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MISSILE SYSTEM WITH PURE FLUID GUIDANCE AND CONTROL
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2 Claims

ABSTRACT OF THE DISCLOSURE
A missile system in which differential pressures from opposite sides of a missile are picked off and used to control fluid amplifiers. The fluid amplifiers in turn have output ports thereof that are controlled by said differential pressures to provide fluid control to exhaust gases from the rocket motor of the missile. By utilizing four fluid amplifiers and their control on the exhaust gases from the rocket nozzle, the missile is guided in two degrees of freedom.

This application is a continuation of application Ser. No. 466,869, filed June 24, 1965, and now abandoned.
The invention described herein may be used by or for the Government for governmental purposes without the payment of any royalty thereon.
This invention relates to a missile system in which a pure fluid mechanism is used to guide and control the flight of a missile.
In the missile industry, there is a constant need for guidance and control mechanisms that are small, simple, accurate, reliable and relatively cheap to build.
Therefore, it is an object of this invention to provide a missile system with pure fluid mechanism that is used to guide and control a missile.
Another object of this invention is to provide a missile system with guidance and control mechanism for guiding a missile in two degrees of freedom.
A further object of this invention is to provide a guidance and control mechanism that has no moving parts.
A still further and primary object of this invention is to sense angle of attack of a missile and constrain the missile to straight line flight.
Still another object of the invention is to provide a guidance and control mechanism that can utilize the atmosphere and pressure from the motor of a missile to actuate and control the guidance and control mechanism.
Yet another object of this invention is to provide a pure fluid guidance system that jets into the atmosphere and/or exhaust gases from the motor of a missile to correct the course of the missile.
A still further object of this invention is to provide opposed sensor ports on the nose or side of a missile to sense deviations of the missile from the intended course.
In accordance with this invention, a missile system is provided and includes a missile that has a motor therefor in propelling the missile to its intended destination and pure fluid guidance and control mechanism for guiding the missile while in flight. The missile is kept along the course as possible by the guidance and control mechanism irrespective of disturbances from wind, gravity, aerodynamic dissymmetry of the missile, misalignment of the rocket thrust relative to the nominal axis of aerodynamic symmetry and relative to the center of mass, and aerodynamic disturbances accompanying the rapid change of flight speed.
In the accompanying drawings forming part of this specification, and in which like numerals are employed to designate corresponding parts throughout the same:
FIGURE 1 is a perspective view, partially cut-away and in section, of a missile with guidance and control mechanism in accordance with an embodiment of this invention.
FIGURE 2 is a sectional view of a portion of another missile with guidance and control mechanism in accordance with another embodiment of this invention.
FIGURE 3 is a sectional view taken on line 3—3 of FIG. 2, and
FIGURE 4 is a sectional view taken on line 4—4 of FIG. 2.
The invention may be better understood by referring to the drawing in which numeral 1 to FIGURE 1 designates a missile according to this invention. The missile has a nose portion 3 and a body portion 5 with fins 7 near the rear thereof. Body 5 has conventional solid propellant rocket motor 9 therein, but this motor could be of the liquid, or hybrid types.
Guidance and control means for the missile include two conventional fluid amplifiers 11 and 13. Each of the fluid amplifiers are supplied with power fluid from the rocket motor by a T-shaped interconnecting line 15 which connects inputs 17 and 19 respectively of amplifiers 11 and 13 to the rocket motor. It should also be noted that the amplifiers may be supplied with power fluid from some other conventional source than the rocket motor, if desired.
Nose portion 3 has four sensing ports 21, 23, 25, 27 located 90° apart about a circle around the nose portion.

29 Tube 29 communicates sensed pressures from port 21 to one side of fluid amplifier 11, and tube 31 communicates sensed pressures from port 25 to another and opposite side of fluid amplifier 11.
Tube 33 communicates sensed pressures from port 23 to one side of fluid amplifier 13, and tube 35 communicates sensed pressures from port 27 to another and opposite side of fluid amplifier 13.
Fluid amplifier 11 has outputs 37 and 39 connected by tubes 41, 43 to jet ports 45, 47 respectively; and fluid amplifier 13 has outputs 49 and 51 connected by tubes 53, 55 to jet ports 57, 59 respectively. Jet ports 45, 47, 57, 59 are located 90° apart on a circle about the outside of the missile.
It should also be noted that even though the sensing ports are illustrated in the nose portion of the missile, they may be located in the side of the missile. Also, the jet ports are illustrated as jetting into the atmosphere, but if desired, they could jet into the exhaust nozzle of the rocket motor or jet partially into the atmosphere and partially into the exhaust nozzle of the rocket motor.
As illustrated in FIGURE 1, the jet ports are in front of the center of gravity of the missile, but they may be behind the center of gravity. This would only require that each output feed the opposite jet port to the one that it is illustrated as feeding in FIGURE 1, or the sensor signals could be fed to the opposite sides of the fluid amplifiers from the ones illustrated.
In operation, power fluid is supplied from rocket motor 9 by way of line 15 to inputs 17 and 19 of fluid amplifiers 11 and 13 respectively. The power fluid is supplied...
in equal proportions through outputs 37, 39 of fluid amplifier 11 and through outputs 49, 51 of fluid amplifier 13 due to the particular alignment of input 17 with outputs 37 and 39 and due to the particular alignment of input 19 with outputs 49, 51. This is true so long as equal and opposite sensor signals are sent from sensors 21, 25 or 23, 27. When signals other than equal and opposite are sent by sensors 21, 25, or 23, 27 to fluid amplifier 11 or 13, the control fluid supplied from the sensors to the fluid amplifiers will cause different amounts of power fluid to flow out the outputs in proportion to the sensor signals. The different amounts of power fluid flowing out the outputs will also flow out the jet ports to create sufficient forces on the missile to cause it to tilt back to the correct position to maintain the desired trajectory.

For example, assume that the missile has tilted off course from a straight trajectory by tilting toward the top of FIG. 1. This will cause a greater sensed pressure at sensor 25 than at sensor 21. Therefore, more power fluid will be deflected to output 37 rather than output 39. The power fluid from output 37 will jet through jet port 45 to cause the missile to be tilted down to the correct position.

Referring now to the embodiment illustrated in FIGS. 2 and 3, numeral 100 designates a portion of the missile according to the invention. The missile has a body portion 102 with a rocket motor 104 mounted therein. The body motor forms a chamber portion 106 and a nozzle portion 108. The rocket motor utilized is of the solid propellant type, but a liquid or hybrid propellant type could be used.

Guidance and control mechanism for the missile includes four fluid amplifiers 110, 112, 114 and 116. Each of the fluid amplifiers has a power input port 118, a power output port 120, and exhaust port 122, control ports 124, 126 and an interconnecting chamber 128. The power input port 118 of each fluid amplifier is arranged relative to the power output port 120 and the exhaust port 122 so that when equal and opposite signals are present at control ports 124, 126, power fluid flowing through power input port 118 will flow out exhaust port 122. When and only when a predetermined differential in pressure exists between control ports 124, 126, power fluid flowing through the power input port will be deflected into power output port 120. Supply lines 130, 132, 134, 136 supply power fluid from rocket motor 104 to power input 118 of each of the fluid amplifiers. Four sensing ports 138, 140, 142, 144 are equally spaced around the side of the missile and supply differential pressures to the control ports of the fluid amplifiers.

Branched line 146 connects sensing port 138 to control port 126 of fluid amplifier 110 and to control port 124 of fluid amplifier 114 and control port 126 of fluid amplifier 110 and control port 124 of fluid amplifier 114 are connected by branched line 150 to sensing port 142. Branched line 146 connects sensing port 140 to control port 126 of fluid amplifier 112 and to control port 124 of fluid amplifier 116; and control port 126 of fluid amplifier 116 and control port 124 of fluid amplifier 112 are connected by branched line 152 to sensing port 144.

Each exhaust port 122 of the fluid amplifiers is communicated by one of tubes 154, 156, 158, 160 to the rear of the missile, and each power output port 120 is in communication with the exhaust nozzle by one of tubes 162, 164, 166, 168. Tubes 162, 164, 166, 168 open into the exhaust nozzle at positions spaced 90° apart around the nozzle to jet power fluid into exhaust gas flowing through the nozzle.

In operation, so long as the missile continues in a straight line trajectory, equal pressures will be sensed at sensing ports 138, 140, 142, 144 and equal and opposite pressures will be communicated to control ports 124, 126 of each of the fluid amplifiers. Since equal and opposite pressures are present at control ports 124, 126 of each of the fluid amplifiers, the power fluid supplied to input ports 118 will be exhausted through exhaust ports 122 and exhaust tubes 154, 156, 158, 160 to the atmosphere. However, when the missile deviates from the straight line trajectory due to some disturbance, the guidance and control mechanism begins guiding the missile back to the straight line trajectory. For example, assume that the missile of FIGURE 2 is caused by some means to tilt to the left as viewed from the bottom. The pressure sensed at sensing port 138 will be greater than the pressure sensed at sensing port 142. Therefore, the sensing pressure communicated to control port 124 of fluid amplifier 114 will be greater than the sensing pressure communicated to control port 126 of fluid amplifier 114, and the flow of fluid through control port 124 will cause the power fluid from input 118 to be deflected through power output 120 and power output tube 166 into exhaust nozzle 108. This deflected power stream will act on the exhaust gases flowing through exhaust nozzle 108 and cause the exhaust gases to be deflected to one side. This deflection of the exhaust gases will cause forces to be exerted on the missile to tilt it back toward the straight line trajectory and correct the course of the missile.

Since sensing ports 138 and 142 form a pair of ports 180° apart and since sensing ports 140 and 144 form another pair of ports 180° apart, the guidance and control mechanism is adapted for guiding the missile in two degrees of freedom, namely pitch and yaw.

I claim:

1. A missile system including: a missile body; a rocket motor mounted in said body, said rocket motor having a single central exhaust nozzle coaxial with said body; and guidance and control mechanism mounted in said missile body and including four fluid amplifier means spaced about said single exhaust nozzle, each of said fluid amplifier means including a power input port, a power output port, and an exhaust port, each of said fluid amplifier means including a chamber intercommunicating all the ports, said exhaust port being in alignment with said input port for directly receiving power fluid therefrom, means supplying power fluid to the input port of each of the fluid amplifier means, first, second, third and fourth sensing means spaced 90° from one another on the said missile body, means communicating sensed pressure from said first of said sensing means to said first control port of a first of said four fluid amplifier means and to said second control port of a third and opposite of said four fluid amplifier means, means communicating sensed pressure from said third of said sensing means to said first control port of said third of said four fluid amplifier means and to said second control port of said first of said four fluid amplifier means, means communicating sensed pressure from said fourth of said four fluid amplifier means to said second control port of said third of said four fluid amplifier means and to said first control port of said fourth of said four fluid amplifier means; and to said second control port of said second of said four fluid amplifier means, whereby the power fluid of at least one of said four fluid amplifier means will be diverted from the exhaust port to the power output port when sensed pressures on opposite sides of the missile exceed a predetermined differential, means communicating the exhaust port of each fluid amplifier means to the rear of the missile, and means communicating the power output port of each fluid amplifier means to one of four openings spaced 90° from each other and which open into said single exhaust nozzle of the rocket motor, whereby said missile body is guided in two degrees of freedom by the power output of said fluid amplifier means: exhaust ports exhausting into said single exhaust nozzle of said rocket motor in response to trajectory deviations of said missile body.
2. A missile system as set forth in claim 1, wherein said fluid pressure from the rocket motor is utilized as the common source of power fluid for each of said four fluid amplifier means.

References Cited

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<th>UNITED STATES PATENTS</th>
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