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FOLDABLE RADAR TARGET

3 Sheets-Sheet 1

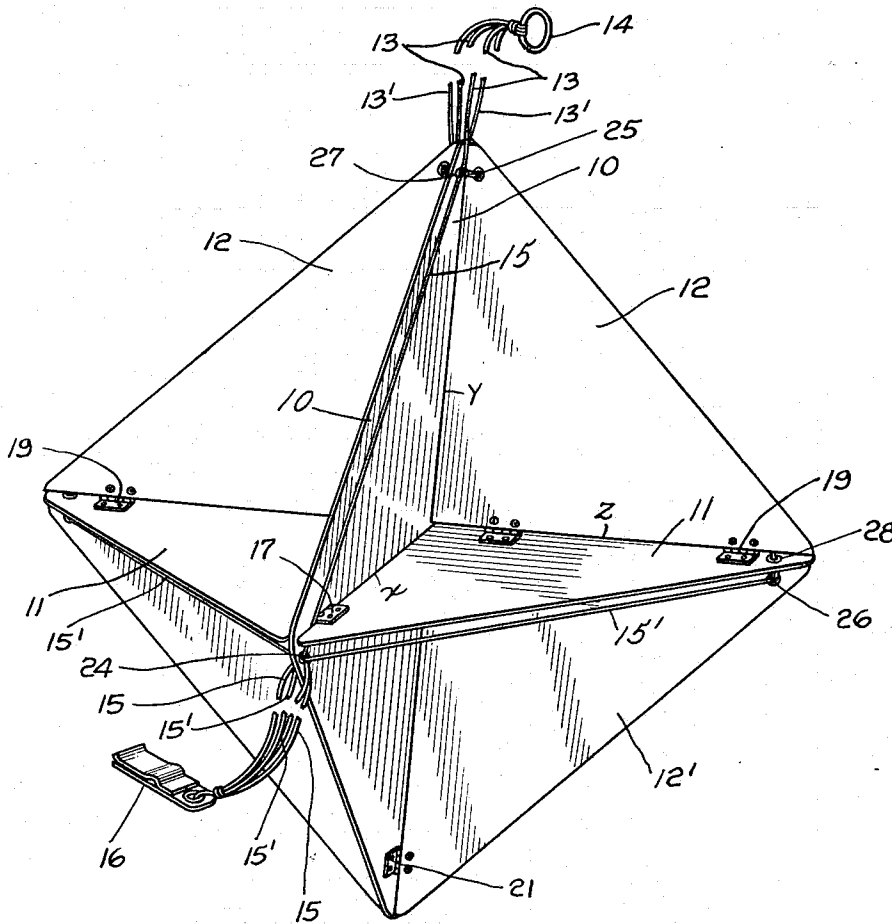


Fig. 1.

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Nov. 10, 1959

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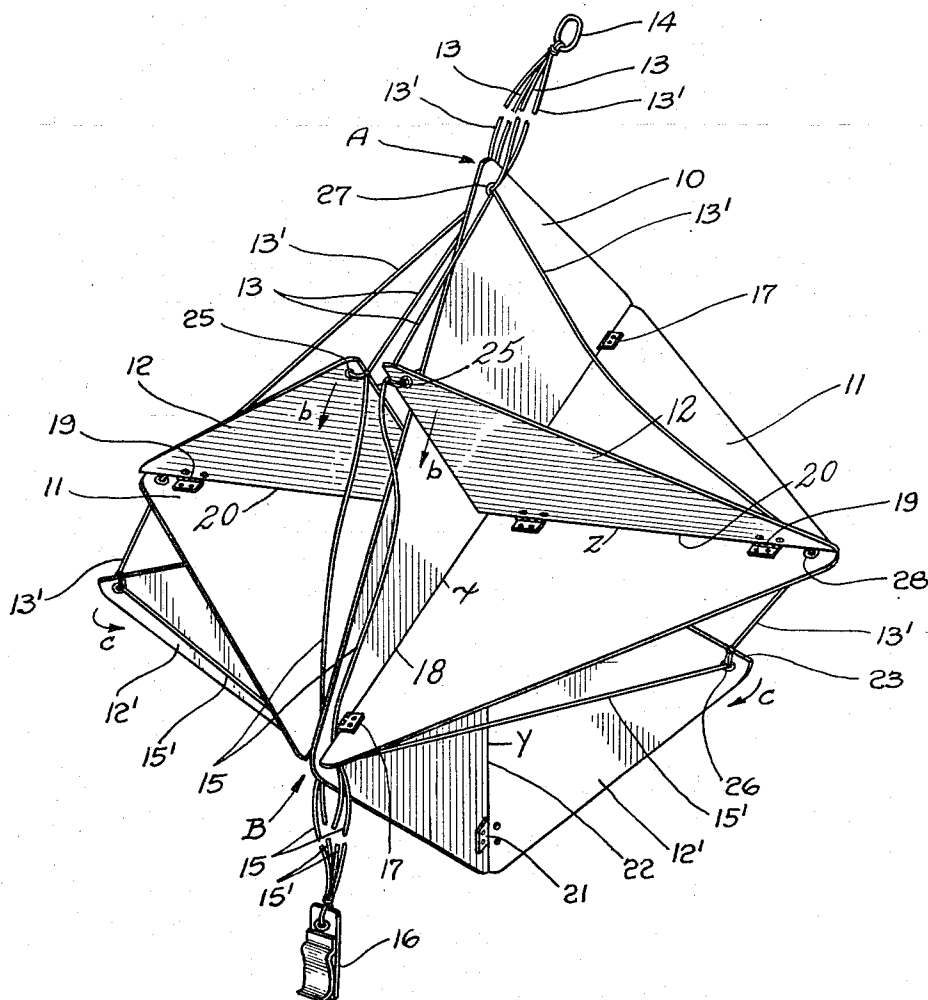


Fig. 2.

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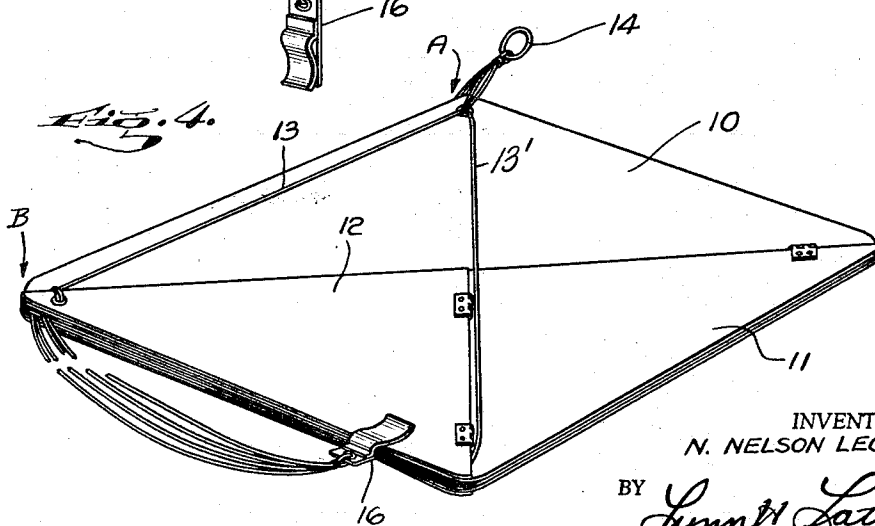
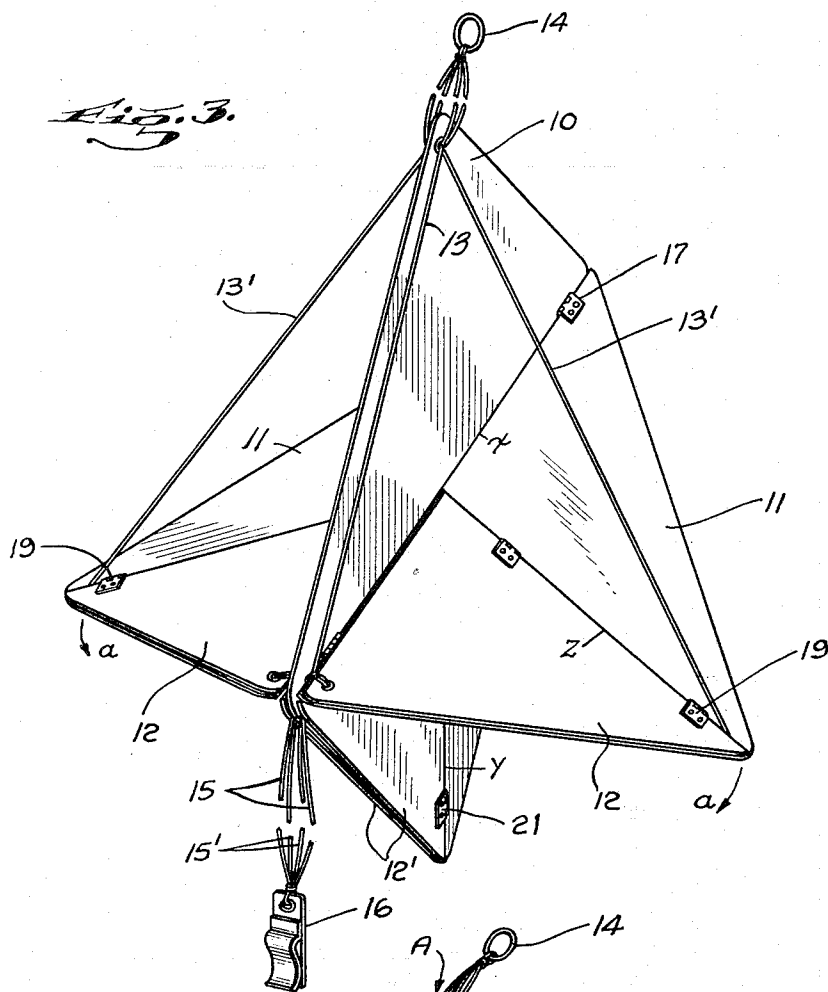
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FOLDABLE RADAR TARGET

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6 Claims. (Cl. 343-18)

This invention relates to foldable radar targets of the type having reflecting surfaces which, in the opened target, are arranged in three planes each normal to the other two (intersecting one another on X, Y and Z axes). The invention deals particularly with a target embodying a series of panels the external edges of which correspond to the edges of a regular octahedron. More specifically, the invention provides an improvement upon the target disclosed in my prior Patent No. 2,778,010, issued January 15, 1957, for Reflector Target, wherein four quarter panels are hinged, in pairs, to two half panels, the quarter panels and half panels being of right-isosceles form, and the half panels being hinged, along their hypotenuse edges, to a square main panel, the several panels being adapted to fold one upon another into a substantially flat package.

The general object of this invention is to provide such a target having an improved arrangement of panels and harness (draw cords) such that the target is opened by pulling one set of cords from one corner of the target, while closing is effected by pulling another set of cords from an adjacent corner of the target.

A further object is to provide such a target wherein all of the quarter panels and the half panels are arranged to be folded toward a single corner of the base panel.

Other objects will become apparent in the ensuing specifications and appended drawing in which:

Fig. 1 is a perspective view of the target in fully open position;

Fig. 2 is a perspective view of the target in half-folded condition;

Fig. 3 is a perspective view of the target in a more advanced stage of folding operation; and

Fig. 4 is a perspective view of the fully folded target.

Referring now to the drawings in detail, I have shown therein, as an example of one form in which the invention may be embodied, a radar target embodying a series of panels each having metallic surfaces, the respective surfaces of which are electrically reflective (such as that provided by sheets of aluminum or other metal foil attached to chip-board mounting boards or, alternatively, solid sheet metal panels). These panels consist in a square main panel 10, a pair of right-isosceles triangular quarter panels 12 and 12' respectively.

Movements of the panels 11, 12 and 12' relative to base panel 10, in order to open and close the target, are effected by a harness comprising a set of opening cords 13 and 13' attached to a terminal element such as the ring 14, and a set of closing cords 15 and 15', attached to a terminal element such as the clip 16.

When open and in use, the target is suspended by the four opening cords 13 and 13'. The main panel 10 is disposed in a vertical plane, the two half panels 11 are disposed in a common horizontal plane, and the four quarter panels 12 and 12' are all disposed in a common vertical plane normal to that of main panel 10. Half panels 11 are attached by hinges 17 to main panel 10 on horizontal X axes at the hypotenuse edges 18 of the respective half panels, such axes substantially registering

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with the horizontal diagonal between the lateral corners of base panel 10.

At this point it may be noted that the several panels cooperatively define a target which presents a multiplicity of plane reflecting surfaces disposed in three planes each at right angles to both of the others, intersecting at a common center and presenting a series of trihedral-angular reflector cavities, each of equilateral, inverted pyramid form. Furthermore, the reflector surfaces of the three respective planes are each of a square shape with the three X, Y and Z axes of intersection (indicated at X, Y and Z in the drawings) being disposed along the corner to corner diagonals of the three square intersecting surfaces, and with the peripheral edges of the three surfaces collectively defining the edges of a regular or equilateral tetrahedron. In such a device, there are eight of the outwardly flaring, trihedral reflector cavities, with the axes of the cavities radiating, at equal annular displacements one from the other, in all directions from the common center of the device, and because of the relationship between the angles of incidence and reflection of a radar beam intersecting the target at any point within its total volume, there will always be at least one of the said beams reflected directly back to the source of the beam. It will be understood of course that this arrangement of reflector surfaces in the open target does not constitute the present invention. Rather, the invention relates to the arrangement of the several reflector panels and the harness by which the target can be opened or closed by simply applying a pull to one of two adjacent corners of the target. For the purpose of opening, the pull is applied to the opening cords 13, 13' at the corner A which is the upper corner of the target as suspended for use. For the purpose of closing, the pull is applied to the closing cords 15, 15' at an adjacent corner B which is the forward corner of the horizontal surface of the target, on the X axis.

In the folding of the target both half panels 11 drop downwardly as indicated by arrows *a* in Fig. 3. Upper quarter panels 12 are attached by hinges 19 to respective half panels 11 on a common horizontal Z axis at the base edges 20 of panels 12, and are adapted to fold downwardly from their open positions, as indicated by arrows *b* in Fig. 2, with their Y edges (vertical in the open target) in closely embracing relation to main panel 10. Lower quarter panels 12', instead of being hinged on a horizontal axis to the half panels as in the case of panels 12, are hinged to the main panel 10 by means of hinges 21 on parallel Y axes at their vertical Y edges 22 on opposite sides of panel 10, for horizontal forward folding movement as indicated by arrows *c* in Fig. 2. In the open target, the half panels 11 are supported upon the horizontal upper Z edges 23 of the quarter panels 12', functioning as brackets. When the quarter panels 12' have been folded forwardly against the opposite faces of the lower forward quarter of main panel 10, the half panels 11 are released to drop downwardly.

The folding movements described above are effected by means of the closing cords 15, attached to the free corners (upper corners in the open target) of quarter panels 12; and the closing cords 15', attached to the free (lateral) corners of quarter panels 12'. The pull of all four closing cords is directed from the forward corner of the main panel 10.

To this end, the closing cords 15, 15' are laced through an eyelet 24 (Fig. 1) in the forward B corner of panel 10. The cords 15 are attached to the free corners of quarter panels 12 by being tied into eyelets 25 therein, extend diagonally downwardly and forwardly on respective sides of the main panel 10 along the upper forward margin thereof, and pass through the eyelet 24 in opposite directions. Thence each cord 15 extends down-

wardly to clip 16 on the reverse side of panel 10 from the side on which it extends between connection 25 and eyelet 24.

Similarly, closing cords 15' are attached to the free lateral corners of quarter panels 12', being looped through eyelets 26 in those corners and tied, and extend diagonally in a horizontal plane from the eyelets 26 to the eyelet 24, through which they extend in opposite directions and are continued on the respective opposite sides of panel 10 to a point where they are attached to clips 16.

Opening cords 13 are attached to the free corners of the upper quarter panels 12, being looped through eyelets 25 and tied, thence extend on opposite sides of main panel 10 to the upper A corner thereof, thence in opposite directions through an eyelet 27 in said upper corner of panel 10. Thence each of the cords 13 extends upwardly on the opposite side of panel 10 from the side on which it extends between eyelets 25 and 27, and is tied to the terminal element 14. Similarly, the cords 13' are attached to the free lateral corners of lower quarter panels 12', as by being looped through eyelet 26 and tied, are thence extended upwardly to eyelets 28 in the free lateral corners of half panels 11 (at the apexes of these panels opposite the hinged base edges 18 thereof) and thence extend upwardly in converging relation to the upper corner of panel 10 where they are passed in opposite directions through the eyelet 27 and thence upwardly on the respective reverse sides of panel 10 to the terminal 14 to which they are tied. The cords 13' are freely slidable in eyelets 28, i.e., they are not tied to the apex corners of the half panels 11. As a matter of simplicity in construction, the cords 13' may constitute integral continuations of cords 15', the two cords in each case being joined by an integral loop around the corner of a respective quarter panel 12' although separate cords each tied separately to the free corner of a panel 12' could be just as well utilized. Similarly, the cords 13 may constitute integral continuations of cord 15.

Operation

In closing the target from the open position of Fig. 1 to the semi-closed position of Fig. 4, the operator, while holding the target suspended from the opening cords 13 and 13', held in one hand, grasps the closing cords 15 and 15' in the other hand and gradually lifts upwardly the corner B of the target while the closing pull is applied. The weight of the target is then gradually shifted from the opening cords to the closing cords, causing the quarter panels 12 and 12' to be drawn toward the corner B as indicated by the arrows *b* and *c* respectively in Fig. 2. In this operation, the target is suspended between the opening and closing cord groups, the corner B being lifted just enough to draw the free corners of the quarter panels to the corner B. The upper quarter panels 12 will then be folded flat against the upper forward quarter faces of the half panels 11 as shown in Fig. 3, and the lower quarter panels 12' will be folded forwardly against the lower forward quarter faces of the main panel 10, as likewise disclosed in Fig. 3. The upper Z edges of lower quarter panel 12' will thus be aligned with the hinged hypotenuse X edges 18 of half panels 11 and the free Y edges of upper quarter panels 12 will have been shifted from their vertical positions to horizontal positions likewise aligned with the hinged X edges 18 of half panels 11.

The half panels 11 are now free to drop downwardly as indicated by arrows *a* in Fig. 3, and by shifting one hand from the cords 13, 13' to the upper corner of main panel 10 and grasping this upper corner and then releasing the tension on the closing cords 15, 15' and shifting the assembly back to the point where the upper corner of main panel 10 is pointed upwardly as in Fig. 3, the half panels 11 will be permitted to drop downwardly against the respective outer faces of the folded quarter panels 12'. During this downward dropping of the half panels

the operator may avoid fouling of the harness by completely releasing the closing cords, again grasping the opening cords 13, 13' and holding back the slack in the latter cords as they are pulled through the upper eyelet 27 in response to the downward dropping of the half panels 11.

Finally, the opening cords will have been pulled through the eyelets 27 so that only very short lengths thereof project beyond the corner A of the target, as shown in Fig. 4, and the operator may then again grasp the closing cords 13, 13' and draw them through the eyelets 24 to take up all the slack in these cords. The extended length of the cords 13, 13' may then be secured and pulled out from corner B by attaching clip 16 to the adjacent lateral corner of the folded target as shown in Fig. 4. The panels are now folded together with the lower panels 12' folded between the main panel 10 and the half panels 11, with the half panels 11 folded between the lower quarter panels 12' and the upper quarter panels 12, with the upper quarter panels 12 lying flatly against the faces of half panels 11 which are now the outer faces, superimposed directly outwardly of the lower quarter panels 12' which are disposed inwardly in the sandwich of folded panels in the forward quarter face areas of half panels 11, and with the sandwich of folded panels clipped together by the clip 16 to preserve the folded condition of the target.

To open the target it is only necessary to release the clip 16 from the sandwich of folded panels, to free the closing cords 15, 15' to a condition freely hanging from corner B of the target, and to then grasp the opening cords 13, 13' (as by grasping the terminal ring 14 and shifting the entire weight of the target to the opening cords) whereupon the weight of the target will cause the panels to be opened up, the cords 13, 13' exerting a lift against the apex corners of half panels 11 which is effective to raise the half panels to their horizontal positions in the open target, before the quarter panels begin to open. The engagement of the opening cords 13' against the eyelets 28, in the folded target, is equivalent to secured connections at the apex corners of the half panels, since the portions of cords 13' which extend from the eyelets 28 to the free corners of lower quarter panels 12', are taut and remain so until the end of the raising movement of the half panels releases the lower quarter panels for movement toward the eyelets 28, and so long as these cord portions remain taut, the cord 13' can not pull through the eyelets 28. Thus the opening cords 13' do not commence to draw upwardly through the top eyelet 27 until the half panels 11 are fully raised, and consequently there is no pull applied to the upper quarter panels 12 until the half panels are raised (since all four cords 13, 13' are tied together at ring 14 and move only as a unit). When the half panels are fully raised, releasing the lower quarter panels 12' for horizontal swinging movement, the pull of cords 13' will become effective against the free corners of quarter panels 12', urging them toward the apex corners of the half panels, and a camming effect of the upper edges 23 of the lower quarter panels 12' against the under faces of half panels 11, will adjust the half panels upwardly with whatever slight additional movement may be required to bring them exactly to the horizontal plane of their position in the open target. The lifting of the upper panels 12 brings their Y free edges into embracing relation to the upper half of the main panels 10 which prevents the half panels 11 being lifted beyond the horizontal plane in which they are brought to rest in the completely opened target of Fig. 1. The free corners of quarter panels 12 and 12' will be arrested when the excess length of cords 13 and 13' are drawn through the upper eyelet 27 of the target and the free corners of the quarter panels are aligned with the respective eyelets 27 and 28 of the main panels 10 and half panels 11 respectively. At this point the pull upon the cords 13 and 13' ties the free corners of the quarter panels to the respec-

tive eyelets 27 and 28 thus securing the target in its fully opened condition of Fig. 1.

It should be pointed out that the use of the adjectives "upper," "lower," "forward" etc. in referring to the panels and other parts of the target, in the foregoing specifications and the appended claims, is to be understood as designating the positions of the panels and other parts as located when the target is in an open, suspended position ready for use, and that such terminology is used for the purpose of facilitating the identification of the various parts of the target, particularly in the claims, and is not intended to provide an accurate designation of the positions of all parts at all times, e.g. during the folding operation.

I claim:

1. In a foldable radar target: a plurality of panels having electrically reflective surfaces, including a main panel, a pair of half panels hinged to said main panel on a bisecting horizontal axis thereof; a pair of upper quarter panels hinged to the respective half panels on axes bisecting the respective half panels, for downward folding movement into face contact with the upper surfaces of said half panels; a pair of lower quarter panels hinged to said main panel on vertical axes aligned with the vertical bisecting axis of said main panel, for forward folding movement into face contact with the respective lower forward opposite quarter surfaces of said main panel; and a harness for opening and closing said target, comprising two pairs of opening cords extended to the upper corner of said main panel, two pairs of closing cords slidably extended to the forward corner of said main panel and guide means at said corners through which said cords are slidably extended, one pair of the opening cords being secured to the free corners of said upper quarter panels for raising the same when pulled, the other pair of opening cords being slidably extended past and guided at the free corners of the respective half panels and being secured to the free corners of said lower quarter panels for moving them toward said free corners of the half panels when pulled, one pair of closing cords being secured to the free corners of said upper quarter panels for drawing them downwardly toward the forward corner of the target when pulled, and the other pair of closing cords being attached to the free corners of said lower quarter panels for drawing them horizontally toward said forward corner of the target when pulled.

2. In a foldable radar target: a plurality of panels having electrically reflective surfaces, including a main panel, a pair of half panels hinged to said main panel on a bisecting horizontal axis thereof; a pair of upper quarter panels hinged to the respective half panels on axes bisecting the respective half panels, for downward folding movement into face contact with the upper surfaces of said half panels; a pair of lower quarter panels hinged to said main panel on vertical axes aligned with the vertical bisecting axis of said main panel, for forward folding movement into face contact with the respective lower forward opposite quarter surfaces of said main panel; and a harness for open and closing said target, comprising two pairs of opening cords slidably extended through an opening in the upper corner of said main panel, and two pairs of closing cords slidably extended through an opening in the forward corner of said main panel, one pair of the opening cords being secured to the free corners of said upper quarter panels for raising the same when pulled, the other pair of opening cords being slidably extended through

openings in the free corners of the respective half panels and being secured to the free corners of said lower quarter panels and moving them toward said free corners of the half panels when pulled, one pair of closing cords being secured to the free corners of said upper quarter panels for drawing them downwardly toward the forward corner of the target when pulled, and the other pair of closing cords being attached to the free corners of said lower quarter panels for drawing them horizontally toward said forward corner of the target when pulled.

3. A target as defined in claim 2, including bearing eyelets in the upper and forward corners of said main panel and in the free corners of said half panels, said eyelets defining said openings through which the cords extend, said eyelets providing for smooth, substantially friction-free sliding of the cords through said openings.

4. A target as defined in claim 3, including means for securing said closing cords against retraction when drawn forwardly to effect the closing of the target.

5. A target as defined in claim 4, wherein said securing means consists in a clip to which the free ends of said closing cords are anchored, said clip being proportioned for snug engagement of the folded panels for securing the closing cords taut with the folded panels restrained against opening movements.

6. In a foldable radar target: a plurality of sheet metal panels having electrically reflective surfaces, said panels including a square main panel, a pair of right isosceles triangular half panels equivalent to half the area of said main panel, hinged along their hypotenuse edges to said main panel on a horizontal diagonal axis thereof, and four quarter panels each of right isosceles triangular form, equivalent to one quarter of the area of said main panel, including a pair of upper quarter panels hinged to the respective half panels on axes bisecting the respective half panels, for downward folding movement into face contact with the upper surfaces of said half panels; a pair of lower quarter panels hinged to said main panel on vertical axes aligned with the vertical bisecting axis of said main panel, for forward folding movement into face contact with the respective lower forward opposite quarter surface of said main panel; bearing eyelets in the upper and forward corners of said main panel and in the free lateral corners of said half panels; and a harness for opening and closing said target, comprising two pairs of opening cords slidably extended through the eyelet in the upper corner of said main panel, and two pairs of closing cords slidably extended through the eyelet in the forward corner of said main panel, one pair of the opening cords being secured to the free corners of said upper quarter panels for raising the same when pulled, the other pair of opening cords being slidably extended through the eyelets in the free corners of the respective half panels and being secured to the free corners of said lower quarter panels for moving them toward said free corners of the half panels when pulled, one pair of closing cords being secured to the free corners of said upper quarter panels for drawing them downwardly toward the forward corner of the target when pulled, and the other pair of closing cords being attached to the free corners of said lower quarter panels for drawing them horizontally toward said forward corner of the target when pulled.

No references cited.