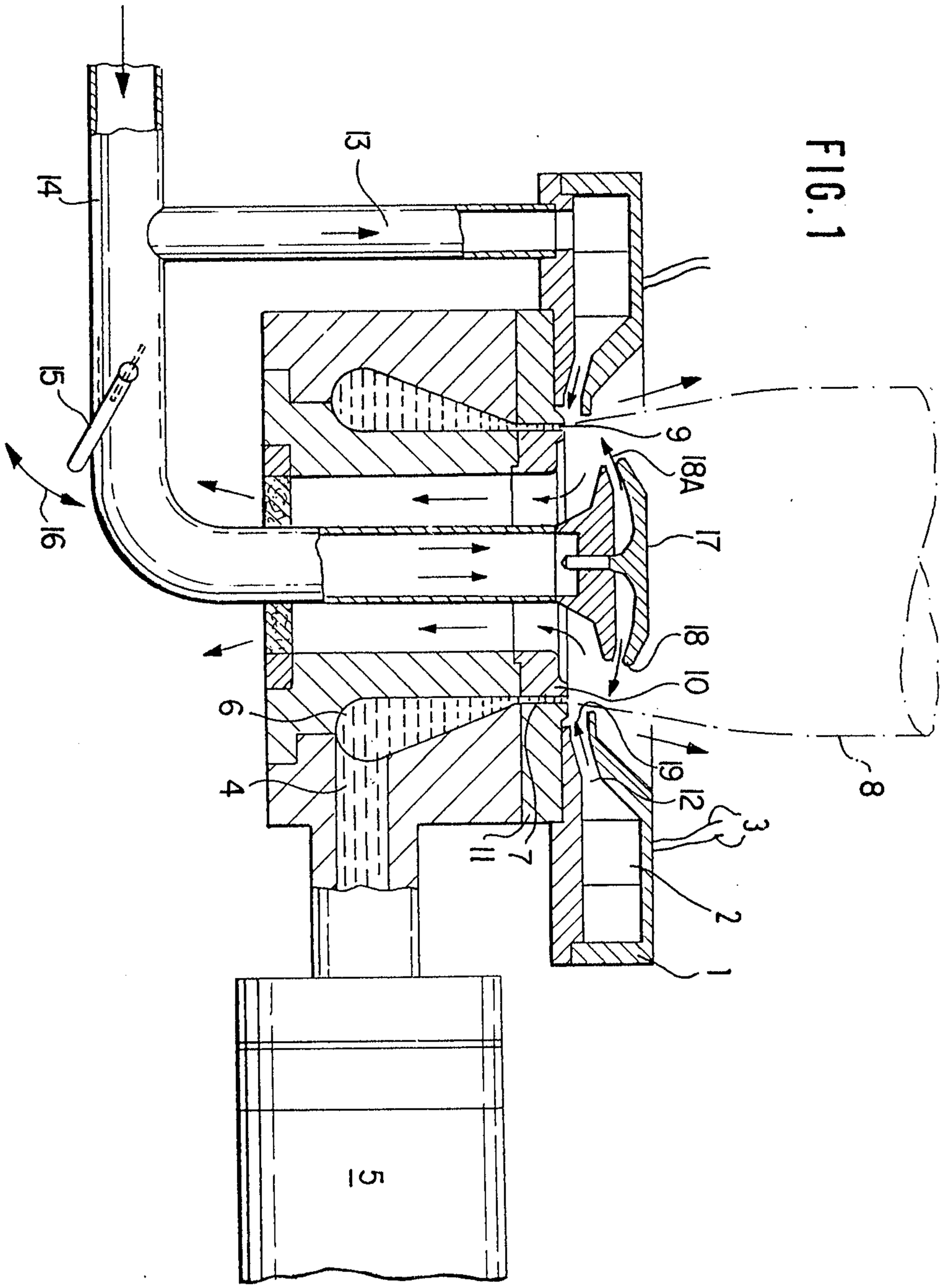

FIG. 1

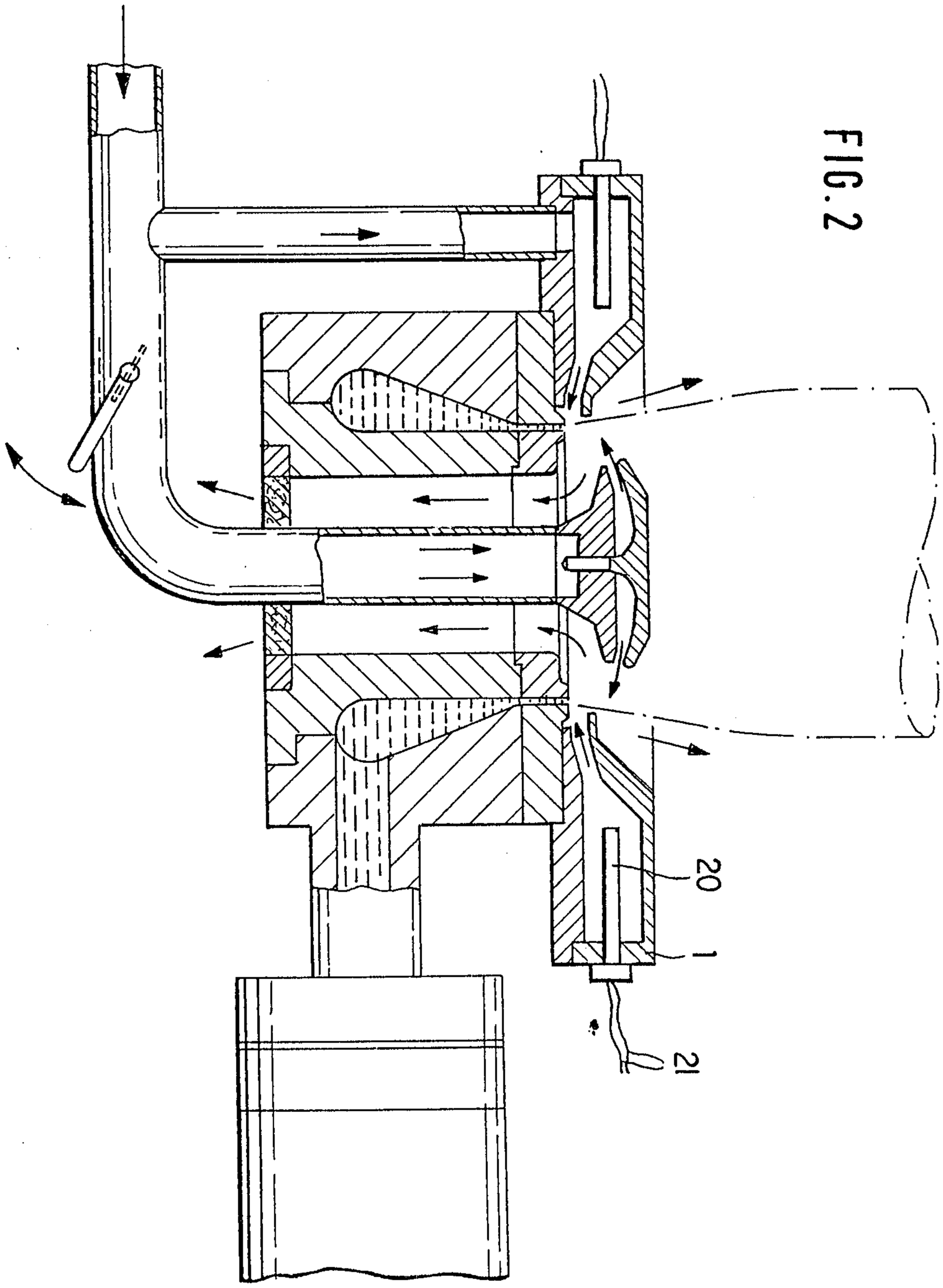

FIG. 2

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FIG.3

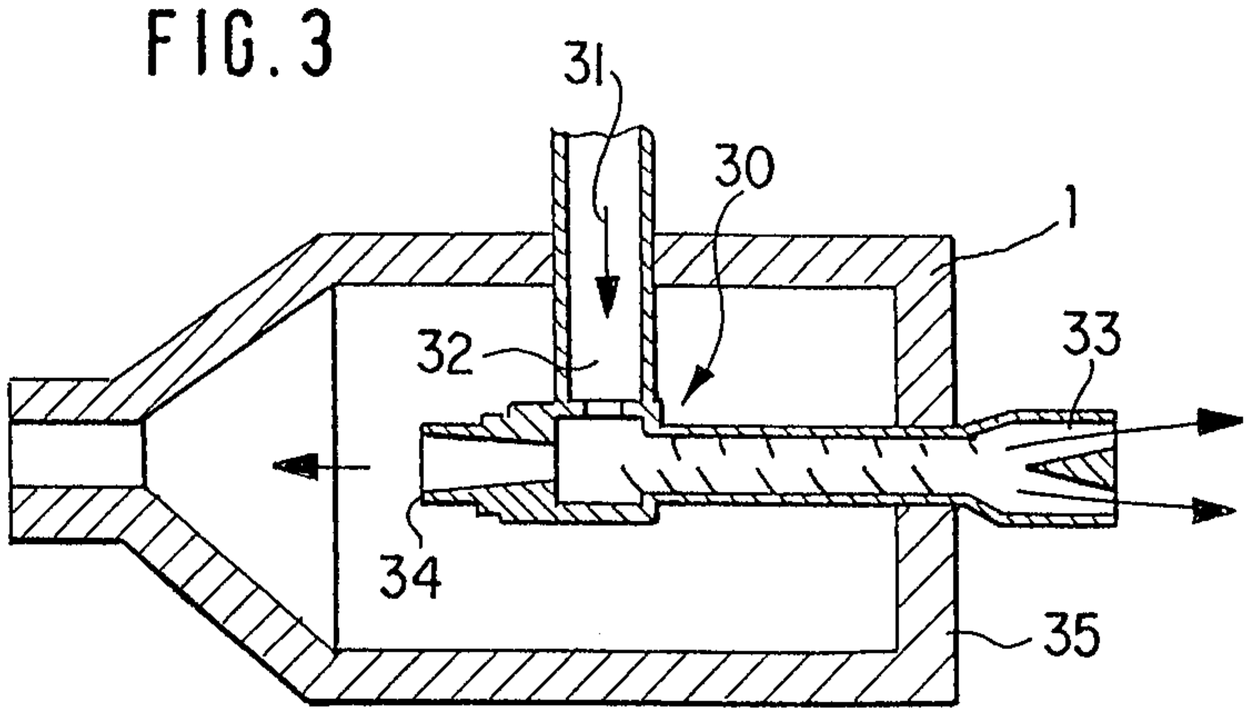


FIG.4

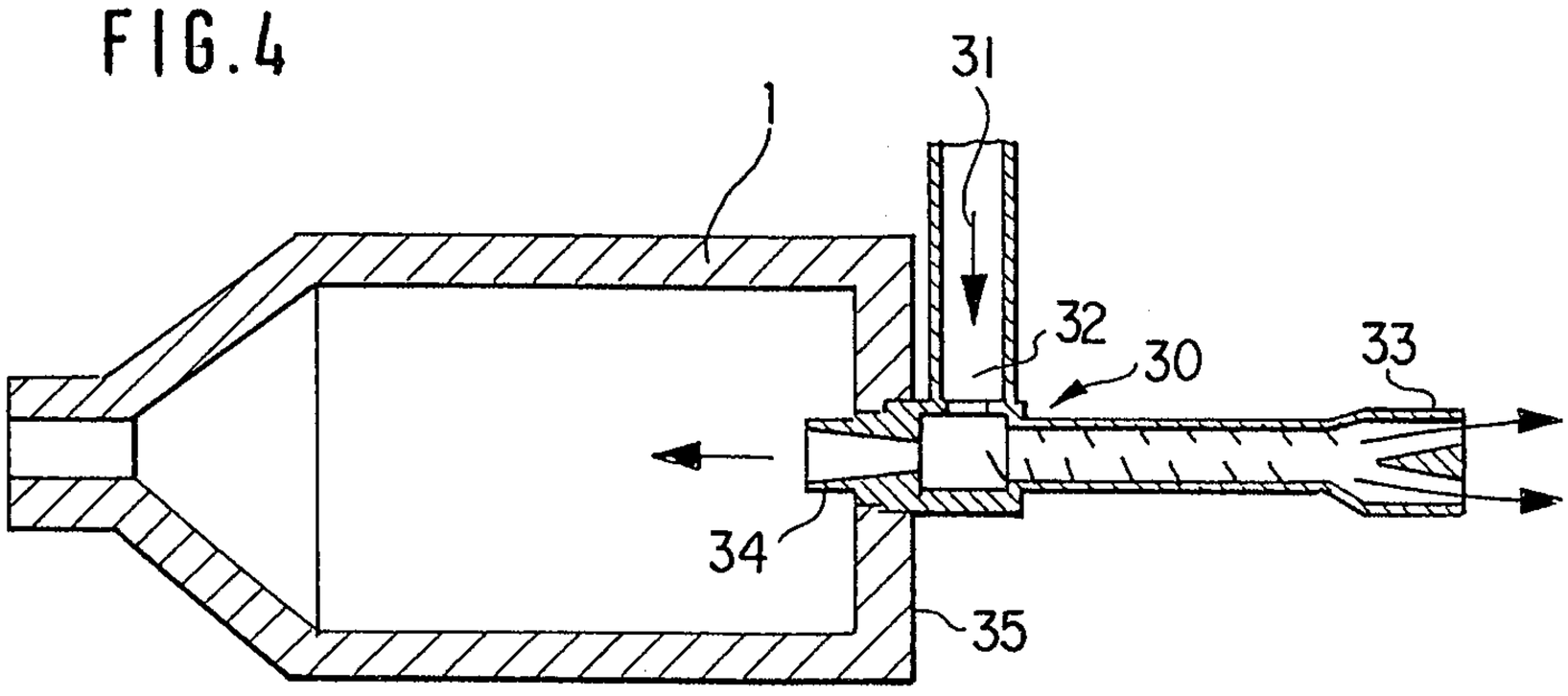
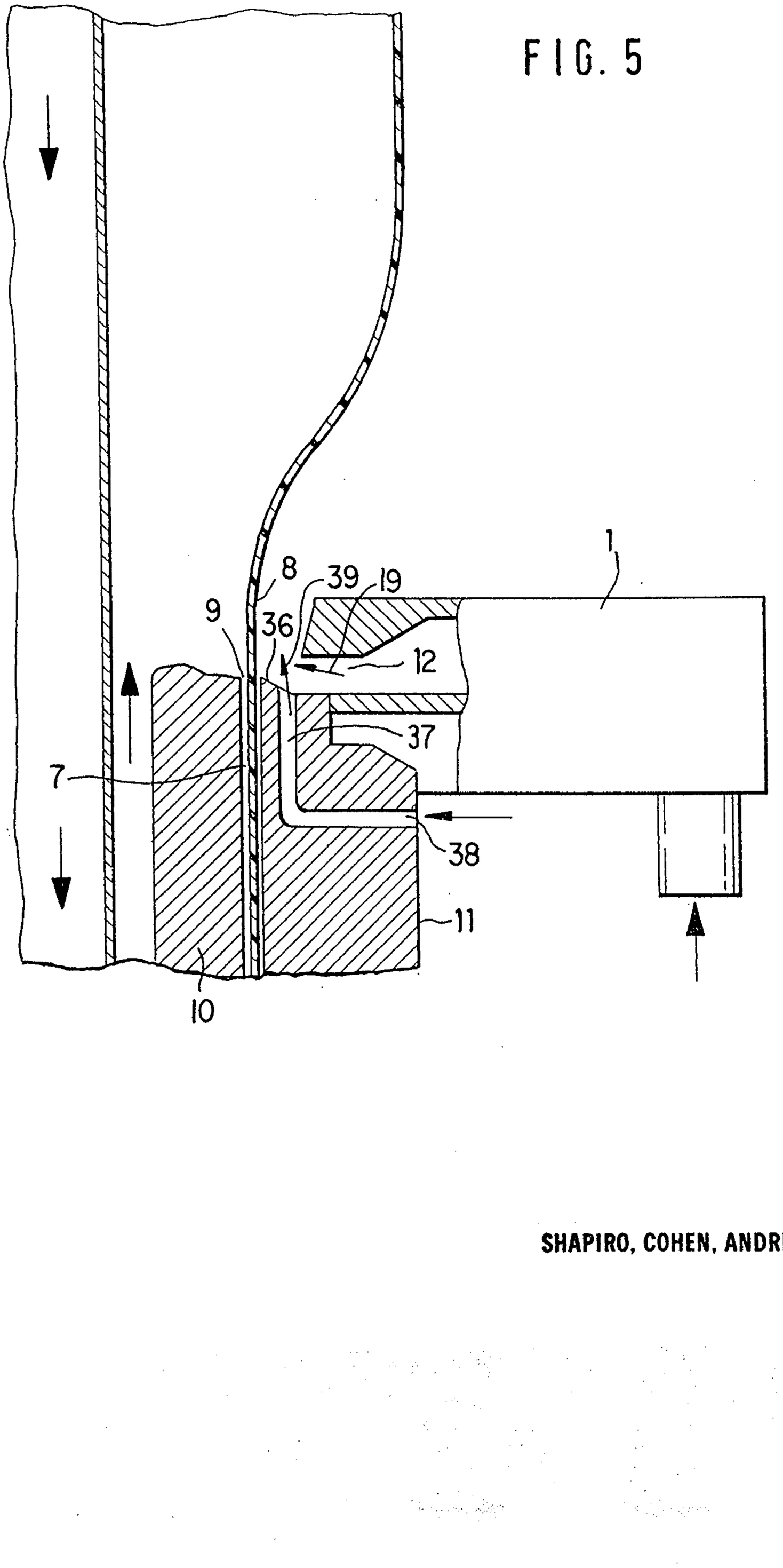
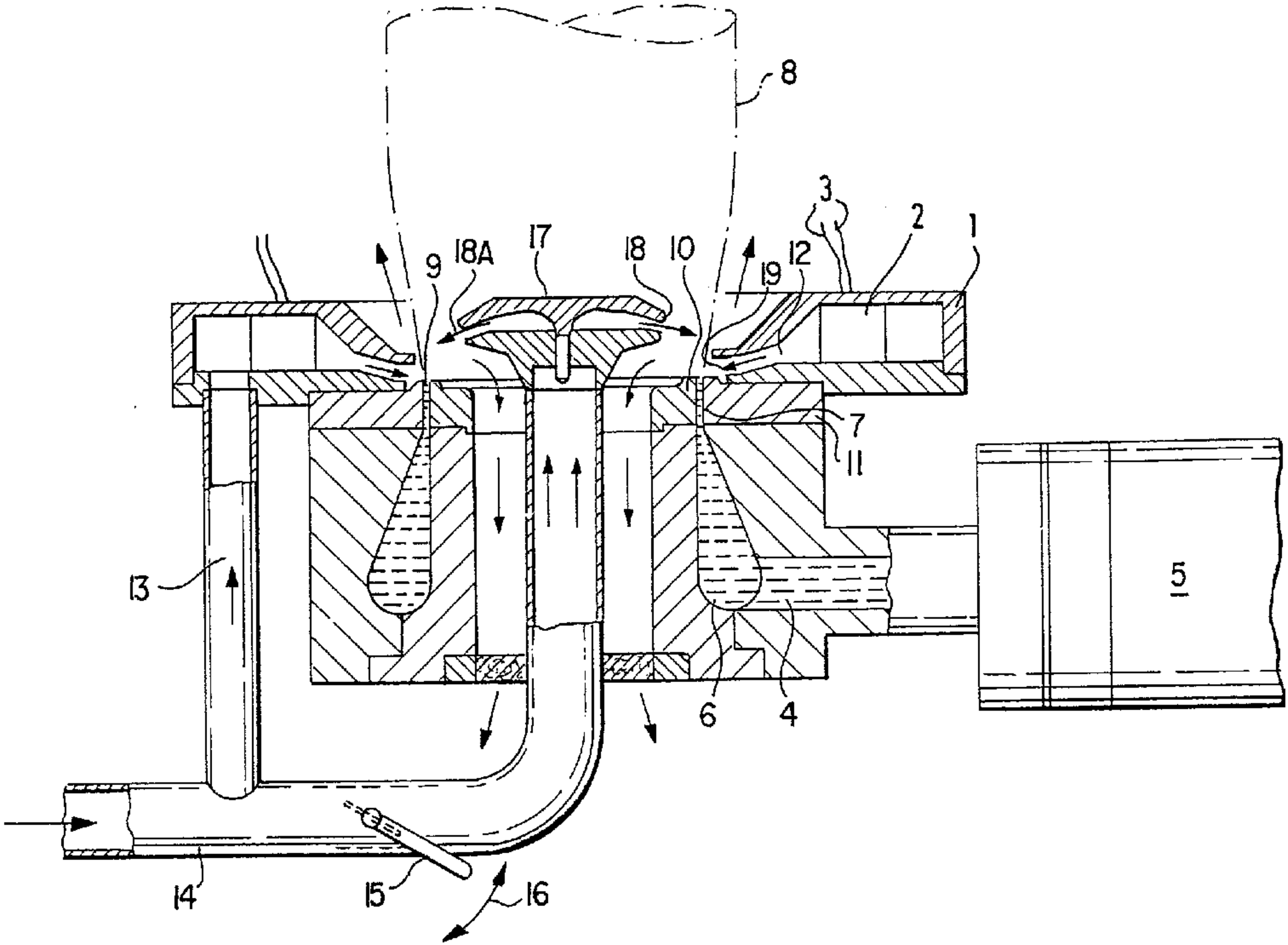


FIG. 5

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