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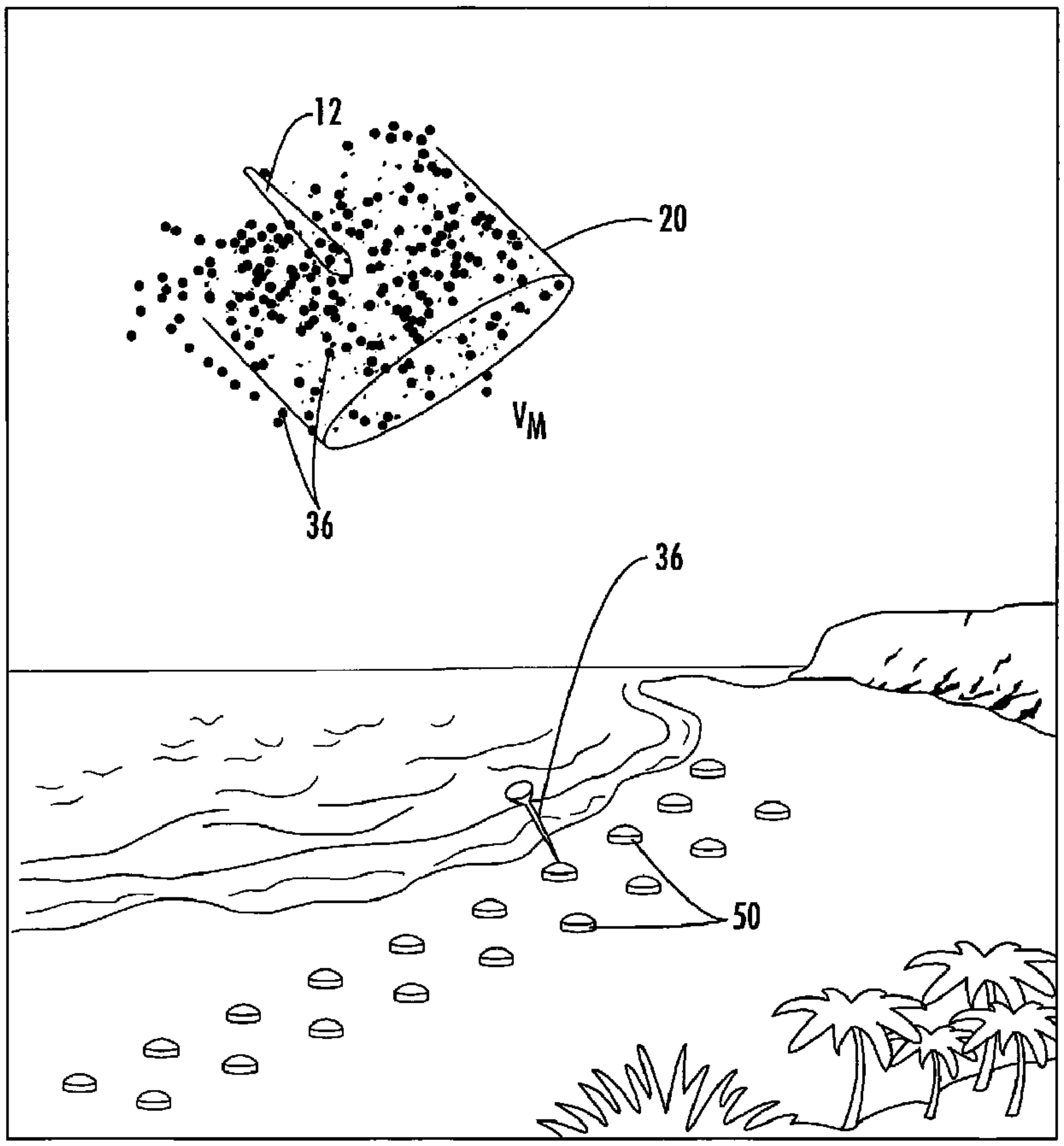

(57) Abrégé/Abstract:
A mine counter measure system and method. There is an explosive in a housing and a number of kinetic energy rods in the housing about the explosive. Each rod has a stabilizer for aligning the rod about its velocity vector to better penetrate the surface above a mine.

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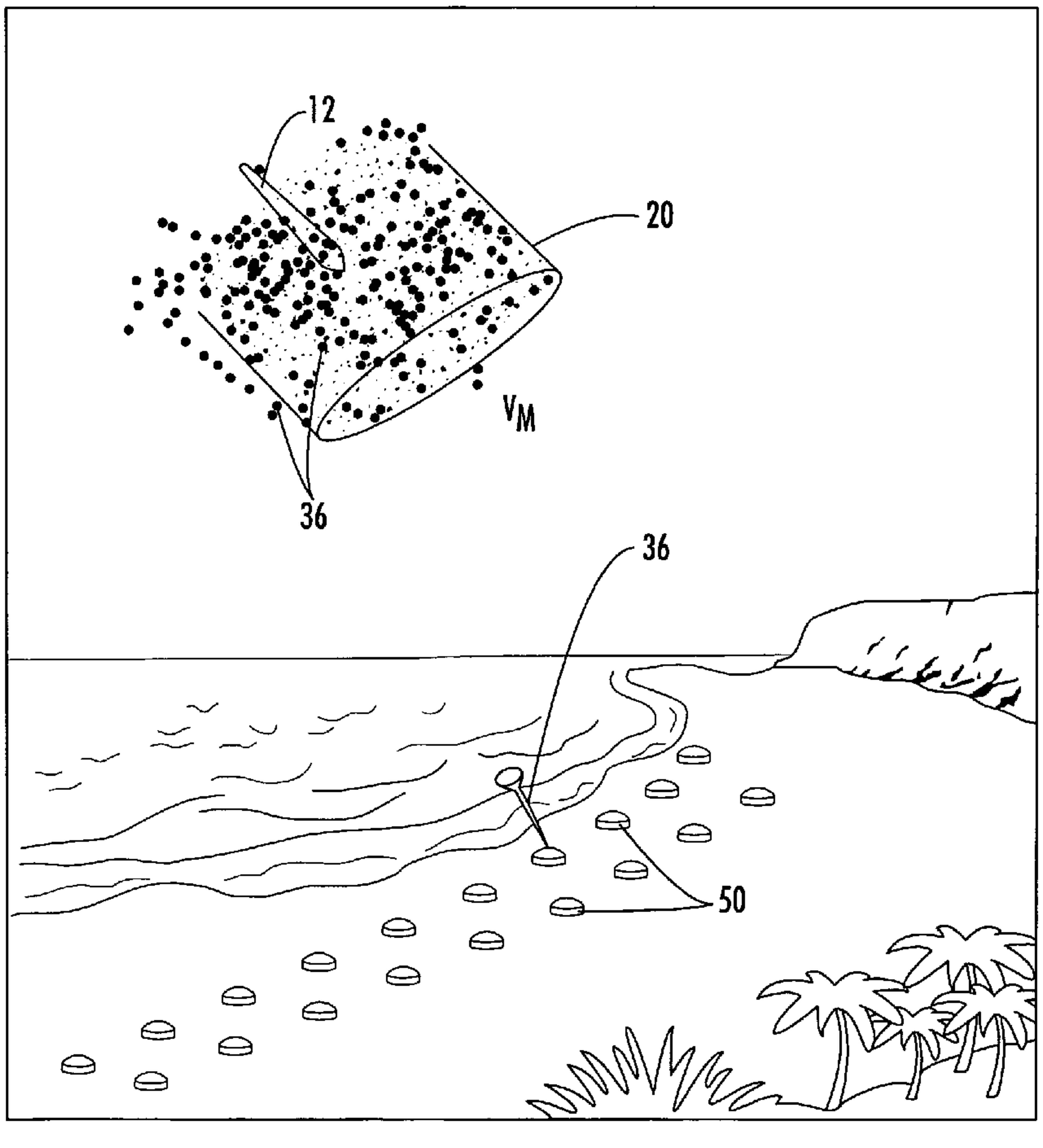
[Continued on next page]

(54) **Title:** MINE COUNTER MEASURE SYSTEM



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MINE COUNTER MEASURE SYSTEM

FIELD OF THE INVENTION

This invention relates to a land mine counter measure system.

BACKGROUND OF THE INVENTION

Land mines pose a severe threat to military and civilian personnel. The idea of detonating land mines using conventional weapons and ordinances is known but such methods are not very effective or efficient since many ordinances would be required to detonate the numerous possible land mines in a given area.

One current idea is to deploy a net carrying shape charges onto the land mine field. But, never is there a guarantee that all the land mines would be detonated and, worse, some shape charges could fail to detonate resulting in an added explosive danger to personnel who then enter onto the land mine field. Also, this approach would not be used during a war where troops are required to engage the enemy from the beach.

Also, land mines are often buried 6 inches beneath the sand on a beach and also beneath the sand under two or more feet of water. Conventional approaches fail to effectively counter such tactics during wartime.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a better land mine counter measure system.

It is a further object of this invention to provide such a system which is highly effective and which can be used during armed conflict.

It is a further object of this invention to provide such a system which is efficient.

It is a further object of this invention to provide such a system which leaves no unexploded ordinances on the land mine field.

It is a further object of this invention to provide such a system which can efficiently and effectively detonate land mines buried in the sand and also under the water.

The invention results from the realization that a more efficient and effective land mine counter measure system is effected by spraying the land mine field with a number of arrow-like kinetic energy rods each aligned about its velocity vector to better penetrate the surface (sand or sand and water) above the mines.

This invention features a mine counter measure system comprising a housing, an explosive in the housing, and a plurality of kinetic energy rods in the housing about the explosive. Each rod has a stabilizer for aligning the rod about its velocity vector to better penetrate the surface above a mine.

In one example, each rod has a length to diameter ratio of greater than 5 and preferably a length to diameter ratio greater than or equal to 10. In one embodiment, the stabilizer is a plurality of fins on the distal end of each rod. In another embodiment, the stabilizer is a flared distal end of the rod. Typically, the proximal end of each rod is pointed. In one example, the proximal end of each rod includes a poly-wedge shape to decrease the drag on the rod. Also, it is preferred that the center of gravity of each rod is proximate the distal end of the rod to orient the proximal end of the rod downward.

Further included may be a foam body in the housing between the rods and the explosive. Or, there may be a foam body in the housing about the rods between the housing and the explosive. In one example, the rods are packaged in coaxially aligned rings and there are coaxially aligned foam bodies between each ring of rods.

The rods may have a circular cross sectional shape, a cruciform cross sectional shape, or a tristar cross sectional shape.

In one example, the housing is a shell. In another example, the housing is a payload. Further included may be a missile for deploying a plurality of said payloads. Typically, the rods are staggered in the housing for better packaging efficiency.

One mine counter measure system in accordance with this invention includes a housing, an explosive in the housing, a plurality of kinetic energy rods in the housing about the explosive, each rod having a stabilizer for aligning the rod about its velocity vector to better penetrate the surface above a mine, each rod having a length to diameter ratio of greater than or equal to 10, each rod having a poly-wedge shaped proximal end, and foam in the housing between the rods and the explosive core.

One mine counter measure system in accordance with this invention features a plurality of munition housings each including, an explosive, and a plurality of kinetic energy rods about the explosive, each rod having a stabilizer for aligning the rod about its velocity vector to better penetrate the surface above a mine and each rod including a poly-wedge shaped tip to decrease the drag on the rod and a length to diameter ratio of greater than or equal to 10. A carrier deploys the munition housings over a minefield.

This invention also features a method of destroying mines in a minefield buried under the surface. The method comprises deploying a munition including a plurality of kinetic energy rods each having a stabilizer into a position above the minefield and deploying the rods above the minefield to fall towards the minefield each aligned along a velocity vector to penetrate the surface and destroy the mines.

In one example, a plurality of the minefields are carried to a position above the minefield and deploying includes detonating an explosive core in each minefield surrounded by the rods.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages will occur to those skilled in the art from the following description of a preferred embodiment and the accompanying drawings, in which:

Fig. 1 is a schematic view showing the deployment of the mine counter measure system of the subject invention;

Fig. 2 is a schematic three-dimensional view showing one embodiment of a projectile for deploying the munitions of the subject invention;

Fig. 3 is a schematic three-dimensional view showing one embodiment of a munition in accordance with the subject invention;

Fig. 4 is a schematic three-dimensional view showing one embodiment of a kinetic energy rod in accordance with the subject invention;

Fig. 5 is a schematic view showing the deployment of the kinetic energy rods of Fig. 4 from the munition of Fig. 3 onto a minefield;

Fig. 6 is a schematic three-dimensional view showing another embodiment of a kinetic energy rod in accordance with the subject invention;

Fig. 7 is a schematic three-dimensional view showing a tristar rod configuration in accordance with the subject invention;

Fig. 8 is a schematic three-dimensional view showing a cruciform rod configuration in accordance with the subject invention;

Fig. 9 is a schematic partial view showing staggered kinetic energy rods for better packaging efficiency in accordance with the subject invention;

Fig. 11 is a cross sectional view showing a munition with a number of kinetic energy rods in accordance with the subject invention;

Fig. 12 is a drawing which characterizes the lethality of the mine counter measure system of the subject invention; and

Fig. 13 is a graph comparing penetrator mass to impact velocity.

DISCLOSURE OF THE PREFERRED EMBODIMENT

Aside from the preferred embodiment or embodiments disclosed below, this invention is capable of other embodiments and of being practiced or being carried out in various ways. Thus, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of components set forth in the following description or illustrated in the drawings.

Mine counter measure system 10, Fig. 1 includes, in one example, missile 12 deployed from ship or submarine 14 or other launcher. In this specific example, missile 12 is an XM 982 Excalibur 155 mm long range guided missile with GPS tracking capability and having a trajectory optimized for range and time of arrival at position A and then having a trajectory optimized for rod delivery at position B over minefield 14. Other ordinances and delivery mechanisms, however, are within the scope of this invention.

As shown in Fig. 2, missile 12 includes bays 18 housing deployable munitions, shells, or other payloads 20 discussed *infra*. Missile 12 also includes antijam GPS/IMU navigation section 22, guidance and electronic unit section 24, inductive fuse setter interface 26, control and actuator section 28, and fin stabilizer base section 30.

As shown in Fig. 3, each munition or shell 20 includes munition housing 32, explosive core 34, and a number of kinetic energy rods 36 in housing 12 about core 34. Typically, foam body 38 is included between rods 36 and explosive core 34. To align each rod about its velocity vector to better penetrate the surface (e.g., sand and/or water) above a land mine, each rod 36, Fig. 4 includes some kind of stabilizer 40 which, in this example, is a flared end. Preferably, each rod is made of tungsten or tantalum and has a length to diameter ratio of greater than 5 and typically greater than or equal to 10.

As shown in Fig. 5, mines 50 are buried beneath sand and/or water and missile 12, Figs. 1-2 has reached deployment position B, Fig. 1 whereupon munitions 20, Figs. 2-3 are deployed and explosive core 34, Fig. 3 detonated which sprays rods 36, Fig. 5 into a desired pattern, each rod aligned along its velocity vector to penetrate the surface above a mine 50 thereby destroying it.

The result is effective and efficient mine distraction without the possibility of leaving unexploded ordinances on the minefield.

In Fig. 6, kinetic energy rod 36' includes a stabilizer in the form of fins 60 on the distal end of each rod and the proximal end of rod 36 includes pointed poly-wedge shaped tip 38. This penetrator nose is designed to reduce air drag (CD) allowing the penetrator to fly faster for longer period of time and enhance its over all stability. There has been much work on the design of these nose shapes. See Gonor A.L., Kazakov M.N., Shvets A.I. Aerodynamic characteristics of star-shaped bodies during supersonic speeds, News of the Soviet Academy of Sciences (Izv. AN SSSR). MZHG. 1971, No 1, p. 97-102. It is also preferred that the center of gravity of each rod is located proximate the distal end of the rod to orient the proximal end of the rod downward upon deployment from housing 12, Fig. 5.

The rods may also have a non-circular cross section as shown for rod 36", Fig. 7 (a tristar configuration), and rod 36"', Fig. 8, (a cruciform construction). As shown in Fig. 9, the fins of the rods can be staggered in the munition or shell for better packaging efficiency.

In Fig. 10, rods 36 are packaged in coaxially aligned rings A, B, and D with coaxially aligned rings W, X, and Y of foam between each adjacent ring of rods. The explosive used between each ring would typically be a detasheet or a PBX based explosive.

In Fig. 11, foam body 38' is about rods 36 between housing 32 and explosive core 34. Also, munition 20 may be a shell launched, for example, from a gun subsystem as opposed to missile 12, Figs. 1-2. Munition 20 would then include a time delay or altitude fuse for deploying core 34. The munition rounds are fired toward the beach at high velocity. The desired dispersal spray pattern and mine spacing will determine the optimum altitude to deploy the rods. The rods are isotropically deployed creating a uniform spray pattern about the munition center axis. The rods became stabilized shortly after explosive deployment because of the tail fin design.

The unique nose shape reduces the penetrator drag ensuring high impact velocity into the mine field. Each rod penetrates the sand or water at high enough velocity to detonate the explosive.

Fig. 12 demonstrates the high lethality obtained by the system of this invention based on computer modeling. A generic minefield was generated and each mine was placed three feet apart while each row was five feet apart. A highly dense spray pattern of 30 gm rods with a length to diameter ratio of 10 impacting the minefield nearly kills all of the mines in a 10 foot by 12 foot area. With a 1000 rods and a burst point at a higher altitude, there is a significant increase in the number of mines that were hit with multiple rod impacts. This calculation demonstrates that an extremely large area minefield can be made safe provided that the proper burse point for a given number of projectiles is selected.

The system of the subject invention also takes into account the effects of water and sand on penetration. Mines that lie on shore can be covered with up to 6 inches of dry or wet sand while mines in the surf zone can be covered with sand and water up to 2 foot.

Fig. 13 shows the design trade-offs between the optimum penetrator concept. If a sphere is used, then it would require a larger mass compared to a slender long rid. A rod is a much more efficient penetrator compared to a sphere. However, the longer the rod becomes the more precise is most impact with low yaw angles. If the penetrator is not aligned then it will not penetrate well and fail to kill the buried mine. Since all weapons are weight restricted, the lightest weight penetrator is the best for optimum lethality.

Although specific features of the invention are shown in some drawings and not in others, this is for convenience only as each feature may be combined with any or all of the other features in accordance with the invention. The words “including”, “comprising”, “having”, and “with” as used herein are to be interpreted broadly and comprehensively and are not limited to any physical interconnection. Moreover, any embodiments disclosed in the subject application are not to be taken as the only possible embodiments. For example, selected structures and techniques of U.S. Patent Nos. 6,598,534; 6,779,462; 6,931,994; 7,040,235; 7,017,496; and U.S. Patent Publication Nos. 2005/0132923 and 2004/0055498, may also be used in the connection with the subject invention. Other embodiments will occur to those skilled in the art and are within the following claims:

1. A mine counter measure system comprising:

a housing;

an explosive in the housing; and

a.plurality of kinetic energy rods in the housing about the explosive, each rod having a stabilizer for aligning the rod about its velocity vector to better penetrate the surface above a mine.

2. The system of claim 1 in which each rod has a length to diameter ratio of greater than 5.

3. The system of claim 2 in which each rod has a length to diameter ratio greater than or equal to 10.

4. The system of claim 1 in which the stabilizer is a plurality of fins on the distal end of each rod.

5. The system of claim 1 in which the stabilizer is a flared distal end of the rod.

6. The system of claim 1 in which the proximal end of each rod is pointed.

7. The system of claim 1 in which the proximal end of each rod includes a poly-wedge shape to decrease the drag on the nose of the rod.

8. The system of claim 1 in which the center of gravity of each rod is proximate the distal end of the rod to orient the proximal end of the rod downward.

9. The system of claim 1 further including a foam body in the housing between the rods and the explosive.

10. The system of claim 1 further including a foam body in the housing about the rods between the housing and the explosive.

11. The system of claim 1 in which the rods are packaged in coaxially aligned rings and there are coaxially aligned foam bodies between each ring of rods.

12. The system of claim 1 in which the rods have a circular cross sectional shape.

13. The system of claim 1 in which the rods have a cruciform cross sectional shape.

14. The system of claim 1 in which the rods have a tristar cross sectional shape.

15. The system of claim 1 in which the housing is a thin shell.

16. The system of claim 11 in which the housing is a payload.

17. The system of claim 16 further including a missile for deploying a plurality of said payloads.

18. The system of claim 1 in which the rods are staggered in the housing for better packaging efficiency.

19. A mine counter measure system comprising:

a housing;

an explosive in the housing;

a plurality of kinetic energy rods in the housing about the explosive, each rod having a stabilizer for aligning the rod about its velocity vector to better penetrate the surface above a mine, each rod having a length to diameter ratio of greater than or equal to 10, each rod having a poly-wedge shaped proximal end; and

foam in the housing between the rods and the explosive.

20. The system of claim 19 in which the foam is a solid body disposed between the rods and the explosive.

21. The system of claim 19 in which the foam is about the rods between the housing and the explosive.

22. The system of claim 19 in which the rods are packaged in coaxially aligned rings and there are coaxially aligned foam bodies between each ring of rods.

23. The system of claim 19 in which the stabilizer is a plurality of fins on the distal end of each rod.

24. The system of claim 19 in which the stabilizer is a flared distal end of the rod.

25. The system of claim 19 in which the center of gravity of each rod is proximate the distal end of the rod to orient the proximal end of the rod downward

26. The system of claim 19 in which the rods have a circular cross sectional shape.

27. The system of claim 19 in which the rods have a cruciform cross sectional shape.

28. The system of claim 19 in which the rods have a tristar cross sectional shape.

29. The system of claim 19 in which the munition is a shell.

30. A mine counter measure system comprising:

a plurality of munition housings each including;

an explosive; and

a plurality of kinetic energy rods about the explosive, each rod having a stabilizer for aligning the rod about its velocity vector to better penetrate the surface above a mine and each rod including a poly-wedge shaped tip to decrease the drag on the rod and a length to diameter ratio of greater than or equal to 10; and

a carrier for deploying the munition housings over a minefield.

31. A method of destroying mines in a minefield buried under the surface, the method comprising:

deploying a munition including a plurality of kinetic energy rods each having a stabilizer into a position above the minefield; and

deploying the rods above the minefield to fall towards the minefield each aligned along a velocity vector to penetrate the surface and destroy the mines.

32. The method of claim 31 in which deploying includes carrying a plurality of said minefields to a position above the minefield.

33. The method of claim 32 in which deploying includes detonating an explosive core in each munition surrounded by the rods.

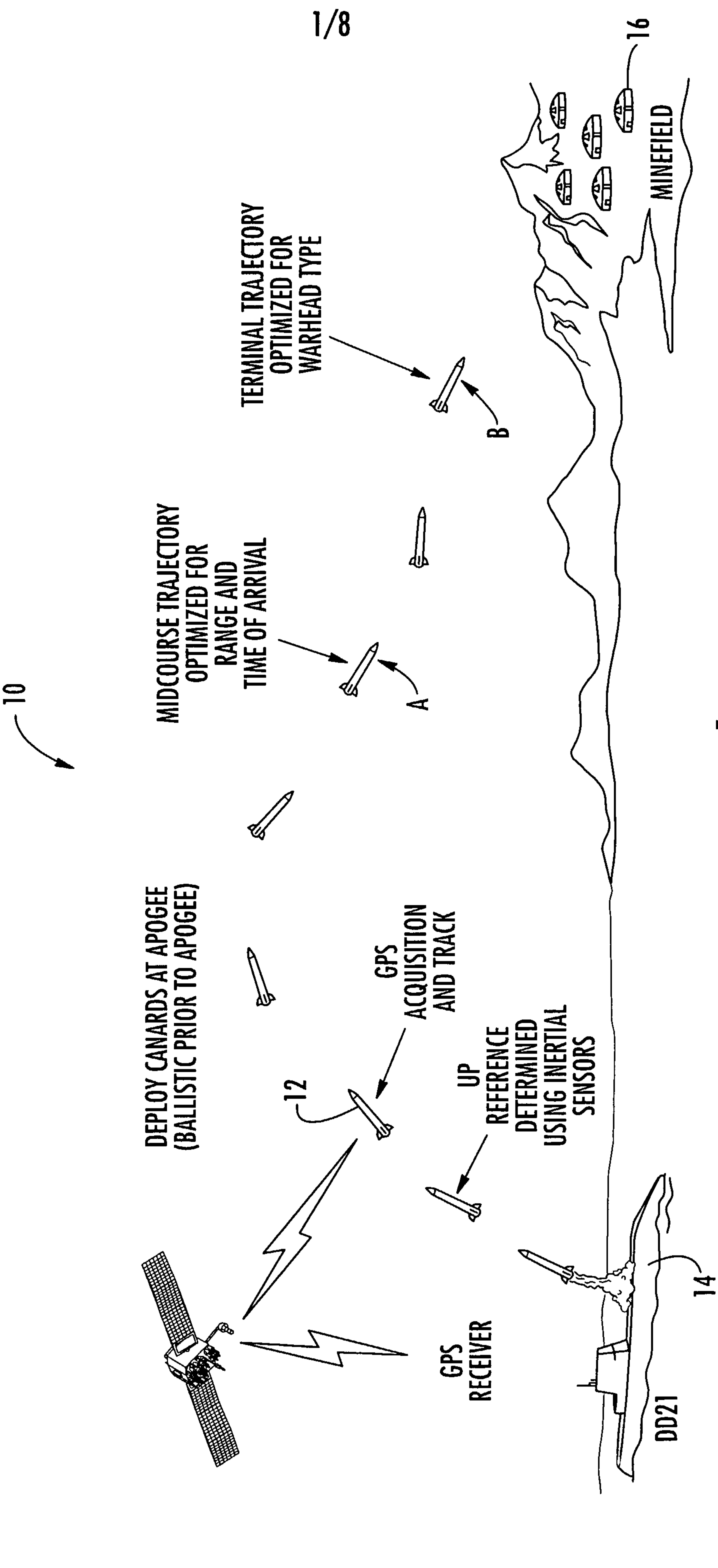

10
GPS
RECEIVER
DD21
14
12
DEPLOY CANARDS AT APOGEE
(BALLISTIC PRIOR TO APOGEE)
GPS
ACQUISITION
AND TRACK
UP
REFERENCE
DETERMINED
USING INERTIAL
SENSORS
MIDCOURSE TRAJECTORY
OPTIMIZED FOR
RANGE
AND
TIME OF ARRIVAL
A
TERMINAL TRAJECTORY
OPTIMIZED FOR
WARHEAD TYPE
B
16
MINEFIELD

FIG. 1

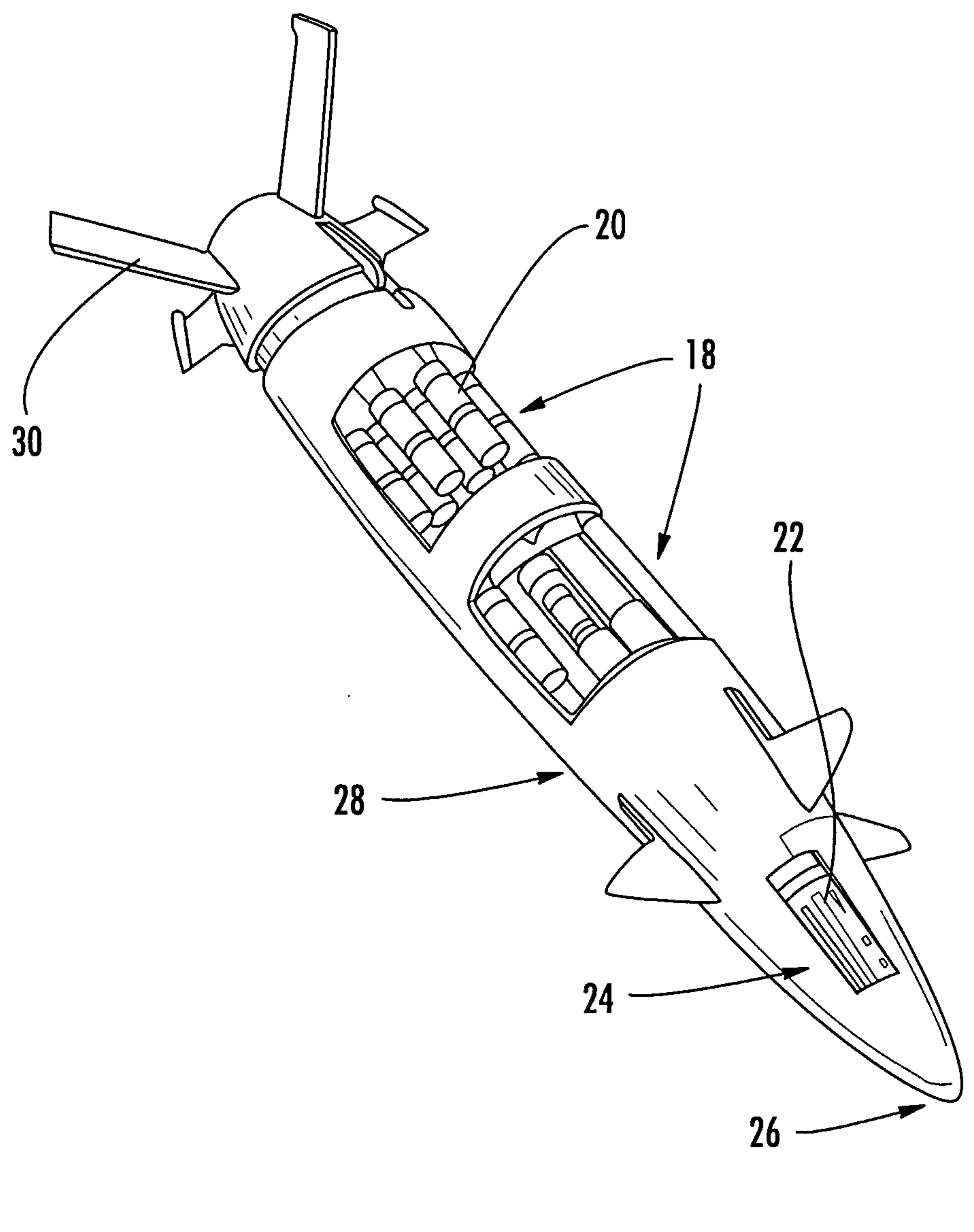


FIG. 2

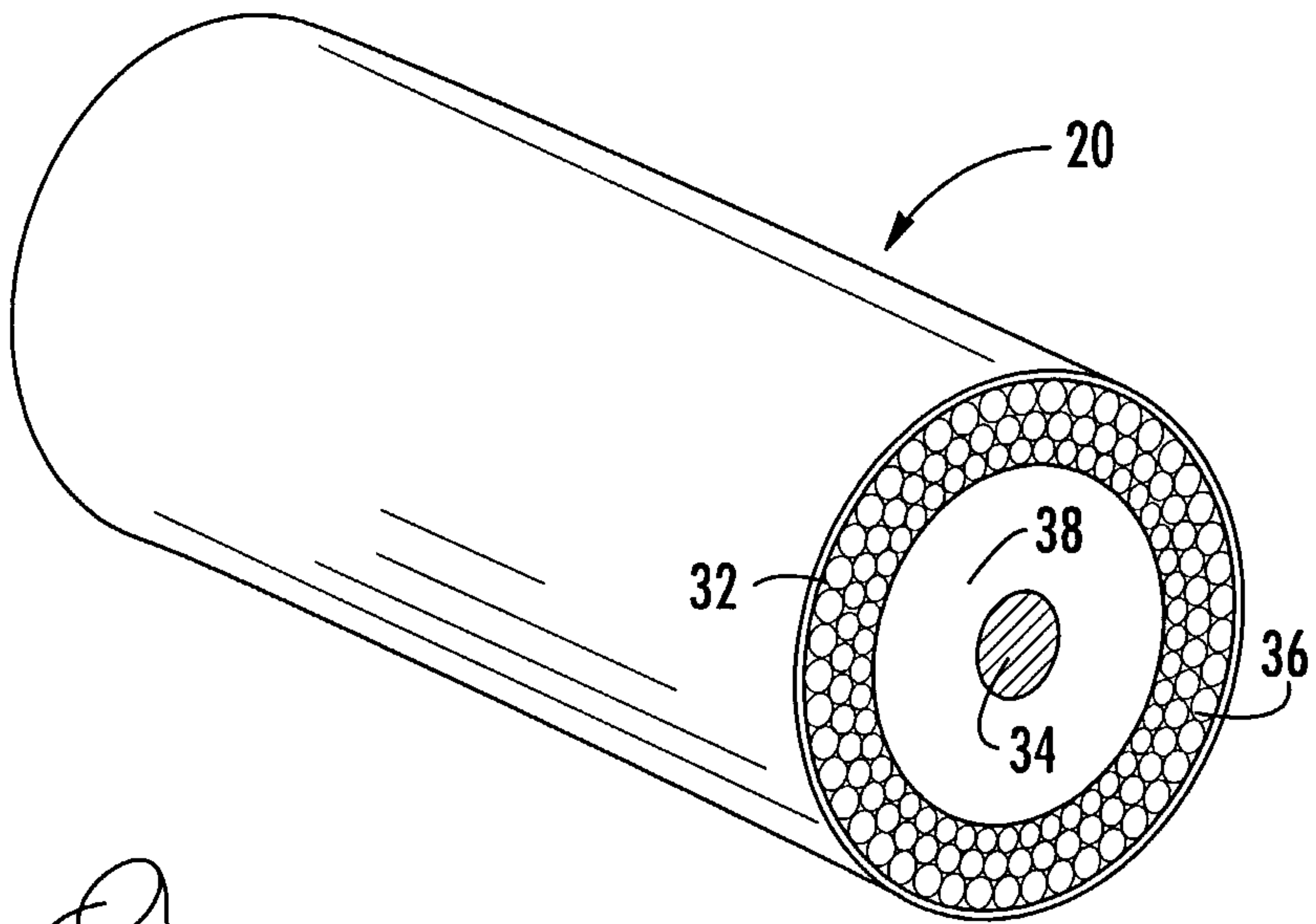


FIG. 3

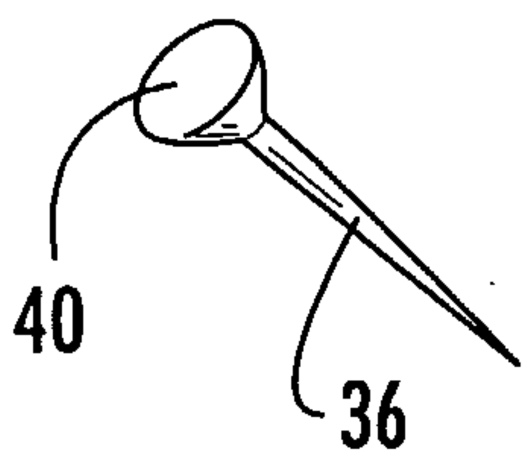


FIG. 4

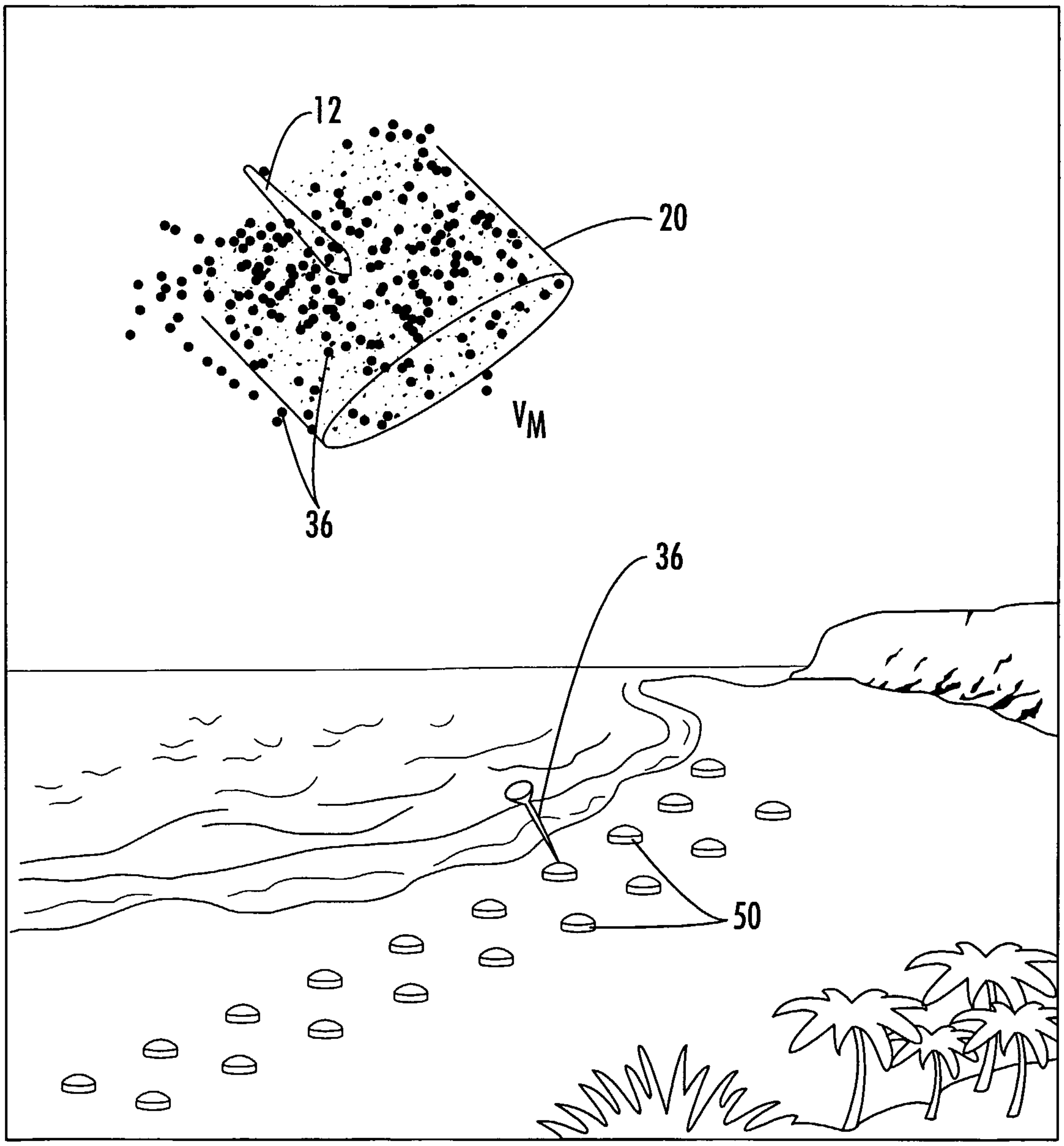


FIG. 5

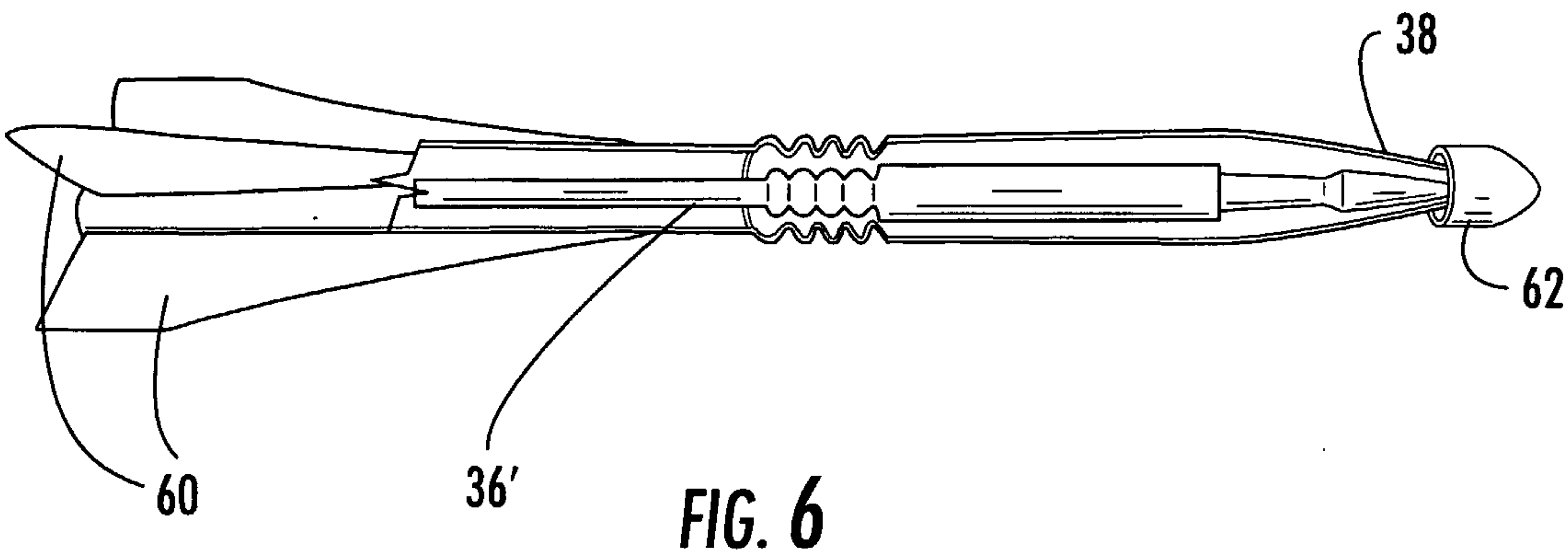


FIG. 6

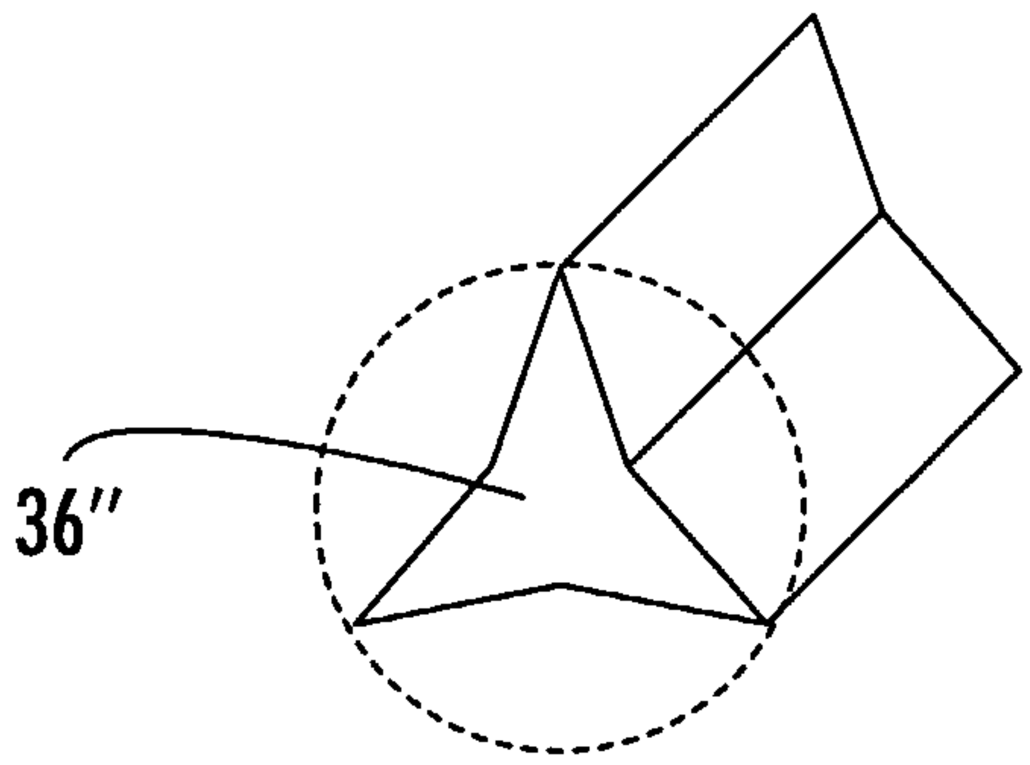


FIG. 7

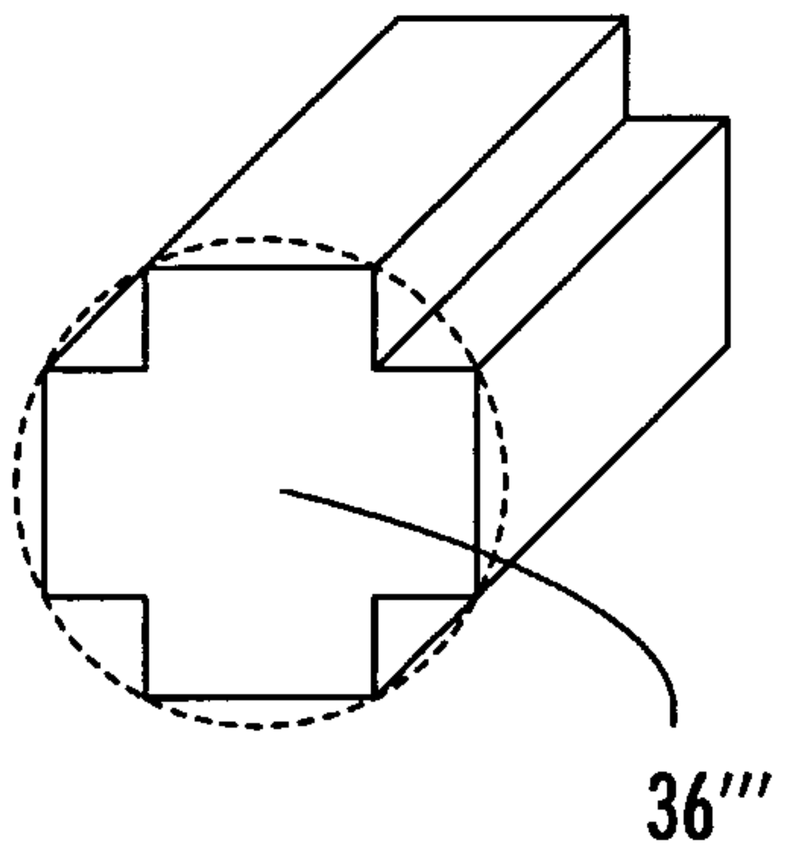


FIG. 8

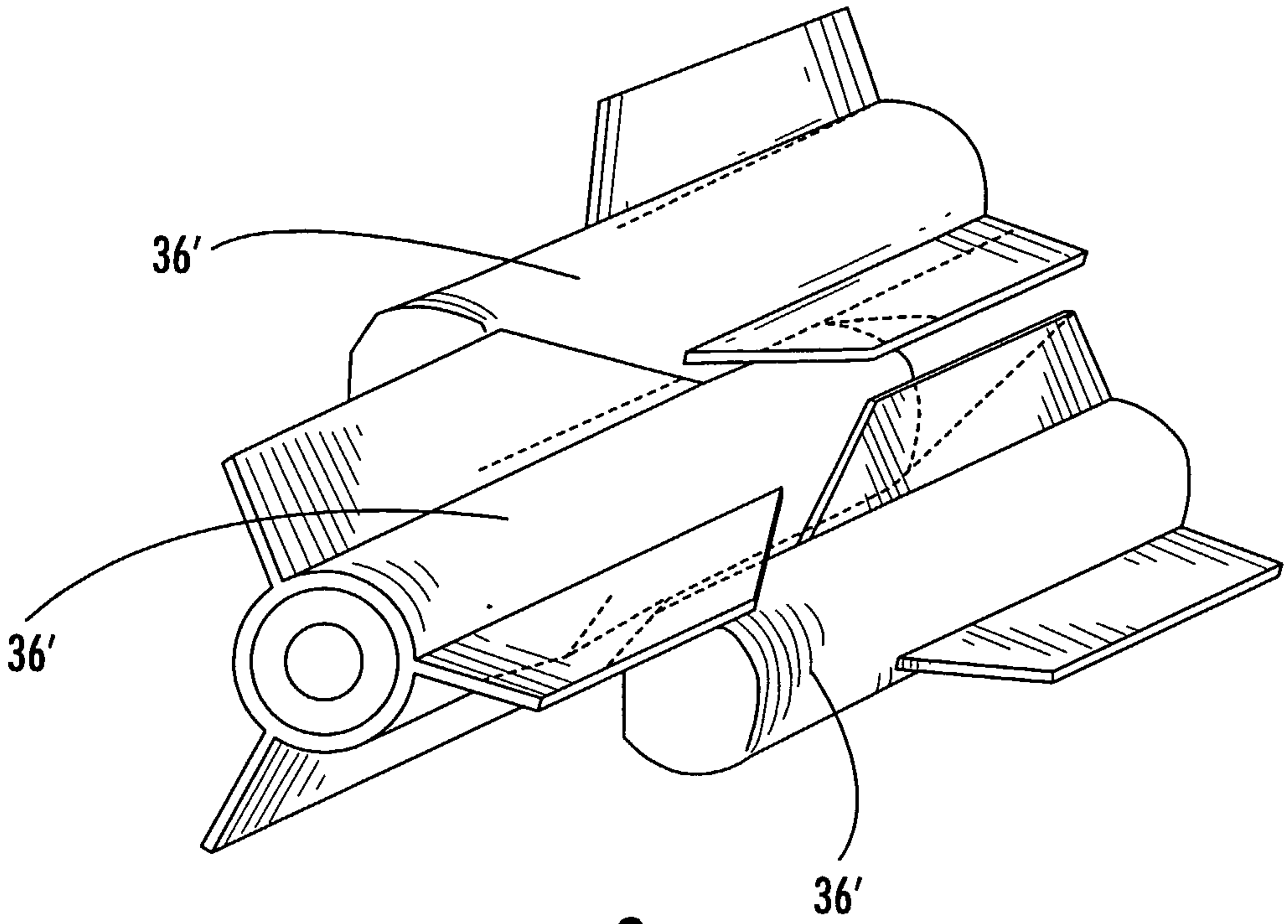


FIG. 9

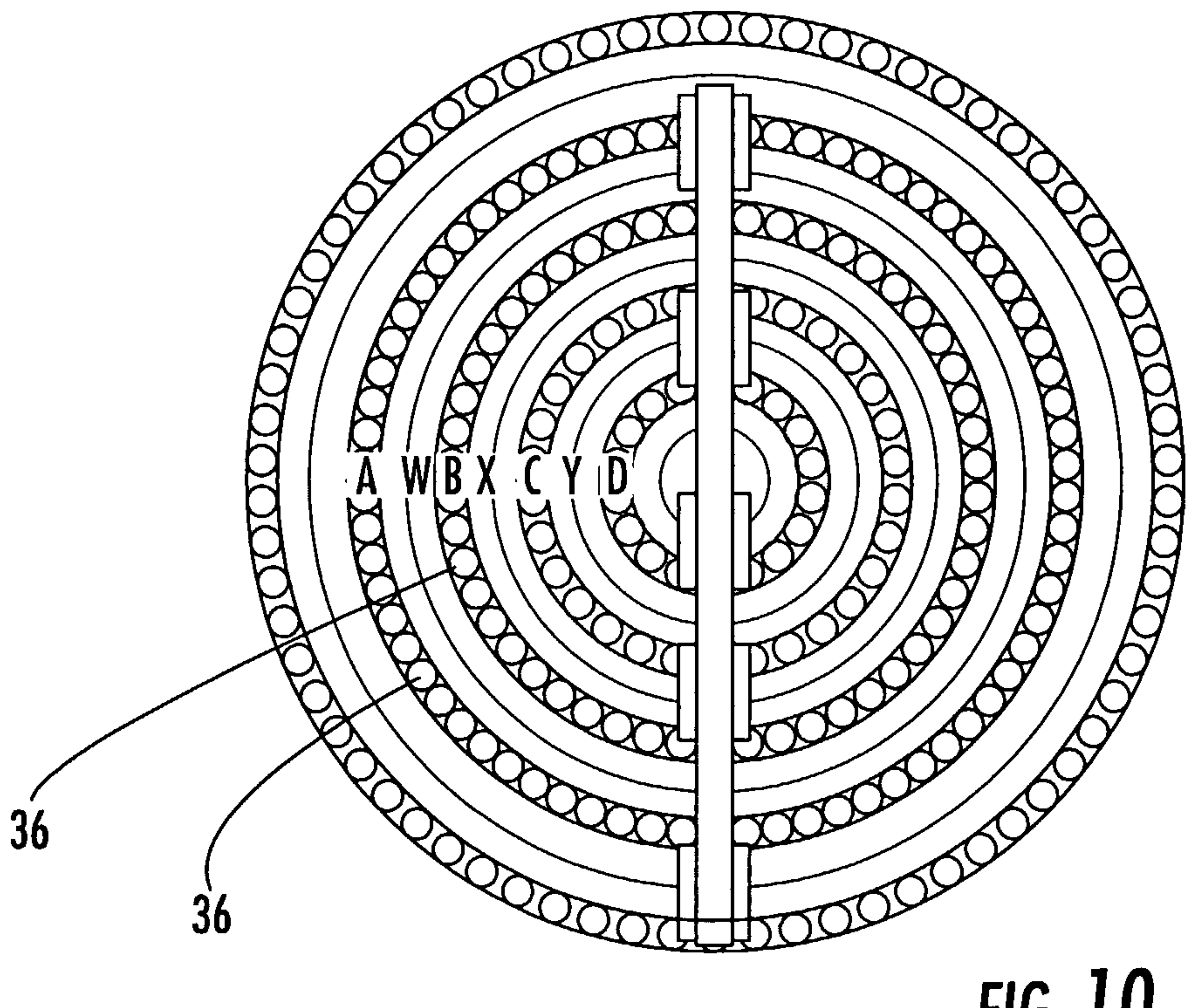


FIG. 10

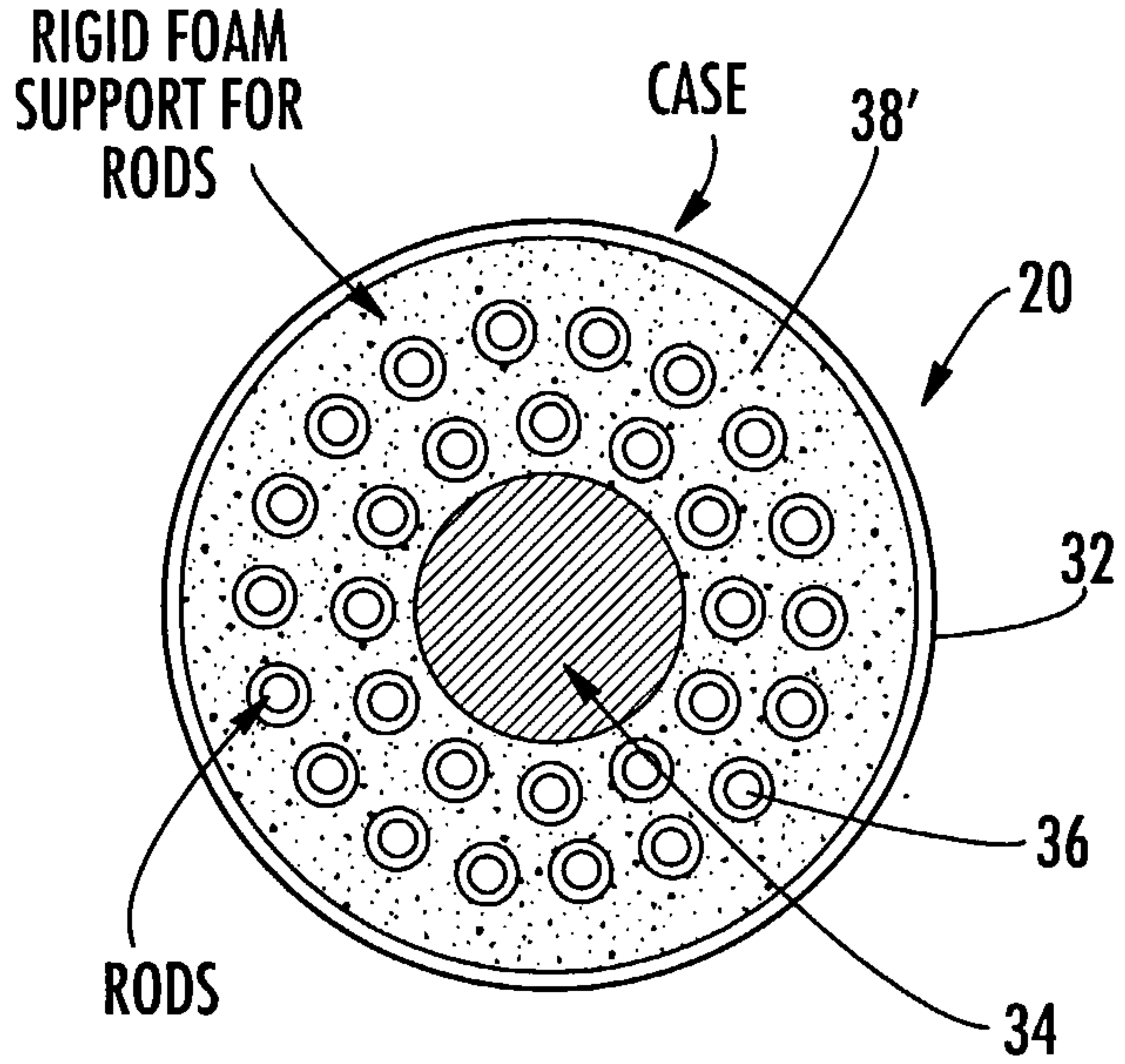

RIGID FOAM SUPPORT FOR RODS
CASE
38'
20
32
36
34
RODS

FIG. 11

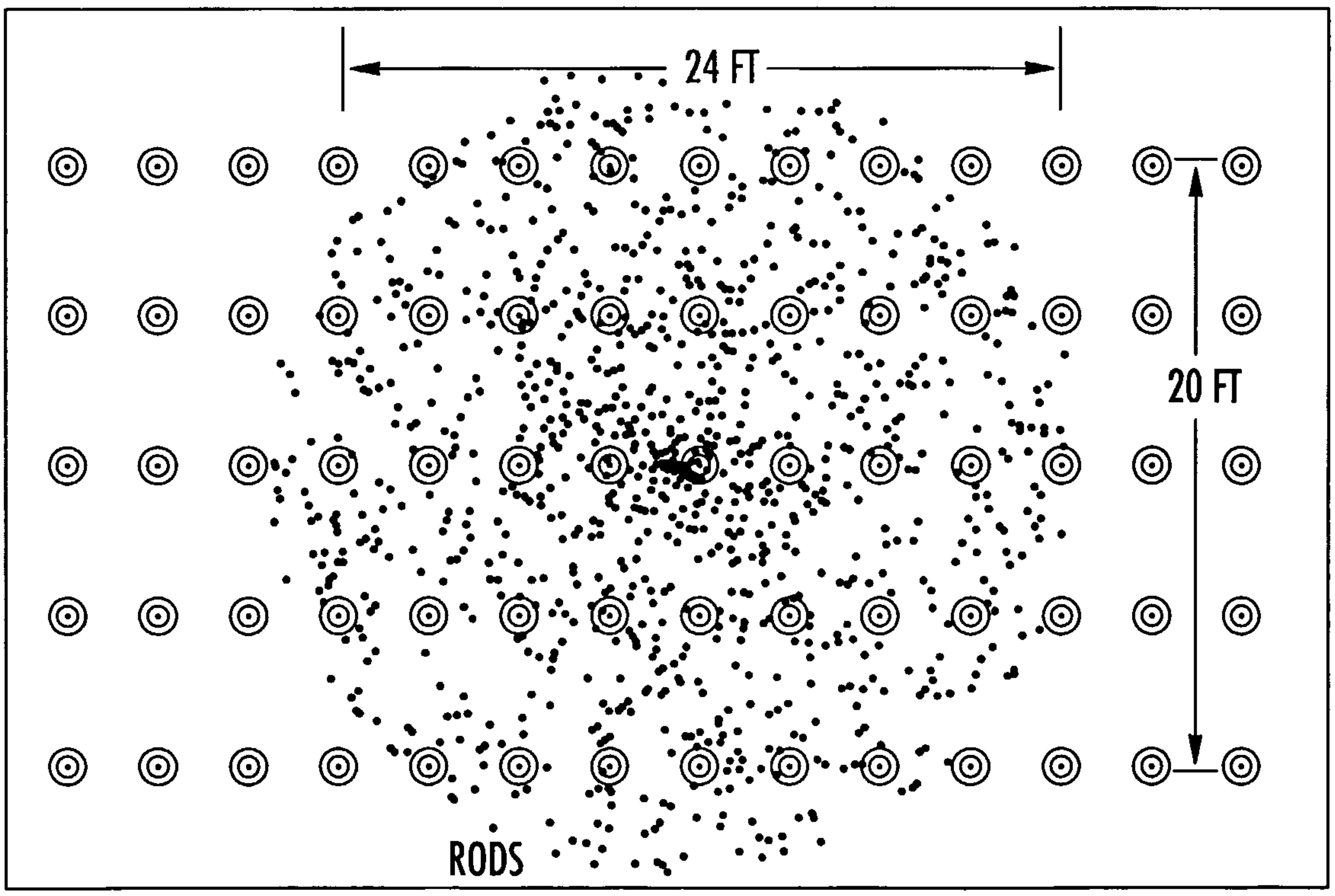

24 FT
20 FT
RODS

FIG. 12

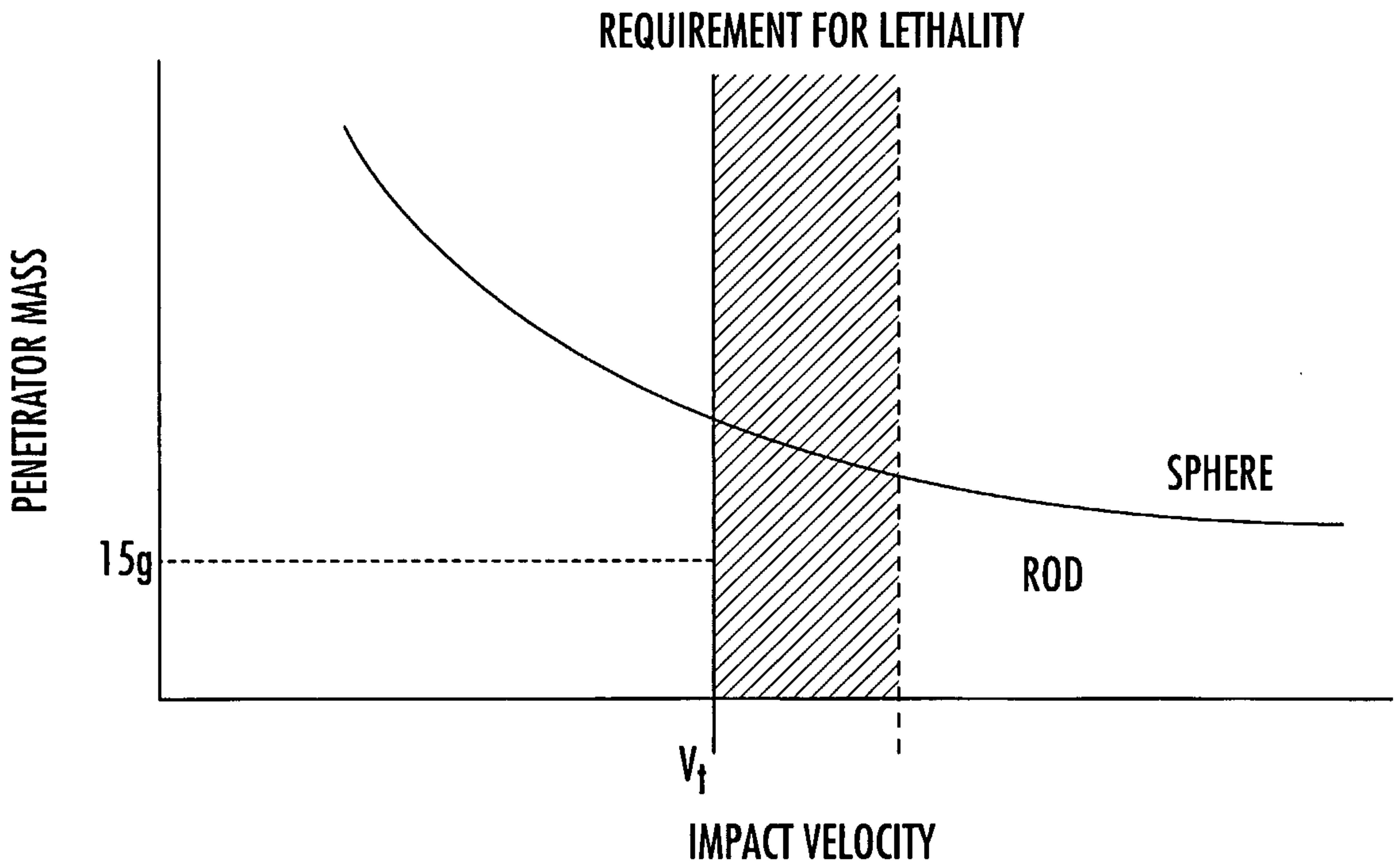
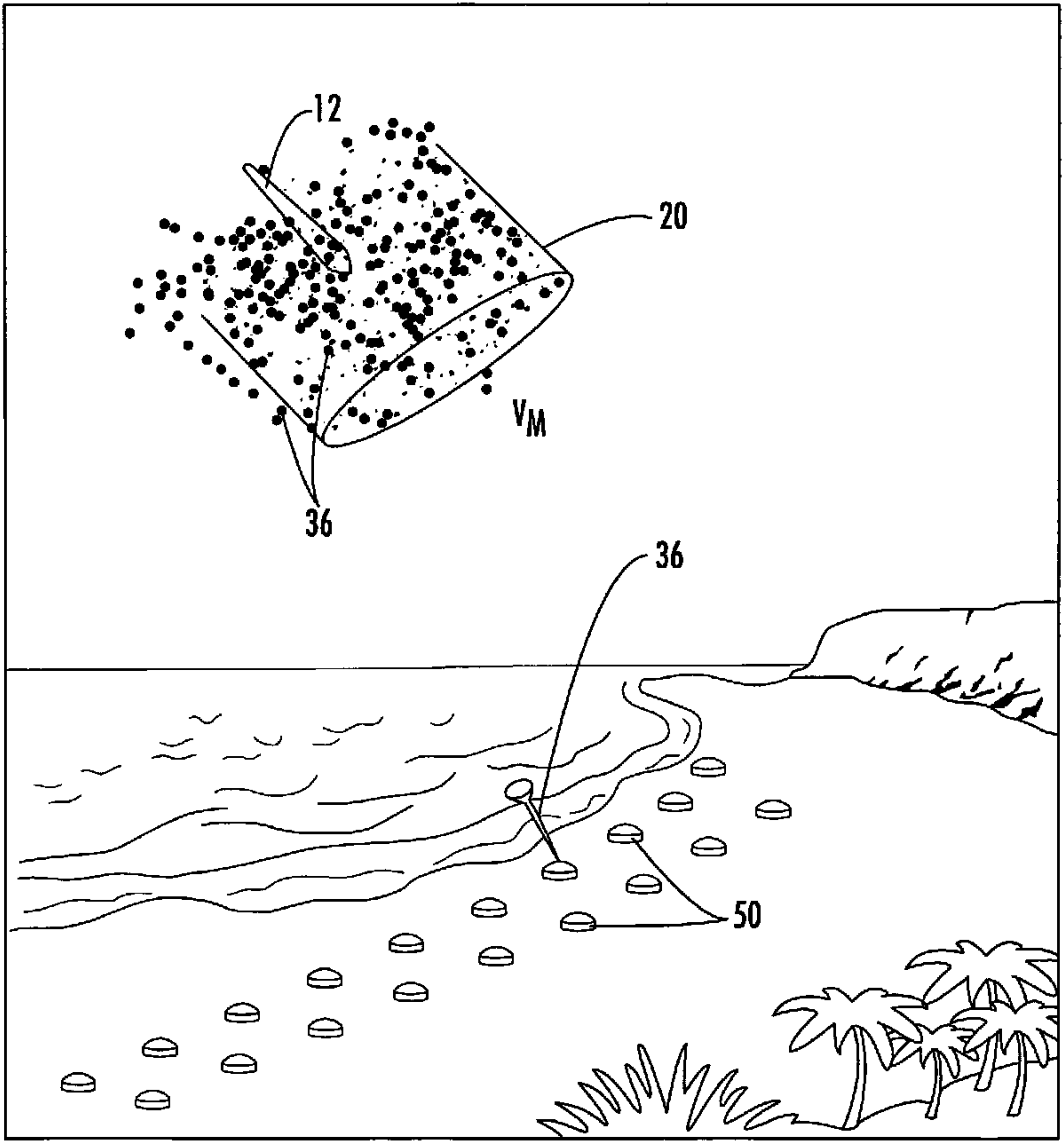

REQUIREMENT FOR LETHALITY
PENETRATOR MASS
15g
SPHERE
ROD
Vt
IMPACT VELOCITY

FIG. 13


12
20
V_M
36
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