Sept. 24, 1957

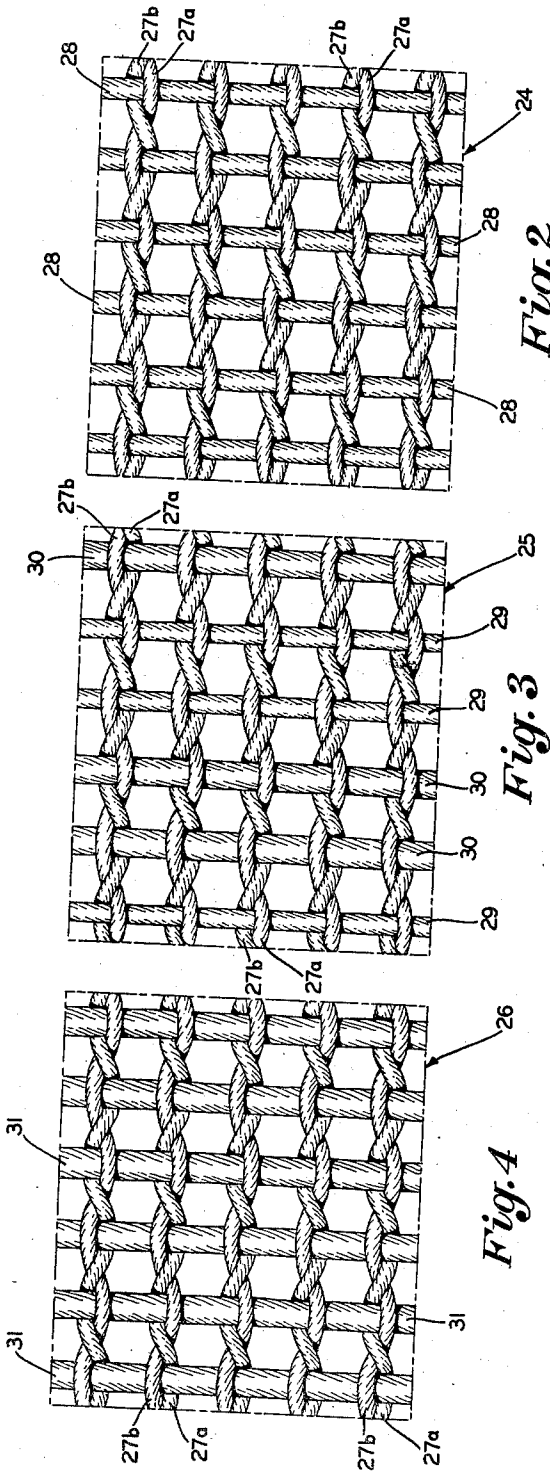
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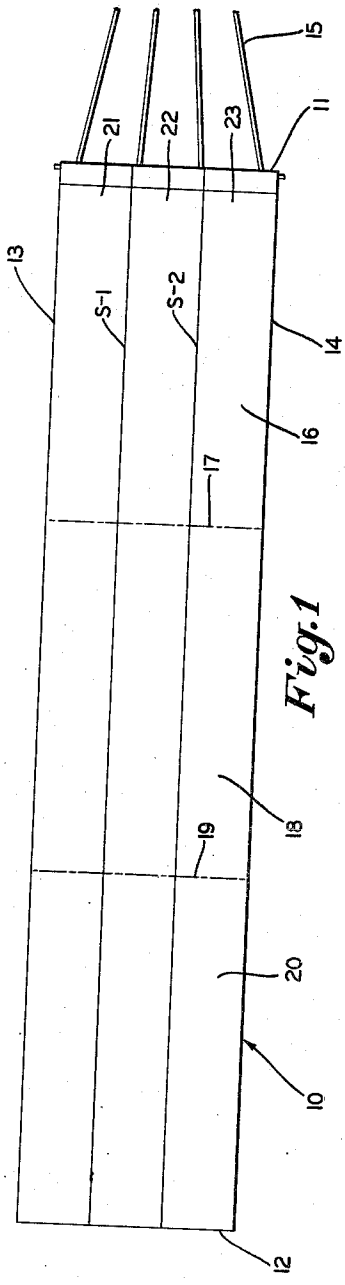
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TOW TARGET CONSTRUCTION

Filed Dec. 23, 1955

2 Sheets-Sheet 1




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2 Sheets-Sheet 2

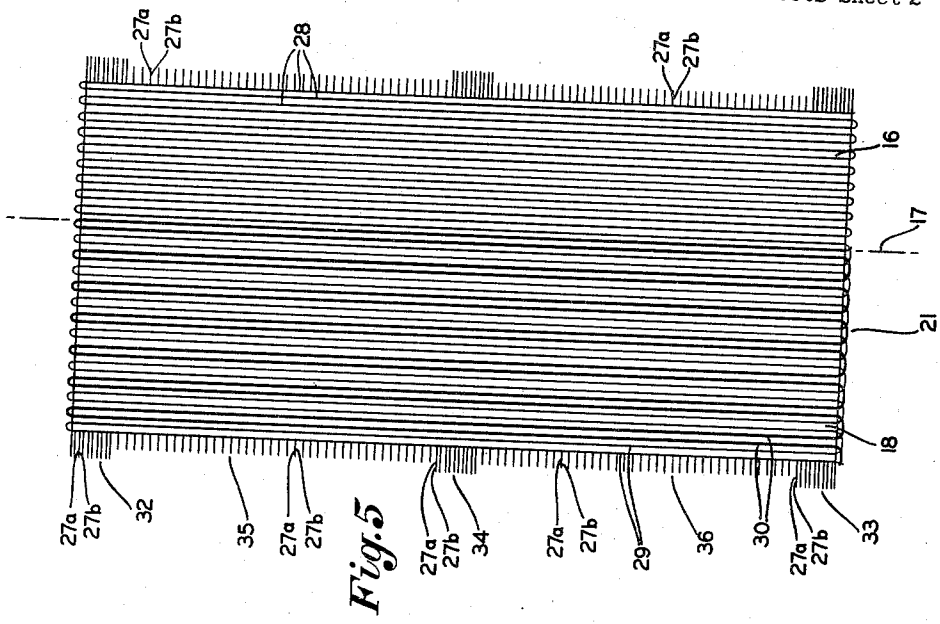



Fig. 5

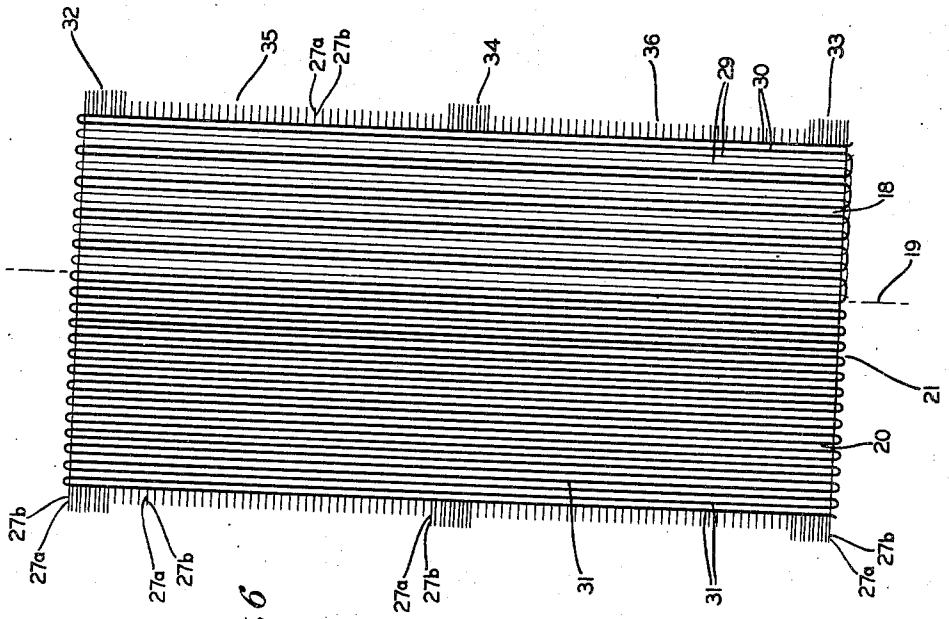



Fig. 6

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United States Patent Office

2,807,287

Patented Sept. 24, 1957



2,807,287

# TOW TARGET CONSTRUCTION

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Application December 23, 1955, Serial No. 554,977

4 Claims. (Cl. 139—419)

The invention or discovery relates to tow target construction for use for training air force personnel in gun, cannon, and rocket firing marksmanship. A tow target for such purpose is connected by a tow line as long as 1,000 feet to a towing aircraft. The marksman trainee operates from another aircraft many miles away. The aircraft bearing the marksman trainee is termed herein a "pursuit plane" for convenience, but may actually be any type of fighting aircraft, from a low-powered, low-speed, training plane, to a high-powered, high-speed bomber, or a high-powered, high-speed fighter escort plane.

Even at relatively low altitudes and low-speeds of tow target travel, difficulties have been encountered in producing tow targets having a useful life of sufficient length to minimize the cost of each training mission, and which are otherwise satisfactory.

Tow targets used prior to the present invention have been made of various types of open mesh flexible fabric material, and may be upwards of nine (9) feet wide by forty-five (45) feet long. The forward end of the target may be termed the leading edge, and is connected by a hitch to the rear end of the tow line. The rear end of the tow target may be termed the trailing edge.

In use, the forward portion of a tow target assumes a more or less flat horizontal position which extends to as much as one-third (⅓) of the total length of the target. The middle portion of the target, which may extend another one-third (⅓) of the total length of the target, assumes a condition of rippling in undulating waves, the peaks and valleys of which extend transversely of the direction of flight. The rear portion of the target, which may extend the final one-third (⅓) of the total length of the target, assumes a condition of whipping or flapping, which is very damaging to the material of the target in this whipping portion of the target.

The difficulties encountered in prior tow target constructions include the following:

First: For the purpose of minimizing the power required in the towing plane, it is desirable to minimize the total weight of the target. A target made of material having a weight per square yard sufficient to reduce rippling and whipping to a satisfactory degree, has a total weight which is prohibitive.

Second: As the speed of the tow target is increased for use in training marksmen operating from the higher speed aircraft, the greater the increase in target speed, the greater is the undesirable rippling and whipping of the target.

Third: A high speed fighting plane is manually controlled until contact with the target is made, then a radar operated control system latches on the target, and operates the fighting plane, until the fighting plane has demolished the target, or vice versa, or the target eludes the fighting plane. Every airborne marksman must be trained in such operations. Tow targets of prior construction have frequently been made of nylon or similar material having no radar reflecting properties. To overcome this, radar reflecting corners have been attached to the forward end of such targets, with the result that the radar operated control system in the pursuit plane has latched on to the radar reflecting tow plane, instead of the target, with disastrous results.



Prior tow targets which have been made of metallized fabrics have been excessive in weight, and subject to operational objections similar to those incident to the use of radar reflecting corners.

The objects of the present invention or discovery include the provision of a tow target construction, by the use of which tow targets may be made in which rippling and flapping may be brought within desired limits, without exceeding desired weight limitations.

A further object of the present invention or discovery is the provision of such a target which may be made of woven fabric in continuous lengths without cross-seams.

A further object of the present invention or discovery is the provision of such a target made of woven fabric, and which is metallized in a manner, so as to produce a target which has the desired weight limitations.

The foregoing and other objects are attained by the tow target construction, parts, combinations, and subcombinations, which comprise the present invention or discovery, the nature of which is set forth in the following general statement, and preferred embodiments of which, together with their mode of use, are set forth by way of example in the following description, and which are particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

The nature of the improvements of the present invention may be described in general terms as constituting tow target construction including side by side seam connected continuous flexible panels, each panel including longitudinally extending laterally spaced warp strands and longitudinally spaced filling strands continuously woven with the warp strands. The filling strands in one end portion of the panel, all have a minimum diameter, and the filling strands in a middle portion of the panel include strands of two different diameters, one of the middle portion filling strand diameters being as great as the minimum diameter and the other of the middle portion filling strand diameters being greater than the minimum diameter, and the filling strands in the other end portion of the panel, all have a diameter greater than the minimum diameter, whereby each panel constitutes a differential weave continuous open woven fabric panel including successive panel portions, each having a woven fabric construction different than the woven fabric construction of each of the other panel portions. Preferably the warp strands are arranged in narrower side bands and a center band and wider bands between each side band and the center band, and the warp strands in the narrower bands including pairs adjacent each other and forming a smaller mesh weave than the weave of the wider bands.

By way of example, embodiments of the improved tow target construction and parts thereof, of the present invention or discovery are illustrated in the accompanying drawings forming part hereof, in which

Fig. 1 is a reduced plan view, diagrammatic in part, showing a tow target including end portions and an intermediate portion of the present invention or discovery.

Fig. 2 is an enlarged fragmentary plan view showing an area of a first leading portion of the improved tow target, the first target portion having a first woven fabric construction.

Fig. 3 is an enlarged fragmentary plan view showing an area of a second intermediate portion of the improved tow target, the second target portion having a second woven fabric construction.

Fig. 4 is an enlarged fragmentary plan view showing an area of a third trailing portion of the improved tow

target, the third target portion having a third woven fabric construction.

Fig. 5 is a reduced fragmentary diagrammatic plan view of a panel length of the improved fabric for the improved tow target showing the transverse continuous junction between the first and second target portions, and other details.

Fig. 6 is a reduced fragmentary diagrammatic plan view of a panel length of the improved fabric for the improved tow target showing the transverse continuous junction between the second and third target portions, and other details.

Similar numerals refer to similar parts throughout the several views of the drawings.

The tow target shown in Fig. 1 is indicated generally by **10**, and constitutes a preferred embodiment of the present invention or discovery.

The tow target **10** is made of a single ply of improved flexible open mesh differential weave fabric hereinafter described in detail, and is an elongated rectangle of such fabric which may be nine (9) feet wide and forty-five (45) feet long, for example.

The elongated rectangular tow target **10** includes a leading edge **11**, a trailing edge **12**, and transversely spaced side edges **13** and **14**. A hitch **15** connects the leading edge **11** in a usual manner with the trailing end of a tow line, not shown, which extends for a mile, more or less, from a usual towing aircraft, not shown.

The tow target **10** is constituted, from the over-all standpoint, by a first leading target portion **16** having a transverse junction indicated by the dot-dash line **17** with a second intermediate target portion **18**, which in turn has a transverse junction indicated by the dot-dash line **19** with a third trailing target portion **20**.

As shown, the tow target **10**, divided over-all into the first, second, and third portions **16**, **18**, and **20**, is made of three continuous longitudinally extending fabric panels including a side panel **21** having the outer side edge **13**, and at its other edge an inside connecting seam S–1 with one edge of a center panel **22**. The other edge of the center panel **22** has an inside connecting seam S–2 with a side panel **23**, which has the outer side edge **14**.

Firstly, each of the three panels **21**, **22**, and **23**, in the first leading target portion **16**, is constituted throughout the major portion of its area, by a first woven fabric construction indicated generally by **24**, and shown enlarged in Fig. 2.

Secondly, each of the three panels **21**, **22**, and **23**, in the second intermediate target portion **18** is constituted throughout the major portion of its area, by a second woven fabric construction indicated generally by **25**, and shown enlarged in Fig. 3.

Thirdly, each of the three panels **21**, **22**, and **23**, in the third trailing target portion, is constituted throughout the major portion of its area, by a third woven fabric construction indicated generally by **26**, and shown enlarged in Fig. 4.

In each panel **21**, **22**, or **23**, each of the first, second, and third woven fabric constructions **24**, **25**, and **26**, has a different weave structure than each of the others, constituted by common warp yarn strands **27***a* and **27***b*, and by different filling yarns.

The first woven fabric construction **24** in any panel such as **21**, includes a continuous filling yarn strand **28** having a diameter which is the least diameter of any filling yarn strand in the entire panel.

The second woven fabric construction **25** in the panel **21** includes a continuous filling yarn strand **29** and a continuous filling yarn strand **30**. The diameter of the yarn strand **29** is less than the diameter of the yarn strand **30**, and the diameter of the yarn strand **29** may be the same as the diameter of the yarn strand **28**, and the strand **29** preferably is continuous with the strand **28**.

The third woven fabric construction **26** in the panel **21** includes a continuous filling yarn strand **31** which has a



diameter greater than the strands **28** and **29**, and which may have the same diameter as, or a greater diameter than, the strand **30**.

A fragment of one of the panels of the target **10**, such as the panel **21**, is shown diagrammatically in Fig. 5, at the transverse continuous junction **17** between the first target portion **16** and the second target portion **18**. In this diagrammatic view, where the filling strands **28**, **29**, and **30**, are shown, the warp strands are removed, to more clearly illustrate the continuity of the filling strands.

At opposite ends of Fig. 5, the filling strands are removed, and each set of warp strands **27***a* and **27***b* is indicated by a single line. Warp reinforcing is provided in side bands **32** and **33** and center band **34**, by providing pairs of sets of warp strands **27***a* and **27***b* at the side of each of the fabric openings, instead of single sets of warp strands in the wide band **35** between the reinforced bands **32** and **34**, and in the wide band **36** between the reinforced bands **34** and **33**.

In Fig. 6, there is shown in a manner similar to Fig. 5, the details of construction of the panel **21** at the transverse continuous junction **19** between the second target portion **18** and the third target portion **20**.

The improved tow target **10** may be furthermore described as a banner style or type tow target. In general each of the target portions **16**, **18**, and **20**, may be termed an open mesh woven yarn fabric of the marquisette type.

Yarn may be furthermore defined as being either monofilament or multi-filament, multi-filament yarn being spun. Any desired filaments or fibres or combinations of fibres may be used, preferably the filaments or fibres are constituted by synthetic materials such as nylon, Orlon, and the like.

The yarn for the warp strands of the improved continuous panels, such as panel **21**, may be nylon yarn, or may be Orlon yarn, or yarn combining different filaments or fibres such as Orlon and nylon. The yarn for the warp strands is required to withstand low temperatures, as is also the yarn for the filling strands.

The yarn for the filling or woof strands may be nylon, or a combined filament or fibre yarn adapted for providing the desired dimensional stability and flexing capacity in operation under temperature extremes of from —65° F. to +165° F.

The improved tow target **10** furthermore may have its second portion **18** and third portion **20** metallized to provide a radar reflecting trailing portion, and a non-radar reflecting leading portion. Such improved construction reduces the over-all weight of the target, and prevents damage of the tow hitch which may occur if the leading portion of a banner type tow target is provided with radar reflecting means.

Whether the tow target **10** is partially metallized, or not, it is desirable to lubricate the target with a silicone preparation to provide maximum flexing and increased rip and tear strength.

*Prior tow target constructions*

In order to show by comparison, the advantages of tow targets including the improvements of the present invention or discovery, the nature and performance of prior tow target constructions is indicated by the following:

I. An early form of banner type tow target was made of cotton covered steel wire woven into a screen fabric similar to door and window screen. Such a target was satisfactory for speed and training purposes on gunnery programs flown at 4000 feet altitude and at speeds of 100 to 150 miles per hour. This construction, however is totally inadequate at an altitude of 10,000 feet and speeds of 200 to 250 miles per hour.

II. Various tow target constructions made of plastic coated fabric material were similarly inadequate.

III. Tow targets made of Leno Weave material woven from an extruded monofilament of polyethylene were similarly inadequate.

IV. Tow targets made of specially woven nylon marquisette gave fairly good results at 20,000 to 30,000 feet altitudes, and true ground speeds of over 300 miles per hour. In order to make it possible for such a nylon marquisette banner tow target to give such performance results, it was necessary to substantially reinforce the target. This was done by binding the edges of the target with nylon webbing, and by adding nylon webbing reinforcing strips lengthwise on both sides of the banner target at intervals across the width of the target. This reinforcing increased the drag of the target to an undesirable degree.

*Tests of present improved banner type tow targets*

A number of improved banner type tow targets of the present invention or discovery have been made and tested in the presence of the inventor at the 4750th Air Training Command of the United States Air Force, at Yuma, Arizona, with the following results.

A. Test flights including Dry Runs and Firing Missions were run during the week of November 15, 1954, with results which were considered to be very satisfactory.

B. Drag Tests were made during the week of December 6, 1954. In each test the improved target returned in excellent condition after having been flown at a true air speed of 385 miles per hour at altitudes as high as 30,000 feet. Drag measurements showed a decrease in drag of better than 40% from the drag of a comparable polyethylene target.

I claim:

1. Banner construction for a tow target and the like, including a plurality of longitudinally extending rectangular panels substantially longer than they are wide, each panel having longitudinally extending laterally spaced side edges with at least one side edge adjacent a side edge of an adjacent panel, each set of adjacent panel side edges having a longitudinally extending seam connection, each panel including end-to-end arranged end and intermediate rectangular panel portions, each panel constituting a single open weave fabric having laterally spaced warp strands extending continuously throughout the entire length of the panel and having longitudinally spaced filling strands extending the entire width of the panel, the filling strands in the rectangular panel portions at one end of the banner being of a minimum diameter, some of the filling strands in the intermediate panel portions having at least the diameter of the minimum diameter filling strands in said one end panel portions and the other filling strands in the intermediate portions having a larger diameter, the filling strands in the other end panel portions of the banner being of a maximum diameter at least as large the larger diameter filling strands in said intermediate panel portions, and the continuous warp strands providing a seamless continuous connection between the filling strands in adjacent panel portions.

2. Banner construction for a tow target and the like including at least one longitudinally extending panel, each panel being substantially longer than it is wide and including end-to-end arranged end and intermediate panel portions, each panel constituting a single woven fabric having laterally spaced warp strands extending continuously throughout the entire length of the panel and having longitudinally spaced filling strands extending the entire width of the panel, the filling strands in the intermediate panel portions including different diameter strands disposed in groups of at least two strands per group, the strands in one group having a diameter of at least the diameter of the strands in said one end portion and the strands in the other group having a larger diameter, the filling strands in the other end panel portion of the banner being of a maximum diameter as large as the larger diameter filling strands in said intermediate panel portions, and the continuous warp strands providing a seamless continuous connection between the filling strands in adjacent panel portions.



3. Banner construction for a tow target and the like including at least one longitudinally extending panel, each panel being substantially longer than it is wide and including end-to-end arranged end and intermediate panel portions, each panel constituting a single woven fabric having laterally spaced warp strands extending continuously throughout the entire length of the panel and having longitudinally spaced filling strands extending the entire width of the panel, all of the filling strands in one end panel portion being of a minimum diameter, the filling strands in intermediate portions including maximum and minimum diameter strands disposed in groups of at least two maximum and two minimum strands per group, all of the filling strands in the other end panel portion being of said maximum diameter, and the continuous warp strands providing a seamless continuous connection between the filling strands in adjacent panel portions.

4. The banner construction as set forth in claim 3 in which some of the filling strands include metallized strands in at least the said other end portion.

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