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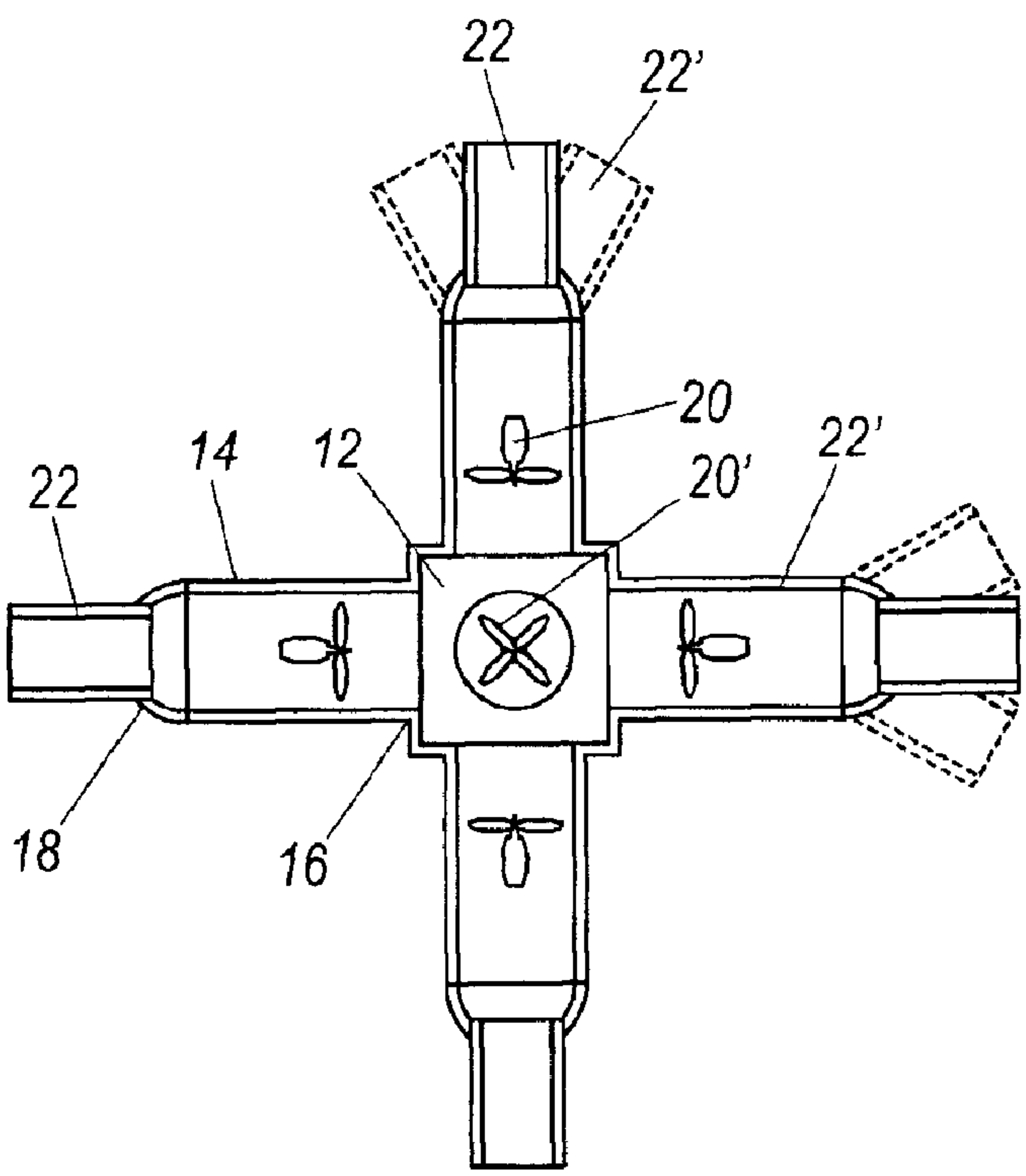


(57) Abrégé/Abstract:
A jet propulsor for use in vehicles or other devices moving in a three- dimensional gaseous or liquid medium such as air or water has a joint chamber and at least four flow passages which are connected to the chamber with one of their ends, have independently controllable reversible pressure units inside, and are provided with independently controllable nozzles on their other ends. The propulsor pumps gas or liquid from the environment through itself and, because of reaction forces, provides for the thrust and thrust moment that are simultaneously and independently in terms of their magnitude/strength and direction. Spatial control of the thrust vectoring and conditional thrust moment vector can be provided for in the spatial range of a full solid angle.

ABSTRACT OF THE DISCLOSURE

A jet propulsor for use in vehicles or other devices moving in a three-dimensional gaseous or liquid medium such as air or water has a joint chamber and at least four flow passages which are connected to the chamber with one of their ends, have independently controllable reversible pressure units inside, and are provided with independently controllable nozzles on their other ends. The propulsor pumps gas or liquid from the environment through itself and, because of reaction forces, provides for the thrust and thrust moment that are simultaneously and independently in terms of their magnitude/strength and direction. Spatial control of the thrust vectoring and conditional thrust moment vector can be provided for in the spatial range of a full solid angle.

JET PROPULSION DEVICE WITH THRUST VECTOR CONTROL

BACKGROUND OF THE DISCLOSURE

The present disclosure relates to propulsors and represents an apparatus for generating controllable thrust and thus for moving a vehicle or another object in a three-dimensional liquid (such as water) or gaseous (such as air) medium.

Similar apparatus well known in the art are, for example, hydro-jet propulsors of various designs and configurations (see, for example, Kulikov C.V., Khramkin M.F. Hydro-jet propulsors, the theory and design. L. Sudostroyeniye, 1969). Such propulsors are able, depending on their particular design, to provide for the control of both thrust vector, and of thrust moment (turning force) within one or other spatial angle range. However, no prior art propulsors have been known to provide for effective spatial control of the thrust vector and moment in a full solid angle range.

Also known in the art have been turbojet engines (engines-propulsion units) with deflecting nozzles (such as Rolls Royce Pegasus engine - http://www.rolls-royce.com/defence/products/combat_jets/pegasus.jsp) having several flow passages (channels) connected to a joint chamber (a turbojet engine compressor). However, pressure units in those engines (compressors, combustion chambers) fail to provide for the gas flow reversible control. Additionally, the Pegasus design fails to provide for the spatial control of the thrust vector and thrust moment in the full solid angle range.

There have also been known in the art a jet system for controlling vertical-takeoff-and-landing aircrafts comprising a plurality of propulsion nozzles spaced at a maximum possible distance from the aircraft center of mass and supplied with compressed air through ducts from a compressor of a vectored-thrust engine. The configuration of the system allows for controlling the nozzle thrust magnitude and direction, thus making it possible to control the system overall thrust and thrust moment in the spatial angle range equal to a full solid angle close thereto. The prior art system, however, does not comprise duct reversal pressure units, which would be important to make the system work effectively as a propulsor rather than a control system.

SUMMARY OF THE DISCLOSURE

The object of the technical solution in the present disclosure is to provide a sufficiently high-speed controlled and effective propulsor capable of creating both a thrust which is magnitude controlled and vector controlled in a maximum wide spatial angle range up to a the full solid angle, and a thrust moment (turn force) which is also strength controlled and vector controlled in the same spatial angle range, no matter what the propulsor spatial orientation is. Thus, a propulsor providing enhanced maneuverability and effectiveness when moving in a three-dimensional gaseous or liquid medium can be realized.

With this object in mind, there is proposed a jet flow propulsor using gas or liquid from the environment the propulsor is in as a working fluid. The propulsor comprises a plurality of flow passages serving for the movement of the working fluid. The passages are interconnected through a joint flow chamber and equipped with controllable reversible pressure units and controllable nozzles. Each of the passages is connected by one end thereof to the joint flow chamber whereas another end of each of the passages is in fluid communication with the environment and includes a nozzle or is provided with same. The number of the flow passages can be ~~is~~ four or more, each of the controllable reversible pressure units is adapted to be independently controlled, and the nozzles in the flow passages can be ~~is~~ independently controllable and adapted to controllably deflect a working fluid exhaust jet, as well as to let the working fluid into the propulsor from the environment.

Other features and aspects of the disclosure will be apparent from the following description, drawings and claims.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 shows a perspective view of an example of a structural layout in implementing the present design.

Figure 2 illustrates a cross-section of the example in Figure 1 along line 2-2, and

Figures 3-6 depict layouts elucidating examples of operation of the structure shown in Figure 1.

DETAILED DESCRIPTION

The following terms have been used throughout the description:

"Working fluid" – that portion of ambient gas or liquid which is accommodated within propulsor internal space; a jet force emerging upon ejecting the working fluid from the propulsor into outside environment is used for creating thrust and thrust moment.

"Joint (flow) chamber" – an enclosed volume, which all passaged are connected to with one end thereof; the passages are open into the chamber; technically, the chamber can include no proper, clearly expressed structural elements, but rather present a propulsor common internal space where the passages interconnect (intersect); accordingly, to be understood by "joint chamber" in this application is the above-mentioned common space at the place of the interconnection of the passages.

“Flow passage” – a structural volume designed for the working fluid movement within same outwardly from the joint chamber and inwardly from outside toward the joint chamber; there are pressure units in the passages; the propulsor flow passages can include no clearly expressed structural elements and no defined length and comprise only the pressure unit with a nozzle attached thereto.

“Pressure unit (pressure apparatus)” – an apparatus providing the magnitude-and-direction controlled pressure head of the working fluid in a passage and a two-way flow of the working fluid within the passage, both from the joint chamber outside and from the outside end of the passage toward the joint chamber; in each passage, the pressure apparatus can be independently controllable; a passage can comprise several pressure apparatuses acting in sync as a single pressure unit, in which case understood by a pressure unit (apparatus) is an aggregation thereof.

“Nozzle” – is represented here as either a mere open outside end of the propulsor flow passage or the end of the flow passage profiled and technically equipped one way or another or an apparatus placed on the passage outside end, which provides for shaping one or more jets of the working fluid and controlling the ejection of the jet (jets) in a predetermined direction; structurally, the nozzle can include a number of apparatuses interacting with each other such as a fixed nozzle and a separate deflecting apparatus diverting the jet that is being ejected, in which case understood by nozzle is the whole aggregation of the apparatuses; when working in a suction mode, i.e. where the working fluid moves from the outside end toward the joint chamber, the nozzles provide for the working fluid flow from the outside environment into the propulsor (i.e. not preventing such a flow from occurring).

“Propulsor power drives” – a technology aggregation providing for the energy input to propulsor actuators – pressure units, nozzles and other units – to secure their work; most commonly, it is the aggregation of engine packages and transmissions.

"Thrust moment conditional vector" – a mathematical (physical) concept, a vector, whose "length" characterizes the torque value, whereas its spatial direction characterizes the direction in which the aggregated torque is applied to the object (according to the rule of thumb).

"Propulsor overall effectiveness" – an overall aggregation of features and technical characteristics illustrating propulsor economic benefits; related thereto can be jointly provided thrust, speed, fuel effectiveness, maneuverability, reliability, operating convenience, safety, and a number of other parameters.

Referring now to Figures 1and 2, the claimed propulsor 10 structurally comprises a joint (central) chamber 12 (see Fig. 1), to which several (four or more, such as six shown in Figures 1-2) flow passages 14 are connected. With one of its ends, 16, each of the passages 14 is in fluid communication with the central chamber 12, with another end, 18, – with a three-dimensional gaseous or liquid medium (i.e., with the ambient environment), which the vehicle is in. The movement of the working fluid (not shown) in the propulsor passages is realized by means of pressure units 20 located in each of the passages. For the definiteness and illustrative purposes, the pressure units 20 are depicted as propellers (reversible propellers are understood), the propeller 20' being located in the passage which is normal to the plane of the drawing. The pressure units 20 provide for a controlled pressure head and flowing of the working fluid inside the passages 14 in the direction both to and from the central chamber 12 of the propulsor. Nozzles 22 at the outside ends 18 of the passages 14 provide for direction-controlled exhaust of the working fluid. Also for illustrative purposes, the nozzles 22 are conditionally shown as devices deflecting the working fluid exhaust jet in the drawing plane only, though all the reasoning herein is equally valid for the case where the nozzles provide for the spatial deflection of the exhaust jet. Reference number 22' shows, as an illustrative, and not limiting, variant, the limits of the controlled nozzle jet deflection. In each and every moment, the pattern of the working fluid movement through all the nozzles 22, passages 14, and central chamber 12 of the propulsor 10 results from the joint work of all propulsor pressure units 20 inasmuch as there is a hydrodynamic communication between all the passages 14 via the central chamber 12.

Spatial configuration of the propulsor nozzles 22 can vary depending not only on particular structural features of the propulsor such as the number of the passages 14, but also on the intended application of the propulsor and demands of the vehicle with which the propulsor is to be used. With that in view, believed to be preferable, as far as the optimization of work is concerned, but not limiting, is a version where the nozzles are located at the tops of a visional centrally symmetric polytope circumscribed about the propulsor, or configuration versions close to that.

The claimed propulsor works as follows: in the main operational regime, one or more passages 14 suck in gas or liquid from the ambient environment to use it as a working fluid, the pressure units 20 of those passages working for suction. Simultaneously, the pressure units 20 of the remaining passages 14 operate for ejecting the working fluid out to the ambient environment, the nozzles 22 of those remaining passages forming the direction of the ejection and the speed of ejecting jets from a nozzle depending not only on the operation of the pressure unit 20 of the respective passage 14 but also on the operation of the pressure units 20 of all other passages 14, both sucking and ejecting, since all the passages 14 are hydrodynamically interconnected via the central chamber 12. Upon ejecting working fluid jets, propulsive efforts emerge. The magnitude of the propulsive effort is correlated with the speed of the jet and depends on the operation of the pressure units 20 of the passages 14. Propulsive effort moments (turning forces) are controlled by both nozzle jet deflection and pressure unit operation. Summarily, all the emerged propulsive efforts define the direction and magnitude of the total propulsor thrust and the direction and strength of the total thrust moment (turning force).

By controlling the magnitude and direction of pressure head of the pressure units 20 of the passages 14, provided that at any moment some of the passages 14 work for suction and some – for ejecting the working fluid, and by controlling the direction of ejecting jets using controlled nozzles 22, it is possible to arrive at any propulsor resultant thrust and resultant thrust moment in terms of the magnitude/strength and direction thereof (within the full solid angle), no matter what the spatial orientation of the propulsor proper is.

Shown in a simplified manner in sketches of Figures 3-6 are examples of operation of the propulsor 10 having configuration with six flow passages illustrated by Figure 1. For illustrative purposes only, the passages in Figures 3-6 located normally to the drawing plane are understood working for suction only in all propulsor regimes reviewed, and they are not depicted in these drawings.

Figure 3 schematically shows the propulsor in the configuration illustrated by Figures 1 and 2. Reference 24 in Figure 3 is the central chamber, reference 26 is one of the flow passages, and reference 28 designates one of the nozzles. Reference 30 in Figure 3 (as well as in subsequent figures) belongs to arrows going from a passage, to thus show the direction of jets of the working fluid when being ejected from the propulsor. Upon the ejection of the jets, propelling forces develop providing for propulsor thrust and thrust moment. Curved and straight arrows 32 in Figure 3 (as well as in subsequent figures) directed into the passages illustrate sucking the working fluid into the propulsor from the outside environment. Shown for illustrative purposes only is the embodiment where the propulsor center of mass coincides with the center of symmetry of the propulsor. Also for more clearness, the operation of the propulsor is described without a vehicle; the propulsor mounted in the vehicle works likewise.

In the example illustrated by Figure 3, the propulsor ejects working fluid jets from the "top" (as conventionally referred to in the drawing and further in the text) and "left" passages 26 in the "up and left" direction and sucks working fluid from the outside environment through the "right" and "bottom" passages 26. The propelling forces emerging in this jet ejection create propulsor overall thrust in the "down and right" direction 34 as thrusts add up, and create no thrust moment inasmuch as thrust moments of the two passages are cancelled by each other.

In the example illustrated by Figure 4, sucking working fluid from the outside environment is performed through the "top" and "bottom" passages 26. The jets eject from the "left" and "right" passages 26 in the directions shown by arrows 36. In this way a "counterclockwise" thrust moment of the propulsor and zero overall thrust are created since thrusts in such a mode are mutually balanced whereas thrust moments add up.

The operating mode of the propulsor illustrated by Figure 5, where sucking is shown being performed through the "bottom" and "right" passages 26 and thrusts through the "top" and "left" passages 26, simultaneously provides the thrust in an approximate direction 38 of "down-down-right" due to adding up thrusts of the "top" and, in part, "left" passages 26, and a "counterclockwise" thrust moment due to the "left" passage 26.

The propulsor operating mode according to Figure 6 simultaneously provides thrust in the "down" direction 40 in the drawing, and thrust moment in the "counterclockwise" direction. Here, the "down" thrust is created by the jet from the "top" passage 26 whereas thrusts from the "left" and "right" nozzles 28 cancel each other. The "counterclockwise" thrust moment is provided by the nozzles 28 of the "left" and "right" passages 26. Sucking the working fluid is performed through the "bottom" passage 26.

The structure of the claimed propulsor gives rise to the following associations and limitations. Maximum of thrust and maximum of thrust moment depend on the structure of a particular propulsor and are limited by the power of power drives. The peak of thrust in propulsor is achieved at zero thrust moment, and the peak of thrust moment – at zero thrust as these parameters are provided for by same actuators – passage pressure units and nozzles – and use same energy source – propulsor power drives.

A structural spatial configuration of the flow passages and nozzles can vary as dictated by design features of a particular propulsor and depends, for example, on the number of the passages. Based on the propulsor described structural principles, a number of configurations can be proposed that assure thrust and thrust moment spatial control in the full solid angle range. Not limiting examples of some of such configurations were set forth in the description and shown in the drawings.

As discussed in the above, the propulsor according to the present disclosure makes it possible to perform controllable thrust and thrust moment (turn force) in any direction (in the full solid angle).

Summing up, the claimed jet propulsor provides controlling simultaneously the magnitude and spatial direction of thrust in the range of the full solid angle and the value and direction of a thrust moment conditional vector in the range of the full solid angle.

The claimed jet propulsor is intended for the use in means of transportation or other apparatuses moving in a three dimensional liquid or gaseous medium such as air or water, and provides for thrust and thrust moment. The propulsor provides controlling the magnitude/strength and direction of both thrust and thrust moment simultaneously and independently, the spatial control of thrust vector and thrust moment conditional vector being provided in a spatial range of the full solid angle unaffected by the attitude of the propulsor itself. Such a propulsor when moving in a three dimensional liquid or gaseous medium offers an enhanced level of maneuverability along with high overall effectiveness.

CLAIMS

1. A jet propulsor using gas or liquid of outside environment, which the propulsor is in, as working fluid, the propulsor comprising:
- at least four flow passages for a working fluid flow to pass through;
- a joint chamber, to which all the flow passages are connected with one of their ends, another end of each of the flow passages being in fluid communication with the outside environment, whereby the flow passages serve to connect the joint flow chamber to the outside environment;
- an independently controllable reversible pressure unit located in each of the flow passages to provide for magnitude and/or direction controllable pressure head in the working fluid flow;
- the other end of each of the flow passages being provided with a nozzle effecting the deflection of an ejected jet of the working fluid.

2. The jet propulsor as claimed in claim 1, wherein the nozzles are located at the tops of a visional centrally symmetric polytope circumscribed about the propulsor.

3. The jet propulsor as claimed in claim 1, wherein the plurality of the flow passages includes four flow passages.

4. The jet propulsor as claimed in claim 1, wherein the plurality of the flow passages includes six flow passages.

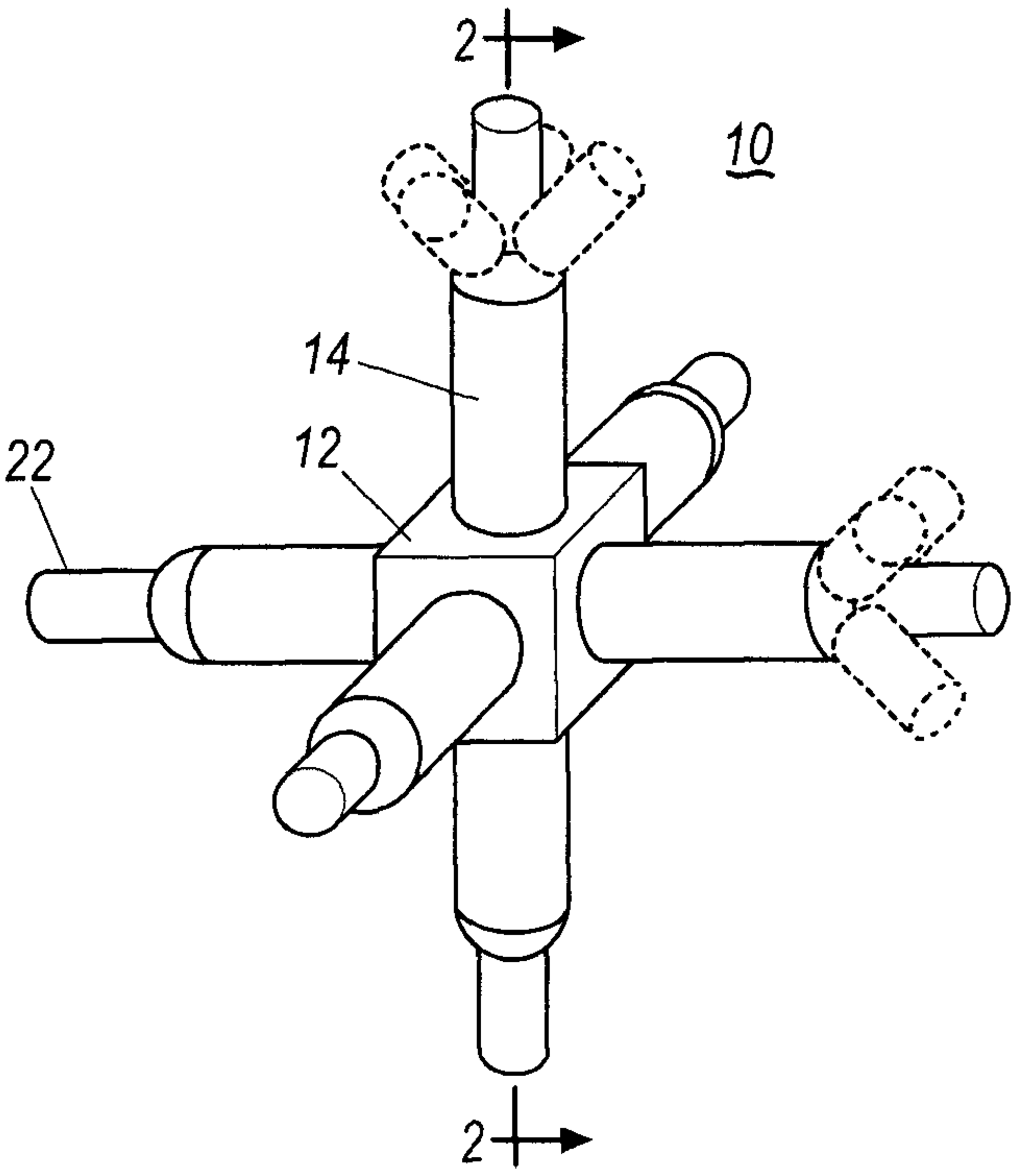


FIG. 1

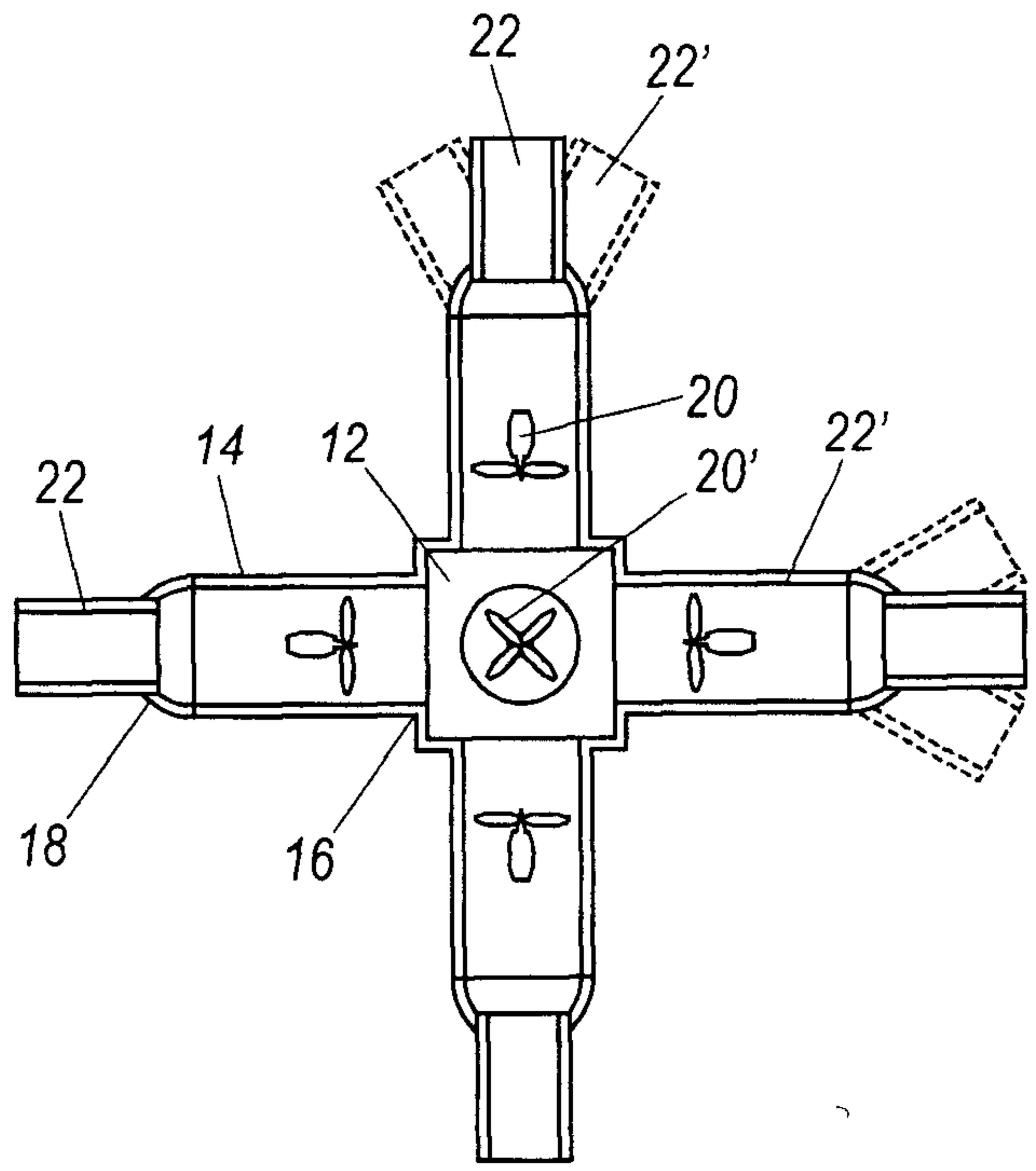


FIG. 2

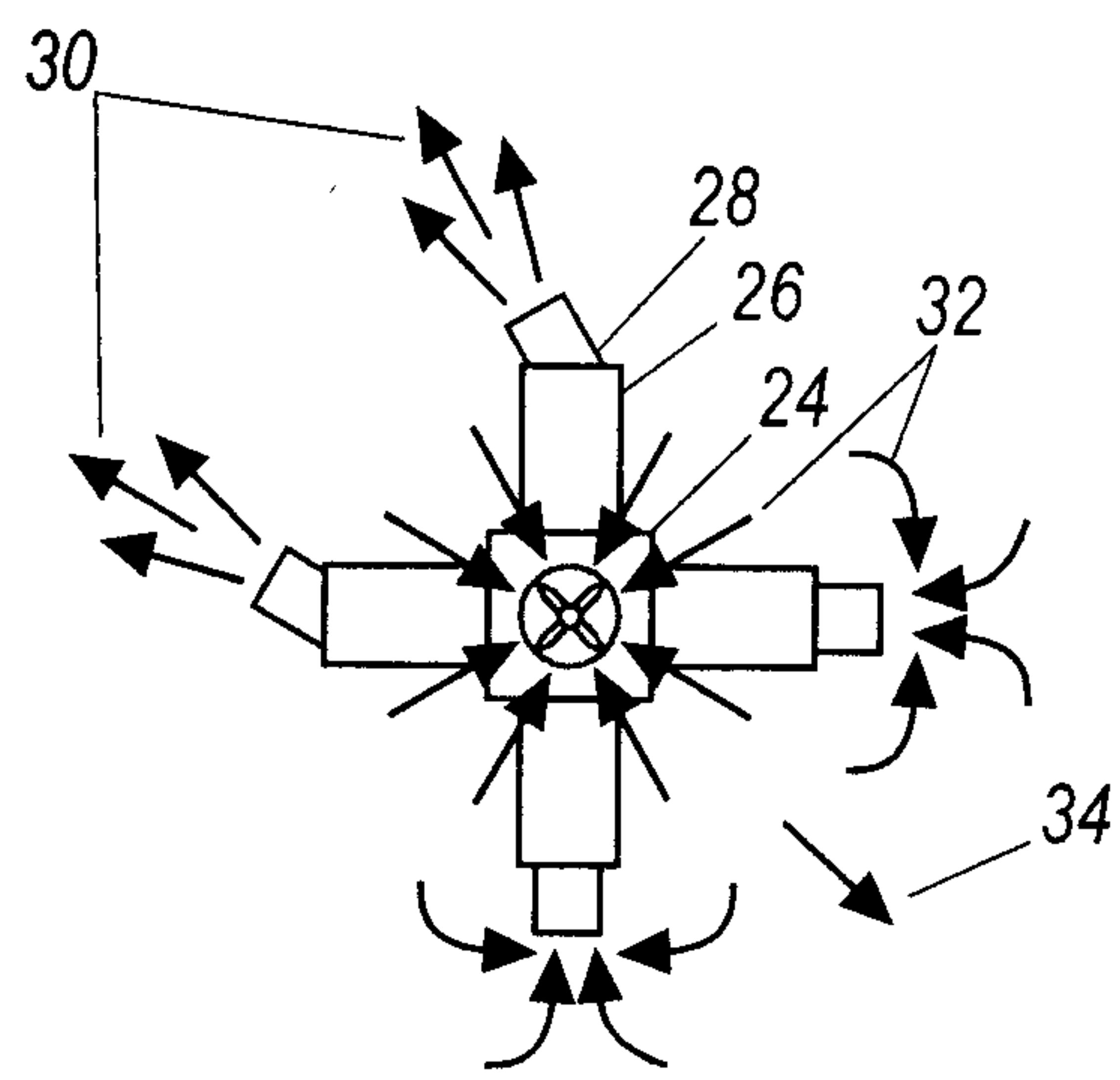


FIG. 3

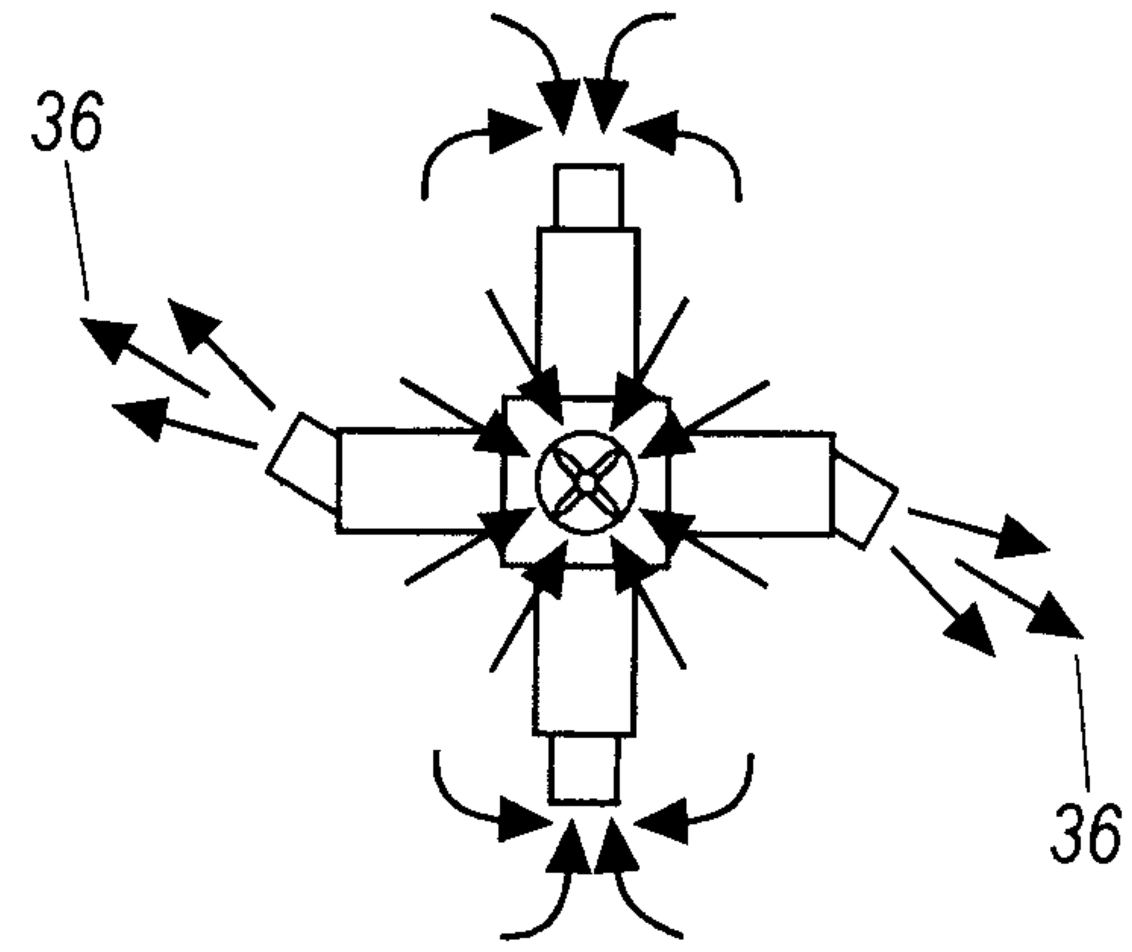


FIG. 4

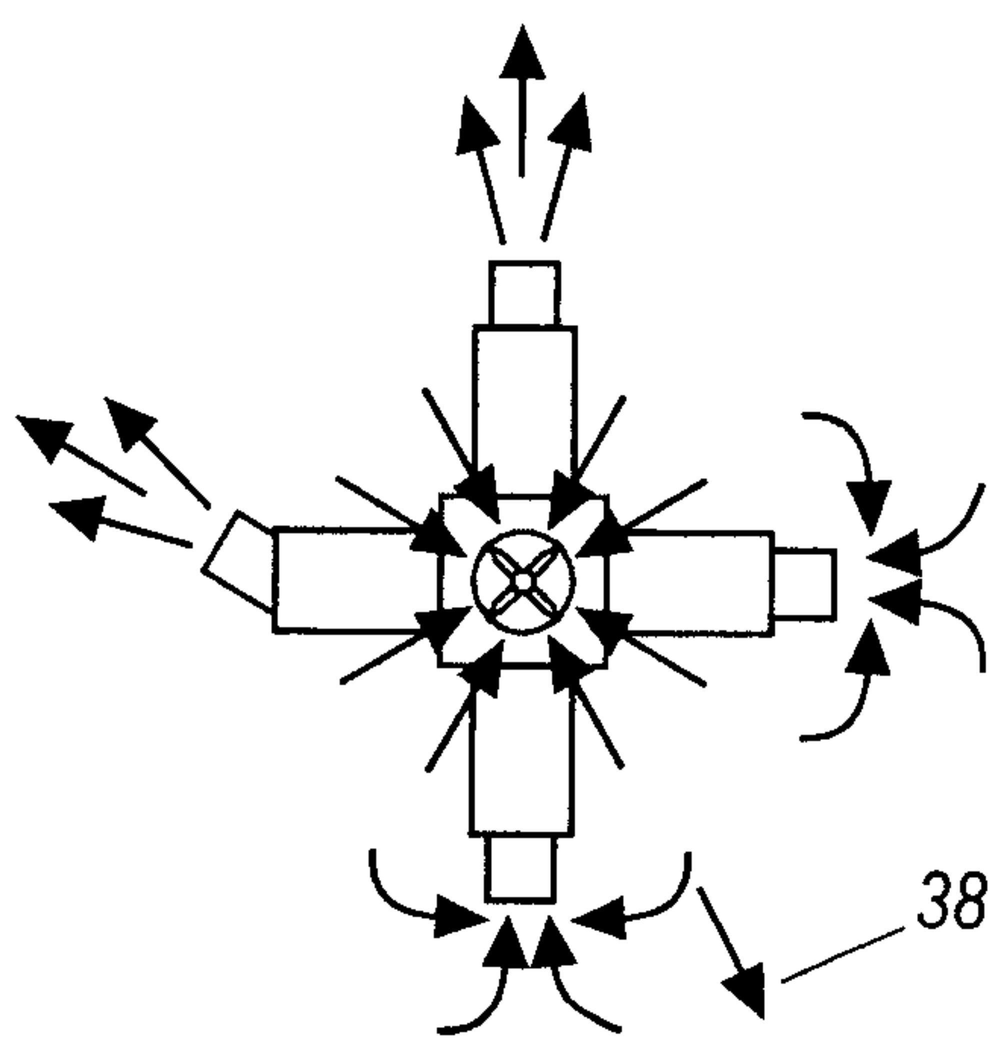


FIG. 5

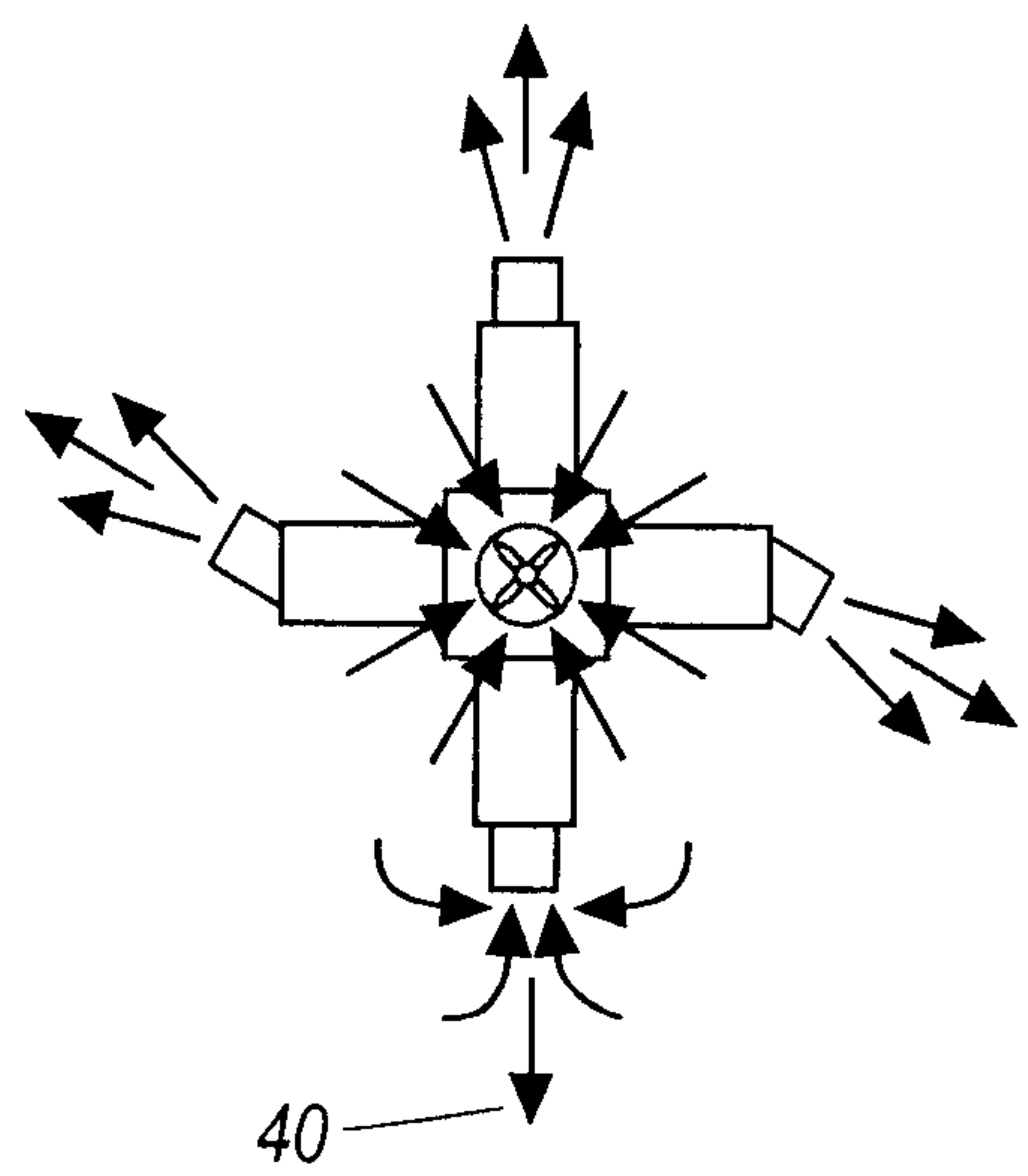
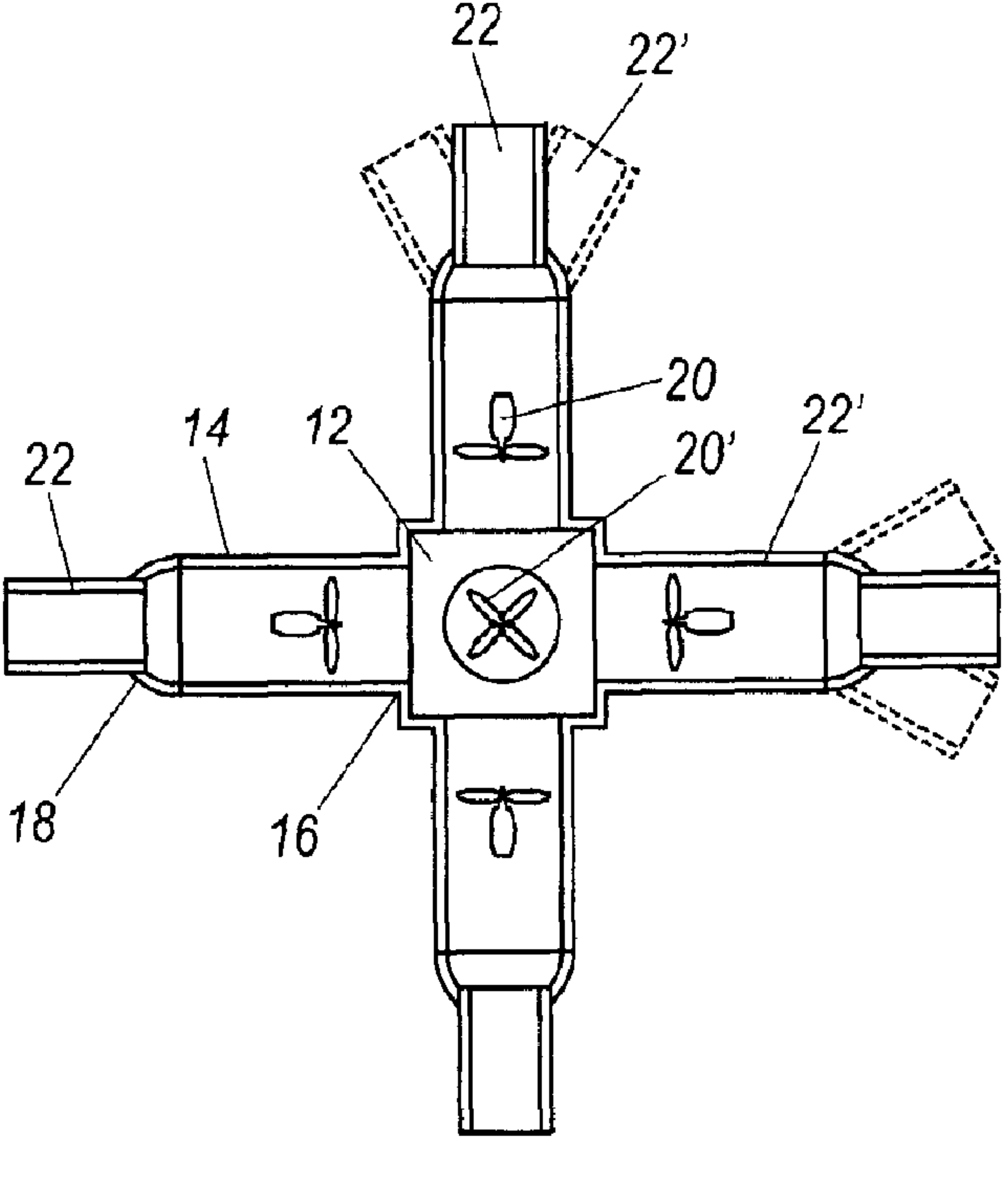


FIG. 6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