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Cohen

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[54] **SUBMARINE MISSILE LAUNCH SYSTEM**

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[52] **U.S. Cl.** **89/1.81,** 89/1.816, 114/238

[51] **Int. Cl.** **F41f 3/08**

[58] **Field of Search** 114/238, 239; 89/1.809, 89/1.81, 1.8, 1.816

[56] **References Cited**

UNITED STATES PATENTS

3,072,022	1/1963	Wood et al.	89/1.81
3,132,562	5/1964	Frevel	89/8 X
3,289,533	12/1956	Brown	89/1.810

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[57] **ABSTRACT**

In a submarine missile launching system a launch tunnel connecting the launching tube and the outer skin of the vessel through which the missile passes. The tunnel is provided with a liner, formed of a matrix of resilient finger-like inward projections separated by longitudinal and transverse grooves. The exit end of the matrix is provided with a radial inward seal ring adapted to flexibly engage the missile. The fingers are selectively provided with sensors monitoring the movement of the missile, which sensors control a hydraulic counter-torquing system regulating the ejection of the missile.

21 Claims, 8 Drawing Figures

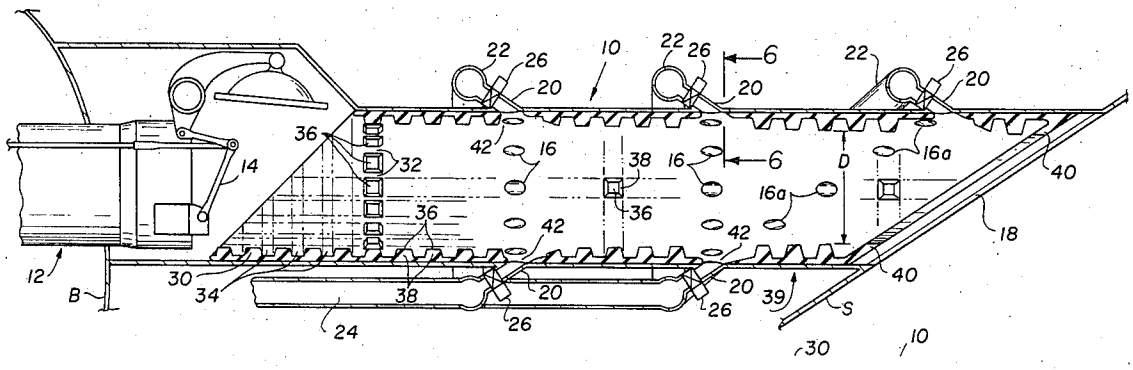


FIG. 1

FIG. 2

FIG. 8

FIG. 7

FIG. 6

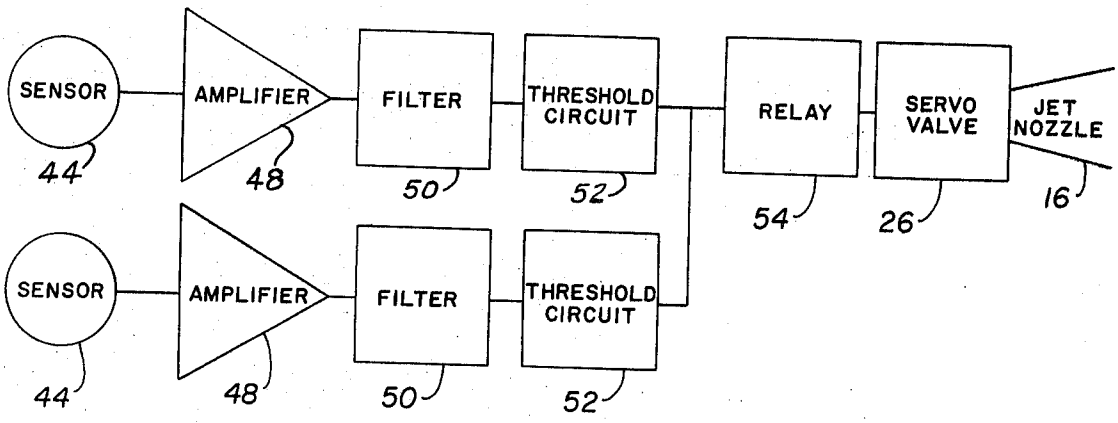


FIG.3

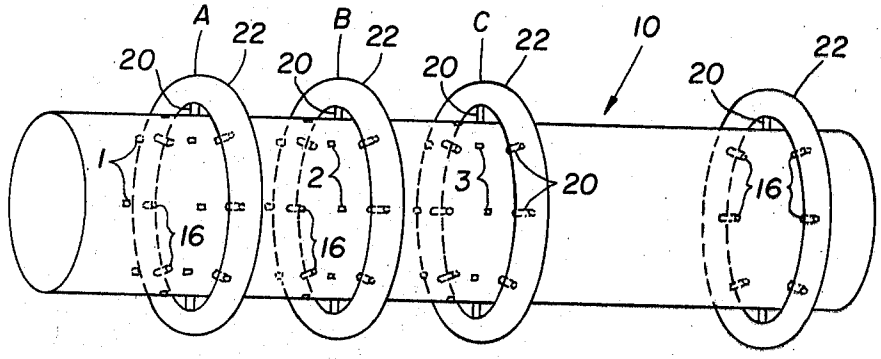


FIG.4

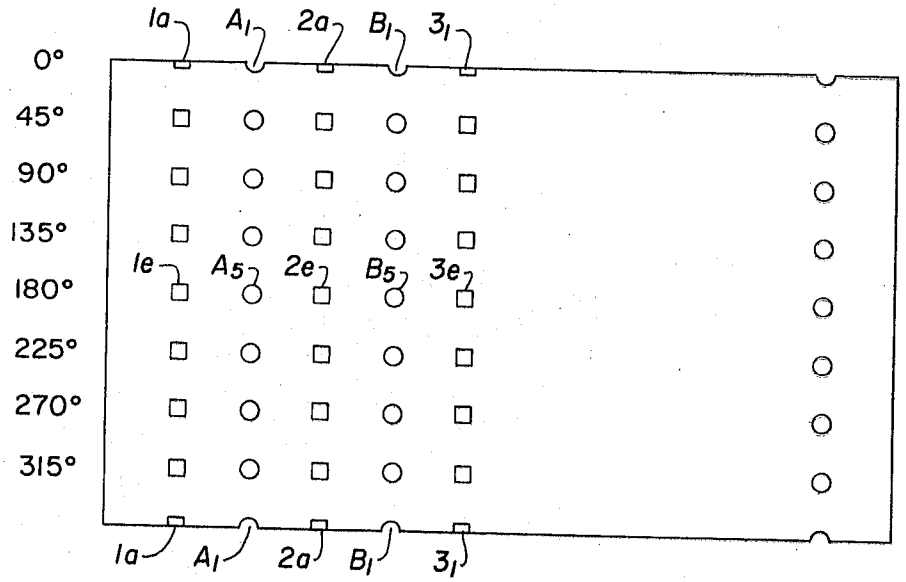


FIG.5

SUBMARINE MISSILE LAUNCH SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for launching projectiles, such as torpedos, from submarines and in particular to the construction and operation of the outer launch tunnel.

Submarines are conventionally formed with a pressure-tight hull surrounded by a skin or outer shield. Between the skin and the hull, various ballast tanks, fuel tanks, etc. are stored, and the space is freely flooded by sea water so as not to require pressurization. The projectile is prepared and initially fired through a launch tube ("torpedo tube") which breaches the pressurized hull but which terminates well before the outer skin shield. Between the muzzle end of the launch tube and the outer skin is a tunnel, generally of a larger diameter than the launch tube itself. The forward end of the tunnel is closed by a shutter which cuts across the tunnel so that, in the closed position, the shutter fairs into the lines of the hull. When the shutter is open, a more or less elliptical opening as large as or larger than the tunnel is revealed. The outer tunnels are in the free flooding portion of the submarine and are not subjected to large differential pressures. They are constructed of metal of a thickness to permit ease of handling and fabrication and for resistance to the shocks and vibrations of usage.

The distance from the muzzle of the inner launch tube to the shutter opening is generally shorter than the length of a projectile. Thus, the forward end of the weapon enters the ocean flow field around the moving submarine before the aft end of the projectile clears the closer-fitting inner tube. Because of the hydrodynamic forces exerted by the flow field on the emerging projectile, and because the projectile is either positively or negatively buoyant, the missile is subjected to large torques, occasionally in more than one plane. Further, as soon as it is physically free to do so, the missile begins to rotate, that is, to pitch and/or yaw, and to translate along transverse axes as well as to move forward. The result is that the projectile frequently strikes some part of the tunnel or shutter opening before it is completely free of the submarine. Such impacts increase in severity with increasing submarine speed, and often result in great damage to the projectile or the submarine. The tunnel is, therefore, made larger in diameter than the inner launch tube so that small amounts of weapon rotation or translation do not result in contact.

One of the most widely used methods of ejecting the missile from the closely fitting launch tube is to generate a slug of water which enters the aft end of the launch tube and pushes the missile out as if it were a free piston. However, the missile frequently has a streamlined stern section. As the aft end of the weapon, with its decreasing diameters, enters the muzzle opening, an annular space of increasing area is created and the water slug no longer can accelerate the missile. Most missiles slow down as they pas through the tunnel.

In applicant's prior patent applications Ser. No. 64,479 filed Aug. 17, 1970, now abandoned, and Continuation-in-Part application Ser. No. 343,815 filed Mar. 22, 1973, it has been shown how the use of pressure water jets can create torques on the missile that counter those due to the external flow field, and how appropriate variation in the exit velocity produced by

jet streams acting on the missile can also reduce or eliminate such contact.

While the techniques disclosed in the aforementioned applications reduce damage to the missile as well as the vessel, it does not entirely eliminate the problem, nor does it permit the more rapid ejection of the projectile than heretofore known.

It is the object of the present invention to provide an improved method for passing and ejecting a missile or projectile such as a torpedo through the outer launch tube which overcomes the disadvantages and defects of the prior art.

It is a further object of the present invention to provide an improved method of ejecting a missile through the outer launch tube which virtually eliminates the lateral motions incurred by differences in buoyancy, pressure or torque exerted on it and in which the possibility of the missile sticking or hanging up in the launch tunnel or its exit shutter is eliminated.

It is a further object of the present invention to provide an improved construction for the launch tunnel in which the above-mentioned disadvantages are eliminated.

It is a specific object of the present invention to provide a launch tunnel having a liner which absorbs shock and which accurately guides the missile.

It is a further specific object of the present invention to provide a liner for a launch tunnel which may be combined with sensors detecting the movement and torque on the missile, which may then be translated into a signal actuating appropriate jet controls.

SUMMARY OF THE INVENTION

According to the present invention, a system for control of the ejection of a submarine missile is provided wherein the launch tunnel, between the inner tube and the sea, is lined with an elastic resilient member or members adapted to absorb the strains and shocks and deflect the moving projectile. The liner comprises a matrix of radially extending fingers which are separated by longitudinal and annular transverse grooves to form a grid pattern of individually deflectable units. The liner may be formed as a unitary carpet-line structure or of individual sections of finger projections secured to the surface of the launch tunnel in tubular fashion.

In combination with the resilient liner, the system may include a directional and force sensing arrangement coupled with a monitoring arrangement by which the direction, ejection force and torque on the missile may be regulated. This arrangement includes a plurality of sensors embedded within selected ones of the resilient fingers, and a plurality of hydraulic jet nozzles selectively supplied with pressurized liquid, which are activated in a programmed manner in response to the sensors to exert a regulating force on the missile.

The cylindrical lining of the launch tube, with a plurality of spaced deflecting fingers, provides a chamber in which the deflection of the missile, traveling at high speeds, can be dampened and absorbed. It also provides the means by which the sensors of the control and regulating system can be spaced at any selected point within the launch tunnel, considering the longitudinal as well as radial position of the missile with respect to any point in the tunnel. It further provides the hydraulic control and regulating system with a high degree of flexibility enabling the exercise of countertorquing

forces on the missile in any programmed manner, taking clearly into account speed, position and force of the missile. Further, lining the tunnel with a resilient carpet of fingers reduces the annular space between the missile and tunnel wall in a manner to decrease destructive contact therebetween. The momentum of the slug of liquid, which accelerates in the tightly fitting inner launch tube **12,** will be dissipated to a much lesser degree by escape through the annulus which is, in the present invention, materially reduced and restricted and of lesser free area than in prior art structures.

A further feature of the present invention lies in providing the outer or exit end of the cylindrical matrix of resilient fingers with a "sphincter" like seal comprising an inwardly directed flexible ring extending above the height of the fingers, so as to have an inner diameter slightly smaller than the diameter of the missile being ejected. The ring engages the surface of the missile and thus, in combination with it, seals the exit end of the tunnel so that during ejection the interior of the launch tunnel is separated from the exterior ocean currents and forces. This seal prevents counter currents or ocean pressure forces from acting on the missile and separates the ocean pressure from acting on the slug of liquid propelling the missile from within the tube.

The use of the resilient lining of fingers reduces the annular area around the missile. This permits greater transfer of momentum from the ejection pulse to the missile while the latter tunnel **10** permits more efficient transer of energy from the ejection pulse to the missile. Thus, the ejection system can continue to operate effectively during the passage of the missle through the outer tube **10.** This new capability permits a lower acceleration over a longer distance and can give higher exit velocities with less peak power in the ejection equipment and with lower acoustic transients.

Preferably, the portion of the matrix of fingers adjacent the sphincter opening is progressively tapered from the diameter of the tunnel liner to the diameter of the sphincter seal ring so that the missile is properly guided. The sphincter ring may be prestressed into a given bias and it may be arranged in any plane relative to the longitudinal axis of the tube.

Full details of the present invention are set forth in the following description and are depicted in the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a horizontal sectional view through a launch tube and launch tunnel employing the liner and sensor system of the present invention;

FIG. **2** is a sectional view similar to FIG. **1** showing the outer end of a launch tunnel having a modified form of the invention;

FIG. **3** is a circuit diagram of the sensing and monitoring system employed in the present invention;

FIG. **4** is a perspective view indicating the arrangement of sensors and hydraulic jet ports for control of the missile;

FIG. **5** is a development of the arrangement shown in FIG. **4**;

FIG. **6** is a sectional view taken along line **6—6** of FIG. **1**;

FIG. **7** is an enlarged view of the portion encircled in FIG. **6** showing one form of sensor; and

FIG. **8** is a view similar to FIG. **7** showing a second form of sensor.

DESCRIPTION OF INVENTION

Turning to FIG. **1,** the present invention will be seen embodied within an otherwise conventional torpedo tunnel, generally depicted by the numeral **10,** running from the torpedo launch tube **12** mounted in the body B of a submarine to the outer skin shield S in conventional manner. The body B and skin S are joined by not shown means to provide an area surrounding at least part of the submarine which is designed to freely flood with sea water. The launch tube **12** is provided with a muzzle door to allow the missile (not shown) to be ejected into the tunnel **10.** The tunnel **10** is provided with a plurality of fluid jet inlets **16** for the introduction of countertorquing fluid, as water, intended to accelerate and correct the trajectory of the missile. The exterior of the tunnel is provided with a conventional shutter opening **18.** The jets **16** are uniformly apportioned into a plurality of annular rows, spaced along the length of the tunnel. In general, the rows of jets are parallel to each other, and arranged transversely to the longitudinal axis of the tunnel, although certain rows may be set at an elliptical angle to the axis (preferably parallel to the plane of the shutter opening), to obtain as large a moment arm as is feasible on the accelerated missile. The fluid jets **16** in each row are connected individually by pipes **20** to common torroidal manifold **22,** which is connected via a conduit **24** to a source of the countertorquing water. The same may be a reservoir, or the ocean, and includes pumping, pressure regulating and other means for its delivery. Interposed in each of the pipes **20** leading to the individual jets is solenoid operated valve **26** responsive to a control signal, in a manner later described.

The angle at which the jets themselves open in the surface of the tube, may be selected as desired to best meet the requirements set for operation of a particular torpedo under given parameters. Likewise, the number and spacing between jets and the rows of jets may also be chosen as desired.

In general, the construction of the launch tube and tunnel is described, and the operation of the jet assist mechanism conforms to those set forth in my aforementioned patent applications, to which reference may be made.

According to the present invention, a tubular liner **30** is secured to the inner surface of the tunnel. The liner is made of elastic material, such as natural or synthetic rubber, plastic or the like, and is provided over its entire surface area with longitudinal grooves **32** and transverse grooves **34** to provide an interior surface face **36** having a plurality of spaced inwardly projecting fingers **38.** Preferably the liner **30** is made as a unitary molded carpet-like structure which may be seamed or welded together as a tube in situ. On the other hand, the fingerlike projection **38** can be individually formed as by molding, cutting or shaping, and secured within the tunnel in separate pieces by seaming, welding or gluing. The base **30** may be bonded or adhered to the surface of the tunnel by the use of suitable glues, vulcanizing agents or even by fasteners. The liner **30** may be made of natural or synthetic materials such as rubber, elastomer plastic or their mixtures. In some instances, the liner as a whole may be made in part of one substance and in part of another substance.

It has been found that the best results are obtained with a liner having a degree of resiliency sufficient to

absorb and dampen the shock of the missile passing through it and exiting from the shutter opening, but one which is not so soft as to inhibit the missile's freedom of movement and the speed of its passage and ejection. Accordingly, a uniformly dense elastomeric material is preferred, and one in which the fingers and base are not formed with any hollows or cavities, although with the proper choice of material the fingers can be hollow if desired.

The liner **30** may extend along any desired extent of the length of the tunnel **10** from muzzle door **14** to shutter opening **18.** Hence, the illustration of the liner **30** in FIG. **1,** extending for the full length of the tunnel, shall not be limiting upon the scope of the invention. The fingers **38** are trapezoidal or pyramidal forms tapering into a flat top. As seen in FIG. **1,** the height of the figures is uniform from the breech door to a point indicated by arrow **39** approximately two-thirds the distance to the shutter opening **18** with a radius slightly larger than the missile, so as to provide a slight annular space around the missile. From the point **39,** the fingers **38** in each transverse successive row progressively increase in height, so that the liner tapers inwardly reducing the apparent cross-section of the tunnel, until a diameter D, substantially equal to that of the missile being ejected, is obtained. Adjacent the outer shutter opening **18,** the liner **30** terminates in an annular inwardly projecting ring **40** which lies in a plane parallel to the plane of the shutter opening **18.** The ring **40** extends inward to the normal diameter D slightly less than the diameter of the missile to be ejected, so that it forms a flexible tight seal and compression ring about the missile as it exits. This tight seal acts as a "sphincter" providing a ring-like gland which constricts about the missile to close off the orifice created by the opening of the shutter **18.** Thus, the interior of the tunnel is sealed off from influence of the surrounding sea so that the accelerating water provided by the jets **16** will not be reduced in effect. Further, the "sphincter" insures that the ejecting missile centers itself uniformly with respect to the shutter opening, reducing its likelihood to hit the skin S.

In the embodiment of FIG. **2,** the "sphincter" is arranged at right angles to the center line of the tunner rather than parallel to the elliptical shutter opening. The liner as a whole and the sphincter ring **40** may be otherwise identical to that shown in FIG. **1.** However, a very advantageous result is obtained when they are modified as per the showing of FIG. **2.** Here, the fingers **38** taper sharply inwardly adjacent ring **40.** The ring **40** itself is permanently curved and set to bend axially inwardly of the tunnel to have a permanent bias against the direction of movement of the missile M (FIG. **2**). During the movement of the missile out of the tunnel, it is engaged by the ring **40** and causes the ring to deflect from its normally biased condition to that shown at **40***a*. When the missile leaves the tunnel, the ring returns to its normally biased condition. The ring **40** is thus required to be positively flexed in order to permit the missile to be ejected and, thus, a tight seal is obtained. The perpendicular arrangement shown in FIG. **2** simplifies the calculations relating to the sizes of the jets and the timing of the openings.

It will be obvious that a missile emerging from the inner launch tube and driven into some part of the outer tunnel or shutter opening will have the shock of contact reduced by the yielding fingers or ridges. These can be displaced much more than can a smooth surface of solid elastomer, and thus can permit a longer period of deceleration at a lower deceleration rate. When the weapon hits an elastomer surface shaped to permit large deflections, many severe vibrations which now accompany impact are eliminated or reduced.

While a cellular or hollow elastomer material could also be used as a liner, it may be difficult, after long usage, to prevent the cells from filling with water. Once this occurs, or even if the hollow cells are filled with a pressurized gas, the material becomes much stiffer than it was originally. Solid fingers or ridges of elastomer, each of which acts as a cantilever beam, can be given contours so that considerable control over the stress-strain curve is achievable, with said stress-strain curves essentially independent of depth.

The slug of water driving the missile out of the inner tube will find less free area between missile and outer tube. It will then be worthwhile to continue to pump water after the tail portion of the missile begins to pass the breech door or muzzle of the inner tube, for less of the momentum of the water slug will be wasted by its flowing around the missile. Thus, the water slug or jet can be made to exert a strong push on the missile during its passage through the outer tube. The missile can be accelerated over a longer distance, either permitting higher exit velocities or lower accelerations. This construction favors a centrifugal pump over a ram pump of limited stroke as a generator of the water slug.

The elastic, serrated inner surface of the outer tunnel will attenuate some of the acoustic transients generated by the water flow and by impact between missile and metal wall.

Lastly, the construction of a liner as described above permits the employment of various sensors which measure displacement or pressure in selected fingers, so that if the missile strikes a specific section of the tunnel wall, those few fingers located in proximity to it will be easily and grossly displaced or subjected to unusual pressure by the impact. The sensors may be arranged to send signals to a control system wired so that the location of each specific sensor is known and its output, when received, is used to open a specific valve at such a location that the hydraulic jet thus set in motion will produce a torque on the missile to reduce the intensity of contact or to remove the missile entirely from the wall.

The liner **30** is cut out with cup-like depressions **42,** forming a mouth for each of the jets **16.** The mouth cutouts may be round, oval, or elliptical as necessary and for the particular function desired. Mounted in selected fingers **38** are sensors **44** which monitor the stresses and/or strains produced by the moving missile.

The sensors **44** may comprise either strain gauges **44***a*, such as seen in FIG. **7,** or pressure gauges **44***b*, as seen in FIG. **8.** Each gauge is connected into a control circuit shown in FIG. **3** wherein the signal produced by the sensor is passed to a signal integrator and amplifier **48** from which it is passed to a high by-pass filter **50,** and a threshold circuit **52** producing a signal activating a relay **54** associated with one or more selected servovalves **26** for the jets **16.**

Appropriate sensors of conventional construction are disclosed in "Standard Handbook for Mechanical Engineers", Baumeister and Marks, Seventh Edition, McGraw-Hill Book Company, Copyright 1958, 1967

by McGraw-Hill, particularly pages 5–78, 5–79, 5–8, 16–8, 16–10 and 16–11.

More detailed descriptions of resistive strain gauges, such as shown in FIG. 7 (which are most appropriate to this application because no voids need be left in the elastomer liner), and inductive strain gauges (which are highly useful for measuring displacements between a fixed surface and a portion of a moving body), can be found on pages 272 to 275, "Electrical Measurements and Their Applications" by Walter C. Michels, D. Van Nostrand Co., Princeton, N.J., Copyright, 1957 by D. Van Nostrand Co. Inc. Such gauges are conventionally connected in A.C. or D.C. bridge circuits as shown in FIG. 4, page 679 "Methods of Experimental Physics, Volume 2, Electrical Methods", edited by E. Bleuler and R. O. Haxby, Academic Press, New York, and London, Copyright, 1964.

The pressure gauges of FIG. 8 can be used in place of strain gauges. These can be of the piezo-electric type, and could be placed between the elastomer liner and the steel tube. For dynamic measurements with such pressure gauges, various precautions are necessary in order to eliminate troublesome noise and drift problems. Solutions are well known. A high impedance circuit including an amplifier suitable for dealing with high frequency, dynamic inputs is described in a publication by Kistler Instrument Corporation, Clarence, N.Y., "Model 566 Multi-Range Electrostatic Charge Amplifier," August, 1964. Such instrumentation is used, for example, on shock tubes.

Each gauge **44***a* is connected in or formed as a part of a control circuit, the details of which are illustrated in FIG. 3. A plurality of sensors or gauges **44** may be utilized to operate a jet nozzle **16.** In order to assure the proper operation of the jet nozzle **16,** it is necessary to signal its relay **54** to operate servovalve **26.** In FIG. **3,** a plurality of valve operating sensors are shown. Many more sensors may be connected to the one relay **54** and valve **26** there shown. However, for convenience, only two such sensors are illustrated.

The circuit illustrated in FIG. 3 comprises an amplifier **48** which receives a signal from its respective sensor. Connected in line with the amplifier **48** is a by-pass filter **50** which insures that only high frequency signals, such as those due to impact of the missile against the sensor finger, wil actuate the servovalve. Slow deformations of the fingers, such as those caused by changes in pressure because of changes in depth of the submarine, will not actuate the servovalve because they will be primarily of low frequency, whereas contacts due to impact will be intense, of limited time duration, and will contain many high frequency components. The use of alternating current and a high by-pass filter **50** results in a characteristic spike which will be absent when low frequency variations affect the fingers.

The threshold circuit **52** screens out the effects of minor noises and high frequency movements of the fingers, such as may occur from the turbulence associated with the high speed passage of a missile along an entirely normal trajectory that does not call for intervention by the countertorque jets. By use of a proper setting of the threshold circuit **52,** signals generated only by large deflections of the fingers caused by impact will be able to reach relay **54.** The purpose of the by-pass filters **50** and the threshold circuits **52** is, therefore, to screen out not only noise, but also any but genuine signals due to impact between missile and fingers, preventing the valve operating relay **54** from responding to undesired forces or pressures.

The specific amplifier by-pass filter and threshold circuit employed in the present disclosure form no part of the present invention. The circuit is merely illustrated and described to enable one to understand the complete operation of the present invention. Such structural details are well known in the art and any one or more conventional amplifiers, by-pass filters and threshold circuits may be employed.

As illustrated in FIG. **1,** the fingers **38** are cut away or eliminated in the area **42** of the countertorque jet ports to form the cup-like depressions in the vicinity of such jets. These cup-like depressions are designed to enhance the countertorque jet action in a number of ways. They can act as part of the jet nozzle or port and help reduce undesirable rapid changes in flow velocity. More important, as a missile is deflected toward a jet port by exterior hydrodynamic forces, the jet flow from the port becomes trapped to a degree and the pressure of the fluid flow at the jet against the side of the missile is increased, resulting in the centering of the missile within the tube. Conversely, if the missile swerves away from a jet, the water is freer to flow annularly from the jet about the missile, creating an area of low pressure about the port and an area of increased pressure opposite the port, both of which cause the missile to right itself by moving into the lower pressure area.

The clearance between the outer surface of the missile and the adjacent surfaces of the elastic yieldable fingers when the missile is centered in the tube enhances the proper operation and ensures the smooth movement of the missile through the tube. Although simultaneous opening of all the jet ports positioned about the circumference of the tube will tend to center the missile, a more accurate and powerful mode of operation is illustrated by FIGS. **4** and **5.** FIG. **4** illustrates in perspective how the sensors can be theoretically arranged in a cylindrical array longitudinally and transversely of the tunnel in "latitudes" and "meridians". In FIG. **5,** the inside of the cylinder is developed onto a plane, with the sensors indicated by a matrix **1***a*, **1***b*, **1***c* . . . , **2***a*, **2***b*, **2***c* . . . , **3***a*, **3***b*, and **3***c* . . . etc., and the jets indicated by A, B, C, . . etc. The integers **1, 2, 3,** etc. and the letters A, B, C, indicate locations from aft forward in the tube-tunnel structure and can be referred to as "meridians". The subscripts *a*, *b*, *c*, etc. and **1, 2, 3** - indicate angular locations around the cylinder, and can be said to locate "latitudes". Thus, in the matrix illustrated, *e* is at 180°, or at the bottom of the tube.

It is not required that there be a one-to-one correspondence between sensors and ports. There can be a denser distribution of sensors than ports. If more than one sensor is activated, integrating circuits will select that jet closest to the center of impact. Or, if the sensors are arranged on more "latitudes" than there are jets, these sensors will be wired to activate that jet closest in angular alignment to move the missile away from the wall.

The chosen jet will either be at essentially 180° away in "latitude" than the activated sensor, or on essentially the same "latitude", depending on whether the jet, when activated, will strike the missile before or after its center of gravity.

Determination of where the jet will strike the missile depends on the geometry of the sensor-jet nozzle arrangement and on the delay between the time the mis-

sile hits a sensor and the time the jet contacts the missile, Quick acting valves can be emloyed which can be fully opened in as little as 10 or 20 milliseconds. However, the inertia of the water in the manifolds and nozzles will create as great or greater delays. If the total delay from actuation of sensor to impact of jet is **50** milliseconds (0.050 seconds), and the missile is moving at 40 feet per second, it will have moved two feet before the jet begins to affect missile rotation. Submarine launched missiles are of many sizes, but characteristically will be about 20 feet or more in length.

By taking into account both the distances between sensors and jets and the delays, prior computations based on a particular launcher design will reveal where, relative to the center of gravity, the jets will strike the missile after a particular sensor is struck.

If the impact occurs early in the launch and the outer tube is long, or if the jet must be activated to relieve bending of the missile while much of it is still in the tight-fitting launch tube, jets close to the tunnel opening will likely operate on the missile forward of its center of gravity. The impacted sensor will actuate a jet valve 180° away from it in "latitude". Thus, in FIG. **5**, if the missile hits sensor **1***e*, it will actuate, through the appropriate amplifier, filter, and threshold circuit relay **54**, a related valve **26** controlling the related jet in the B meridian.

If the impact occurs so far forward that the jets cannot strike the missile forward of its center of gravity, then the port to be opened should be on or near the same "latitude" as the sensor which is struck. As an example of such a case, jet B_1 would be actuated by sensor **2***a*.

The present design provides a self-compensating system in which the missile moves in a variable field of fluid. The operation of the sensors and fluid jets provide substantially instantaneous centering of the missile to keep it on course as it leaves the tube, resisting all gravity and external forces that might tend to divert or deflect the movement of the missile from its intended path. Operatively, the amplifier, filter and threshold circuit are combined in a preprogrammed computerized control module, which is capable of receiving signals from the various sensors, and integrating them with the known parameters of missile firing such as the force of the propelling slug, speed of the missile, ocean forces, distances, etc. and as a result, select the one or plural number of jets to operate.

Various modifications, changes and embodiments have been shown, since it is intended that the present disclosure be illustrative only of the invention. Reference should be made to the accompanying claims only for the limitations of the scope of the invention.

Referring to the embodiment of FIG. **1**, it will be noted that the last series of jets **16** are positioned along the torpedo tunnel **10** at an angle to the axis of such tunnel, unlike the remaining jets **16** which are positioned substantially circumferentially about the tunnel. The last series of such angled jets **16** are positioned as close to the terminal end of the tunnel and as close as possible to the opening **18** thereof so that they can impart forces to the torpedo or missile at the very last moment of exit of such torpedo from the tunnel, thereby assuring a most immediate, final and accurate control of the torpedo as it leaves the tunnel and even for a distance therebeyond. Thus, the angled jets **16** here identified as **16a** for convenience are directed toward the opening **18** of the tunnel **10** and, thus, apply their forces to the missile even as the missile is about to leave the tunnel and for a distance thereafter. This arrangement assures a more accurate control of the torpedo even after it has left the confines of the tunnel.

What is claimed is:

1. A submarine missile launcher for a submarine having a propulsion tube and a tunnel connecting the interior propulsion tube and the exterior of the submarine comprising

a circumferential resilient covering lining a lengthwise extent of the interior of said tunnel,

flexible means projecting to extend from said covering radially inwardly toward the tunnel axis for engagement with a missile being launched from said tunnel,

a plurality of fluid dispensing jets relatively spaced about the tunnel,

and sensor means connected with said jets and responsive to the flexing of said flexible means during the movement of a missile through the tunnel to cause said jets to apply a stream of fluid laterally to the missile.

2. A submarine missile launcher according to claim **1** wherein said flexible means are fingers arranged in a matrix and said fingers flex in response to touching engagement therewith by the missile moving through said tunnel.

3. A submarine missile launcher according to claim **2**, said sensor means being operable in selected ones of said fingers to provide a signal of engagement by the missile moving through the tunnel,

means for controlling the flow of fluid through selected ones of said jets,

and said last named means being selectively operable in response to the selected operation of certain ones of said sensor means.

4. A submarine missile launcher according to claim **2** wherein a flexible radially inwardly directed ring extends into said tunnel between the tunnel and the missile being launched therefrom.

5. A submarine missile launcher according to claim **4** wherein said matrix is arranged to taper radially inward adjacent the exterior end of said tunnel.

6. A submarine missile launcher according to claim **1** including a flexible radially inwardly directed ring in said tunnel, said ring having an inner diameter slightly smaller than the outer diameter of the missile adapted to be ejected therefrom.

7. A submarine missile launcher according to claim **6** wherein said ring is flexibly biased in an axial direction.

8. A submarine missile launcher according to claim **6** wherein said ring lies in a plane substantially parallel to the exterior opening of said tunnel.

9. A submarine missile launcher according to claim **6** wherein said ring lies in a plane substantially normal to the axis of the tunnel.

10. A submarine missile launcher according to claim **6** wherein said matrix of fingers defines a surface for engagement by a missile moving through said tunnel and for guiding the missile during its movement.

11. A submarine missile launcher according to claim **1** wherein at least certain of said jets are positioned within said tunnel to apply a lateral force to the missile after the same has exited from the tunnel.

12. In the control of a missile along a given path of movement through the launch tunnel of a submarine,

lining at least a portion of said launch tunnel with a resilient covering that is displaceable in response to deviations of the missile from its given path during a launch thereof,

including within said covering sensors to signal deviations of the missile when the missile moves from its given path,

and means operable in response to the signals of said sensors to cause a stream of fluid to be applied laterally against the missile to cause the missile to move back along its given path.

13. In the control of a missile according to claim 12 wherein said stream of fluid is directed through a plurality of jets,

and selected ones of said jets being associated with selected ones of said sensors.

14. In the control of a missile according to claim 13 wherein selected ones of said jets apply a stream of fluid against the missile after the same has left the confines of said launch tunnel.

15. In a submarine launch tunnel having an inner end communicating with the propulsion tube and an outer end communicating with the ocean through which a missile is adapted to move in a path substantially aligned with the axis of the tunnel,

means in said tunnel and cooperating with the missile to seal said tunnel from said ocean including sensing means to sense the movements of the missile along its path and an annular flexible ring extending radially inwardly from the surface of said tunnel, said ring having an inner diameter normally less than said missile,

and means in said tunnel to apply a lateral force to the missile in response to movements of the same from its path as sensed by said sensing means.

16. The launch tunnel according to claim 15 wherein said ring is biased axially inward counter to the direction of movement of said missile.

17. The launch tunnel according to claim 15 wherein said ring lies in a plane substantially parallel with the edge of the outer opening.

18. The launch tunnel according to claim 15 wherein said ring lies in a plane substantially perpendicular to the longitudinal axis of the tunnel.

19. The launch tunnel according to claim 15, said lateral thrust applying means including means to apply lateral forces to the missile after the same has left the launch tunnel.

20. The method of controlling the movement of a missile along a given path during its launch from a submarine tunnel wherein the tunnel has sensing means displaceable in response to deviations of the missile from its given path the method comprising

sensing deviations of the missile from its given path of movement as it moves along the launch tunnel and into displaceable engagement with the sensing means,

and applying a stream of fluid laterally against the missile in response to the sensed deviations to counter the deviated movement of the missile to cause the same to assume its given path.

21. The method as in claim 20,

sensing the deviations of movement of the missile from along its given path as it leaves the submarine tunnel,

and applying a countering stream of fluid against the missile after it leaves the tunnel.

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