

March 25, 1969

I. HERMAN ET AL
CONTINUOUS ROD MAT

3,434,422

Filed April 22, 1959

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Fig. 1

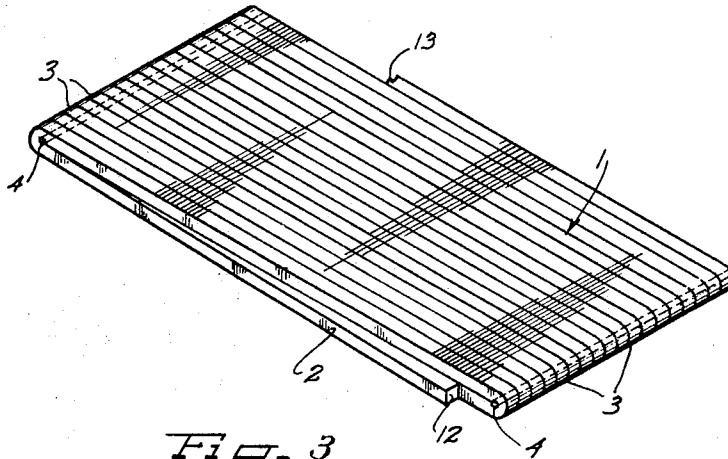


Fig. 3

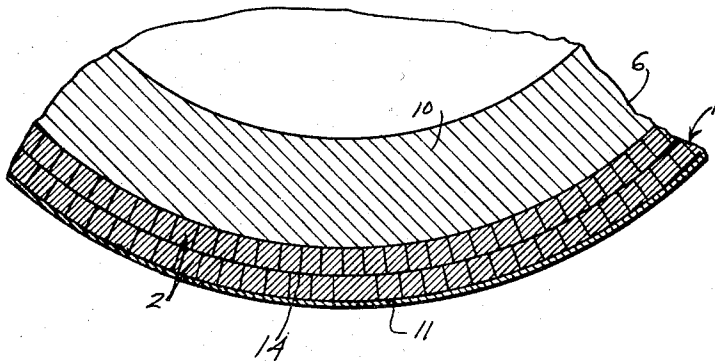
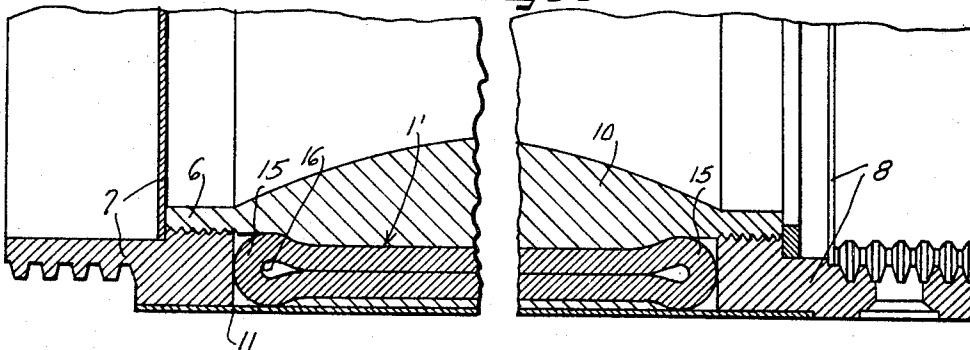


Fig. 4



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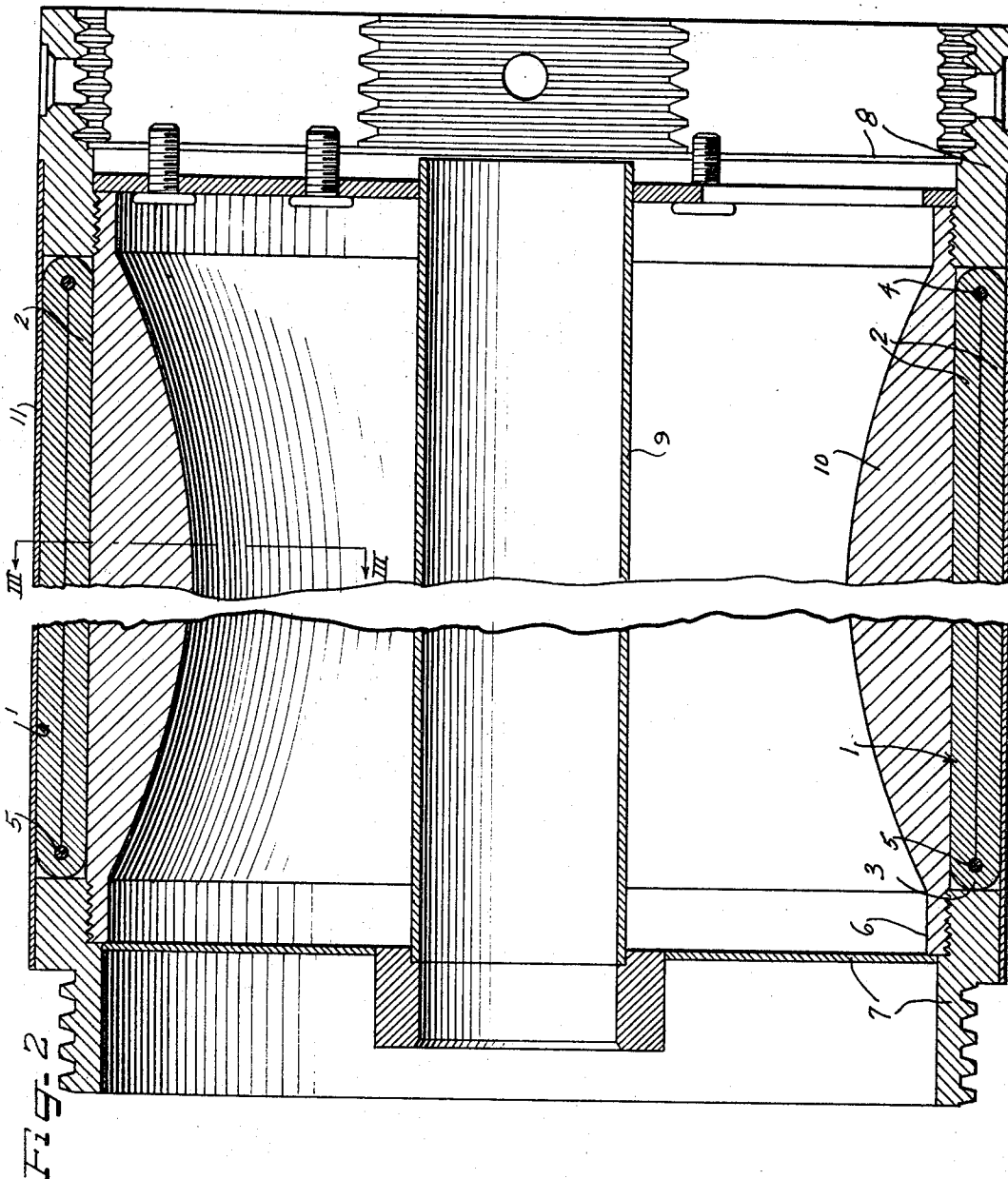
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Fig-5

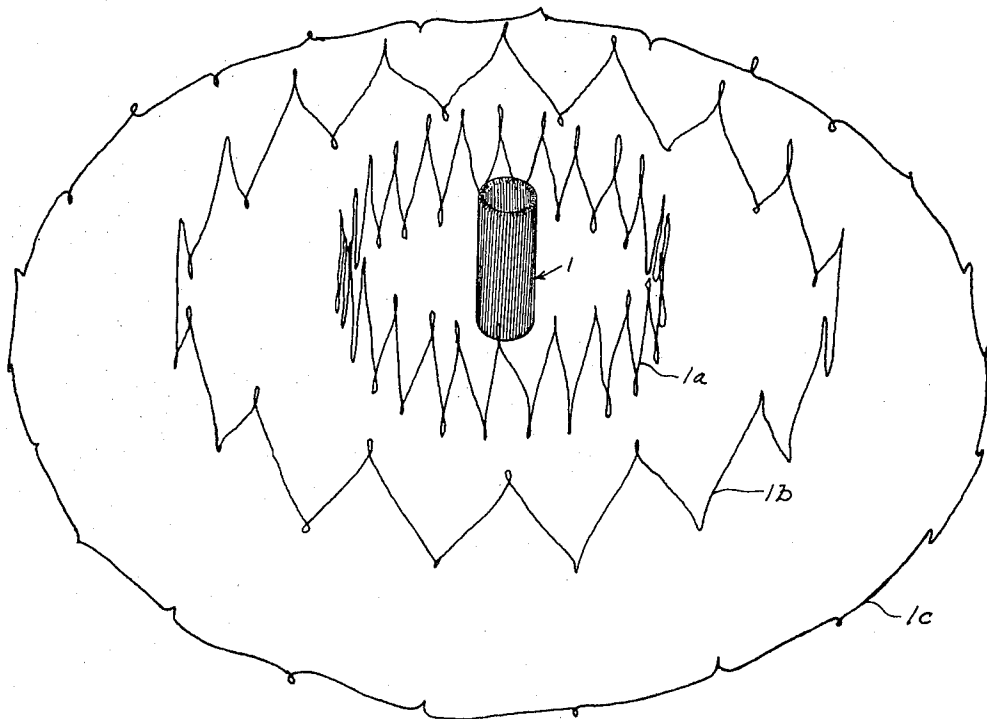


Fig. 6

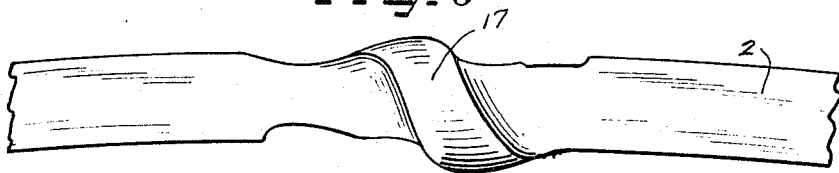
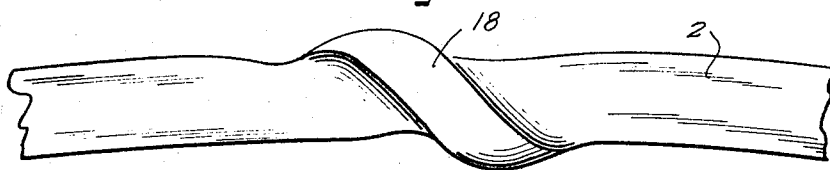


Fig. 7



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3,434,422

CONTINUOUS ROD MAT

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Filed Apr. 22, 1959, Ser. No. 808,268

Int. Cl. F42b 13/48

U.S. Cl. 102—67

5 Claims

This invention relates to improvements in a continuous rod mat, the invention being highly desirable for use in connection with warfare missiles, warheads, projectiles, and the like, although there will be other uses and purposes, such as providing a rough or resilient covering for various objects, all as will be apparent to one skilled in that art.

The instant invention is an improvement upon the continuous rod or wire mat set forth in a copending application of Elso R. Caponi and Edward J. Webster entitled, "Continuous Rod Mat for Hollow Elements and Method of Making the Same," filed Apr. 22, 1959, Ser. No. 808,266.

As pointed out more fully in the aforesaid copending application, continuous rod mats, particularly for missiles or warheads, were heretofore objectionably expensive and time consuming to construct. Further, there was difficulty in controlling the dimensions of the mat, when constructed as heretofore known, and accurate dimensions are, of course, of the highest importance in connection with missiles, warheads, and the like. Those objections were corrected by the invention set forth in the aforesaid copending application.

When mats of this kind are used around a missile or warhead, they may be said to be in a compact or compressed form, and preferably are constructed to assume the characteristics of a continuous rod or wire forming the entire mat. When the missile carrying the mat is detonated, the mat tends to expand into substantially a hoop, and fragmentation should not occur until the expanded mat reaches its point of maximum diameter. Thus, from a comparatively small compact mat, such as one, nine or ten inches in diameter and approximately a foot long, an expansion may result into a hoop of several hundred feet in diameter. This expansion occurs at terrific velocity, and so that expanding mat clears a substantially circular space upon detonation of the missile, which space is of considerable size, and amply sufficient to permit the landing of a helicopter, if so desired. Obviously, these expanding mats will have numerous usages when used in warfare.

With the foregoing in mind, it is an important object of the instant invention to provide a continuous rod or wire mat so constructed as to give further assurance against fragmentation prior to the mat expanding to its maximum diameter.

Another object of the instant invention is the provision of a continuous rod or wire mat which may be in the form of a flattened or substantially flattened helically wound coil, and which is so constructed that the mat is of substantially uniform strength throughout, or in other words the wire or rod forming the mat is substantially of uniform strength through out notwithstanding the relatively sharp bends occurring between courses.

Also a feature of this invention is the provision of a continuous rod or wire mat which may be in the form of a flattened or substantially flattened helically wound coil having inner and outer courses, the structure being such that the tensile strength of the wire forming the mat at the bends in the wire approximates or even exceeds the resistance of the wire to fragmentation in its straight courses.

Also a feature of the instant invention is the provision

of a continuous rod or wire mat in the form of a flattened helically wound coil, providing a double layer mat with the courses in contact with each other, and which is provided with elongated apertures adjacent the bends joining the inner and outer courses of the mat, such apertures or openings extending longitudinally through the mat at opposed edges thereof, thus increasing the strength of the bends in the wire to further resist fragmentation upon expansion of the mat.

Still a further feature of the instant invention resides in the provision of a continuous wire or rod mat formed in the shape of a flattened helically wound coil, with loops formed at the bends of the wire joining the courses of one layer with the courses of the other layer of the mat.

It is also a feature of this invention is provide a continuous rod or wire mat in the form of a flattened spirally wound coil having longitudinal openings extending lengthwise of the mat adjacent the inside of the bends joining the courses of one layer to those of the other layer, such openings being filled with a suitable material to resist collapse of the bends in the wire at the openings when the mat is forcefully expanded, such as by an exploding missile or warhead.

While some of the more salient features, characteristics and advantages of the instant invention have been above pointed out, others will become apparent from the following disclosures, taken in conjunction with the accompanying drawings, in which

FIGURE 1 is a fragmentary perspective view of a continuous rod or wire mat embodying principles of the instant invention;

FIGURE 2 is a fragmentary vertical sectional view through a warhead showing the same equipped with a mat embodying principles of the instant invention;

FIGURE 3 is an enlarged fragmentary vertical sectional view taken substantially as indicated by the line III—III of FIG. 2, looking in the direction of the arrows, illustrating the staggered effect present between the layers of the mat;

FIGURE 4 is a fragmentary vertical sectional view of the warhead of FIG. 2, showing the same equipped with a mat of somewhat different construction but also embodying principles and features of the instant invention;

FIGURE 5 is a diagrammatic showing illustrating the action of the mat upon detonation of the warhead;

FIGURE 6 is a fragmentary greatly magnified view illustrating the shaping of the wire or rod at the bends upon expansion, this being a portion of the mat seen in FIGS. 1 and 2; and

FIGURE 7 is a view similar in character to FIG. 6 illustrating the action of the wire or rod making up the mat of FIG. 4, when the same is forcefully expanded.

As shown on the drawings:

In the making of the instant mat, either a wire or rod circular or polygonal in cross-section may be utilized. In most instances, a polygonal rod is utilized because the elongated lines defining corners provide sharper cutting edges when the mat is forcefully expanded.

The first illustrated embodiment of the instant invention, seen in FIGS. 1 and 2, is a mat, generally indicated by numeral 1, made up of a single square wire 2. This wire is helically wound in the form of a circular or partially flattened coil, as may be deemed most desirable, after which the coil is completely flattened by the use of suitable die means. This provides a mat of substantially rectangular configuration and of a length sufficient to reach once around the object to be covered or enclosed by the mat. As seen best in FIG. 1, the mat is of double thickness, and the inner layer has its courses of wire in contact with those of the outer layer. Preferably, also, the courses contact each other laterally of the mat.

Upon crushing of the coil to form a mat, opposed side edges of the mat will be defined by a series of relatively sharp bends 3 in the wire, each bend connecting an individual course of one layer with an individual course of the other layer. The flattened coil mat is next placed in any suitable form of holding means, and an elongated aperture or opening 4 is provided lengthwise of the mat at or immediately adjacent the insides of the bends defining the end edges 3—3 of the mat. In the instance of the structure of FIGS. 1 and 2, these openings may be provided by drilling the mat lengthwise. Preferably, though not essentially, the diameter of each opening slightly exceeds half the diameter or cross dimension of the wire.

In some instances, and at present the essentiality of this has not been established, it is desirable to fill each opening 4 with a material that prevents the wire collapsing at the opening when it is forcefully expanded as occurs upon the detonation of a warhead. This is illustrated at 5 in FIG. 2 of the drawings, where a filling medium is shown extending through each opening 4. That filling medium may be in the form of a suitable thermoplastic, a thermosetting plastic, or a metallic wire of a diameter approximating that of the opening, or some other suitable substance capable of accomplishing the purpose.

In FIGURE 2, we have shown, rather diagrammatically, a warhead comprising a shell 6 of cylinder formation to which end cap structures 7 and 8 are threadedly engaged. A central tube 9 may be provided for detonating mechanism. Interiorly thereof the shell 6 is provided with means indicated at 10 to insure a uniformly outward application of force entirely around the shell upon detonation. The means 10 as well as the structure of the shell itself form no part of the instant invention. As seen in FIG. 2, the threaded hubs on the end cap structures 7 and 8 project outwardly farther than the body 6 of the shell, and the instant mat 1 is disposed around the shell body between those end cap hubs. After the mounting of the mat in position, a skin-like cover 11 may be provided to insure a smooth external surface for the warhead.

In applying the mat to the shell or body of the warhead, the mat of FIG. 1 may be taken and wrapped around the shell, and then the terminal ends 12 and 13 of the wire 2 may be welded together by suitable means forming no deposit.

Preferably, however, the mat will originally be formed into a shape complementally to the contour of the shell or other object it is to cover, the terminal ends of the wire welded together, and then the mat telescoped over the shell casing or other object. This method provides means for adequately die sizing the mat so as to provide very accurate dimensions before application to the shell or other object, and such sizing will also tend to reduce voids between the courses of the wire forming the mat.

In FIGURE 3 we have illustrated a section of the shell provided with the mat to show that the courses of the wire in the outer layer are preferably in staggered relationship to the courses of the wire in the inner layer as indicated at 14. This further provides a more even force upon the mat upon detonation of the shell and lessens the danger of fragmentation of the wire prior to its expansion to its point of maximum diameter.

In FIGURE 4 we have illustrated the same warhead structure as above described, and in this instance the warhead is equipped with a mat 1' of somewhat different construction. This mat may comprise the same wire as above described, wound helically, but when the coil is flattened, it is flattened only in the central region, thus leaving bends in the wire between courses of the inner and outer layers that are in the form of loops 15 which define opposed end edges of the resultant mat. These loops, on each side of the mat define a longitudinal opening 16 extending lengthwise of the mat, and in this

instance the opening is somewhat larger in size than the openings 4—4 above described. Consequently, in this particular case no filling of the openings need be provided, although it could be done, if so desired. While the provision of the loop edges 15—15 on the mat render the marginal portions of the mat thicker than the intermediate portion, such may readily be compensated for in the manner of mounting the mat over the shell of the warhead, as clearly seen in FIG. 4.

In FIGURE 5 we have endeavored to illustrate diagrammatically the action of the mat upon the detonation of the warhead. Assuming the warhead to be in the non-detonated stage, the mat 1 would be of the compact form illustrated centrally of the figure. Upon detonation of the warhead, fragmentation occurs in the shell of the warhead and there is an even force entirely around the warhead outwardly tending to expand the mat into a somewhat uneven hoop at great velocity. The mat would assume in general first the position of FIG. 1a, then merge into the showing at 1b, and gradually reach substantially its maximum diameter as indicated at 1c. Any fragmentation or breaking of the wire or rod forming the mat should not occur until the position 1c has been reached. Of course, it will be understood that this FIGURE 5 of the drawings is not drawn to scale, since while the compact position of the mat 1 may be only 8 or 9 inches in diameter, the diameter of the form 1c may be several hundred feet.

In FIGURE 6 we have endeavored to illustrate diagrammatically the action of the wire at one of the bends 3, when the wire tends to straighten out or form the hoop 1c of FIG. 5. It will be noted that there is a definite twisting 17 in the wire at this point as distinguished from a reverse bend without any opening 4, which would be directly in shear at the bend. Consequently, the additional torsional resistance to breaking greatly strengthens the wire.

In FIGURE 7 we have endeavored to illustrate diagrammatically the action of the wire embodied in the mat 1' of FIGURE 4 at one of the loop bends 15. Here, a greater twisting of the wire occurs as indicated at 18 and the wire is even less prone to break at the bend or loop than in the case of FIGURE 6.

Tests made upon a $\frac{3}{16}$ " wire have indicated that when there is a complete reverse bend in the wire at the edge of the mat, and without any opening provided, the bend will be in shear when the mat tends to spread out, and at the bend the strength of the wire will be approximately $\frac{1}{5}$ the tensile strength of a straight course portion of the wire. In the case of the mat of FIGS. 1 and 2, there will be a twisting as indicated at 17 in FIG. 6, and the test indicated then that the strength at the bend 3 is approximately $\frac{13}{16}$ of the tensile strength of the intermediate straight course of the wire. In the case of the bend in the form of the loop 15 as shown in FIG. 4, with the twist thereof shown in FIG. 7, the added torsional resistance of the wire strengthens the loop bend to a point where it at least equals if it does not exceed the tensile strength of an intermediate straight course portion of the wire. Thus, it will be seen that with the instant invention there is much less likelihood of fragmentation of the wire before it reaches its fully expanded position after detonation of the warhead.

It is believed that the method of making the instant invention is sufficiently set forth herein as to warrant no further description.

We claim as our invention:

1. A continuous rod mat, comprising a flat double layer coil formed of a single helically wound wire with the course of one layer in contact with the courses of the other layer and the bends joining the courses defining opposed edges of the mat, there being an opening extending lengthwise of the mat at the inside of the bends between courses of the layers along each of said opposed edges, said mat being formed in tubular shape with the bends of the wire

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forming the ends of the tube and the terminal ends of the wire secured together, and each opening having a wire of approximately the diameter of the opening extending lengthwise therethrough.

2. A continuous rod mat capable of being forcefully expanded into an endless loop, comprising a flat double layer coil formed of a single helically wound wire with the courses of one layer in contact with the courses of the other layer and the bends joining the courses defining opposed edges of the mat, there being an opening extending lengthwise of the mat at the inside of the bends between courses of the layers along said opposed edges, said mat being formed in tubular shape with the bends of the wire forming the ends of the tube and the terminal ends of the wire secured together, and each said opening being filled with a plastic material to prevent collapse of the wire at an opening when the mat is forcefully expanded.

3. A continuous rod mat capable of being forcefully expanded into an endless loop, comprising a single wire in the form of a flat coil having juxtaposed courses and the bends between courses defining opposed edges of the mat, there being an opening extending lengthwise of the mat at the inside of the bends between courses along each of said opposed edges with the courses contacting between said openings, said mat being formed in tubular shape with the bends of the wire forming the ends of the tube, and the terminal ends of the wire secured together along an element of the tube to render the wire continuous, said openings causing a twisting action at each bend to strengthen the wire against breakage when the wire is forcefully expanded until the loop has reached maximum size.

4. A continuous rod mat capable of being forcefully expanded into an endless loop, comprising a single wire helically wound into a coil which is flat its full length centrally thereof to provide a double layer mat with the layers in contact, the courses of each layer being connected by open loops in the wire defining opposed edges

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of the mat, said mat being formed in tubular shape with said loops at the ends of the tube, and the terminal ends of the wire being secured together along an element of the tube to render the wire endless, whereby said loops cause a twisting action at each such location to strengthen the wire against breakage when the wire is forcefully expanded until the endless loop reaches maximum diameter.

5. In combination, a warhead including a hollow body part having a chamber for a charge of explosive material therein, and a rod mat shaped tubularly and disposed around said body part radially outward of the charge chamber, said rod mat comprising a flat double layer coil formed of a single helically wound wire with the courses of one layer in contact with those of the other layer and the bends between courses defining opposed edges of the mat and the ends of the tube when the mat is tubularly shaped around said body part, the terminal ends of the wire being secured together to render the wire endless, said mat having an opening extending therethrough at the inside of the bends along each of said opposed edges, and material filling each of said openings to prevent collapse of the wire at an opening upon detonation of a charge in said chamber.

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U.S. Cl. X.R.

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