Sept. 20, 1960 R. J. HOPPER ET AL 2,953,442

TOW TARGET APPARATUS FOR HIGH SPEED FLIGHT

Filed Oct. 22, 1956 3 Sheets-Sheet 1

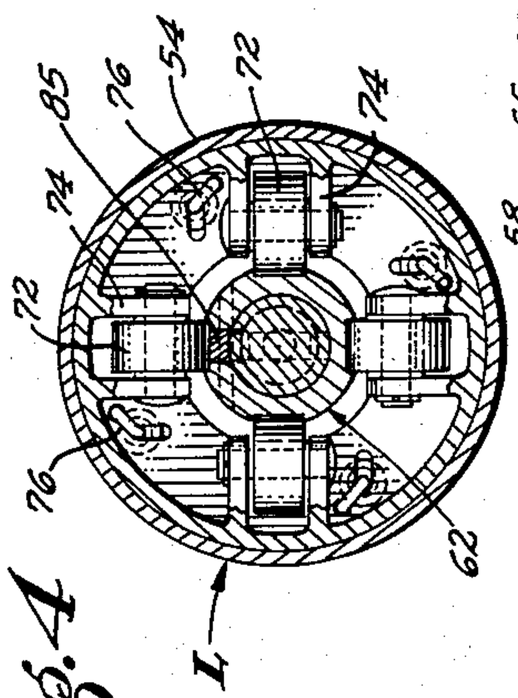

Fig. 4

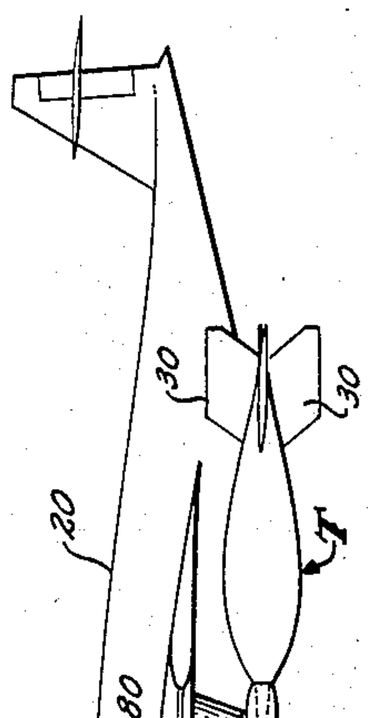

Fig. 1

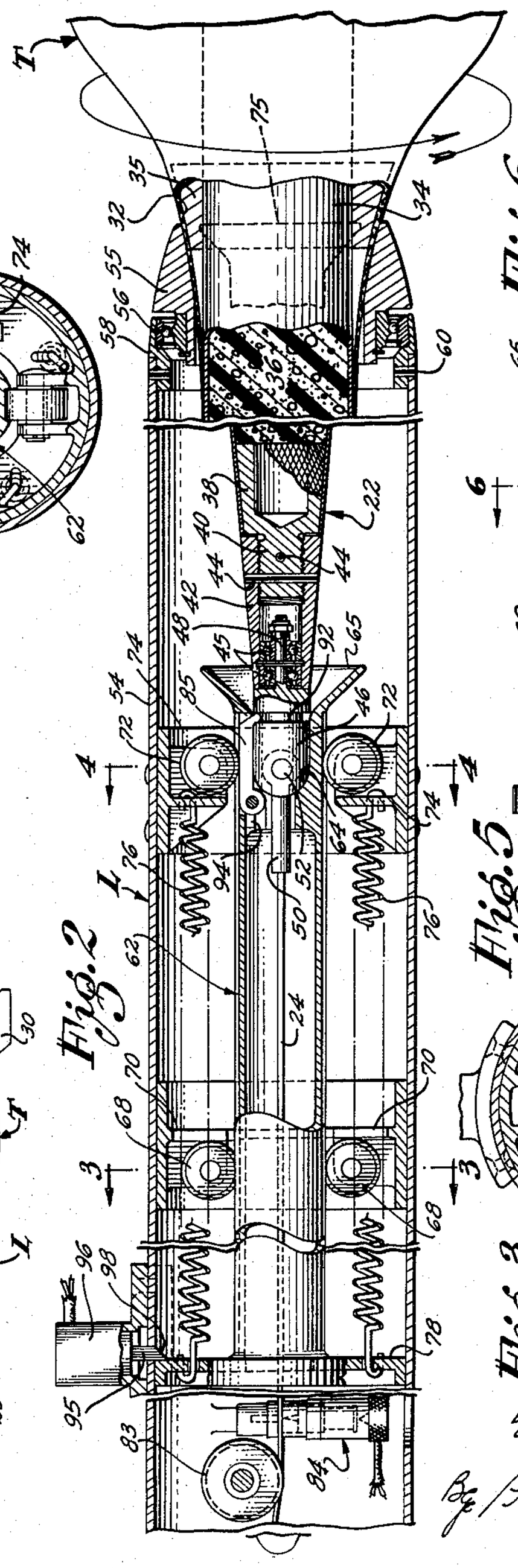

Fig. 2

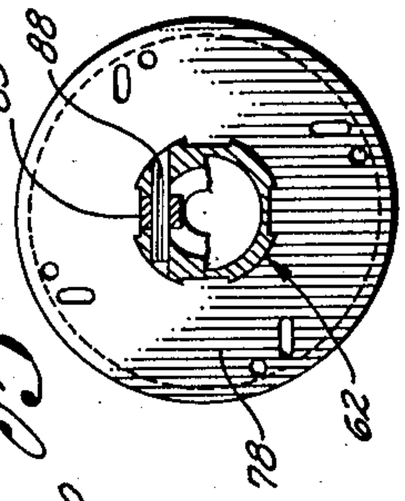

Fig. 6

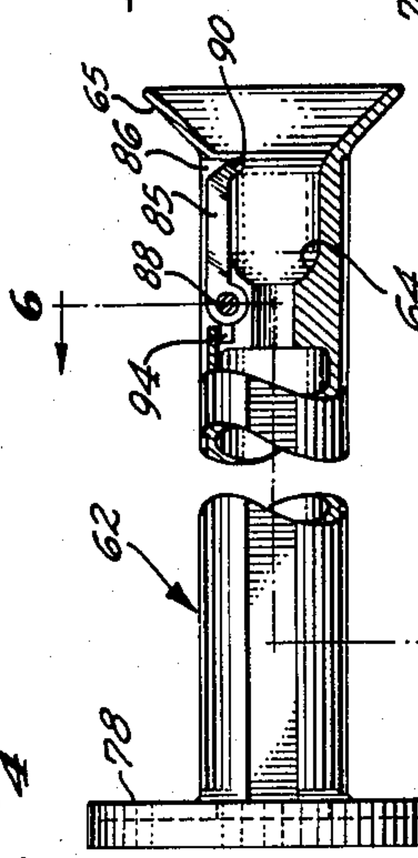

Fig. 5

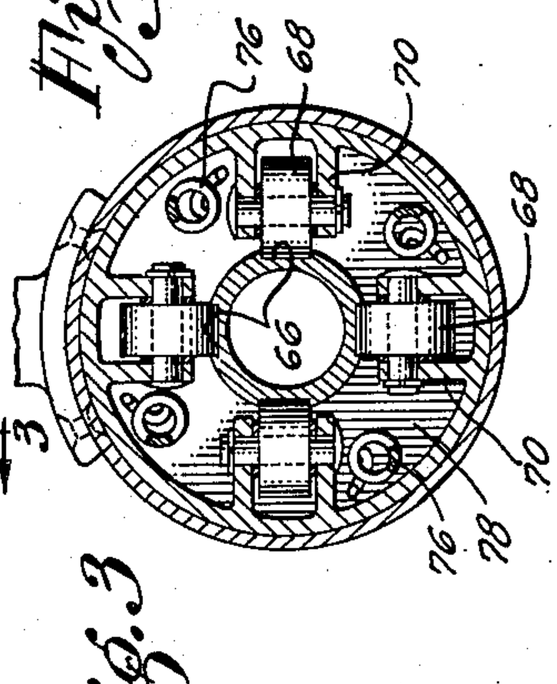

Fig. 3

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Sept. 20, 1960 R. J. HOPPER ET AL 2,953,442

TOW TARGET APPARATUS FOR HIGH SPEED FLIGHT

Filed Oct. 22, 1956 3 Sheets-Sheet 2

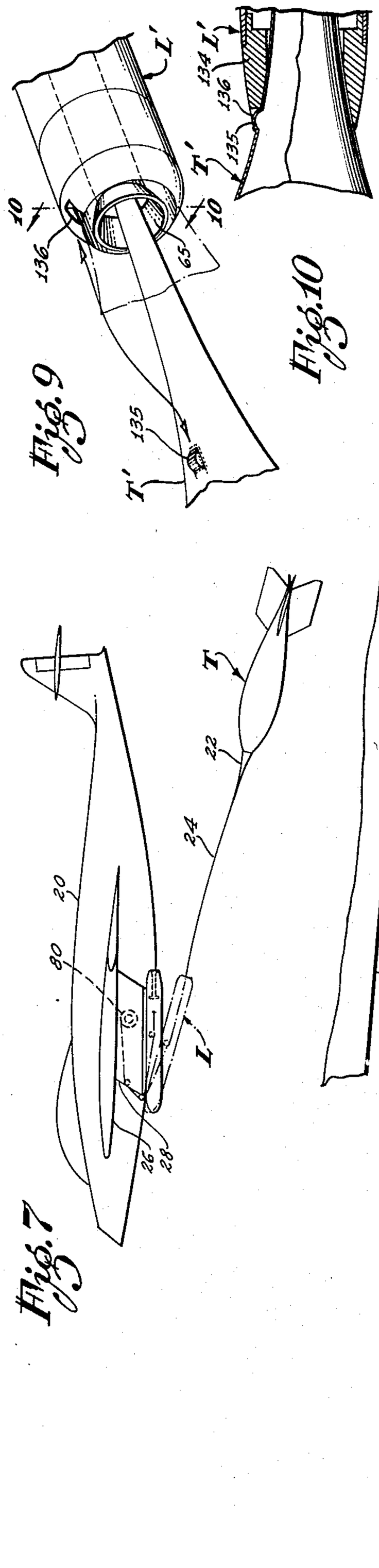

Fig. 9

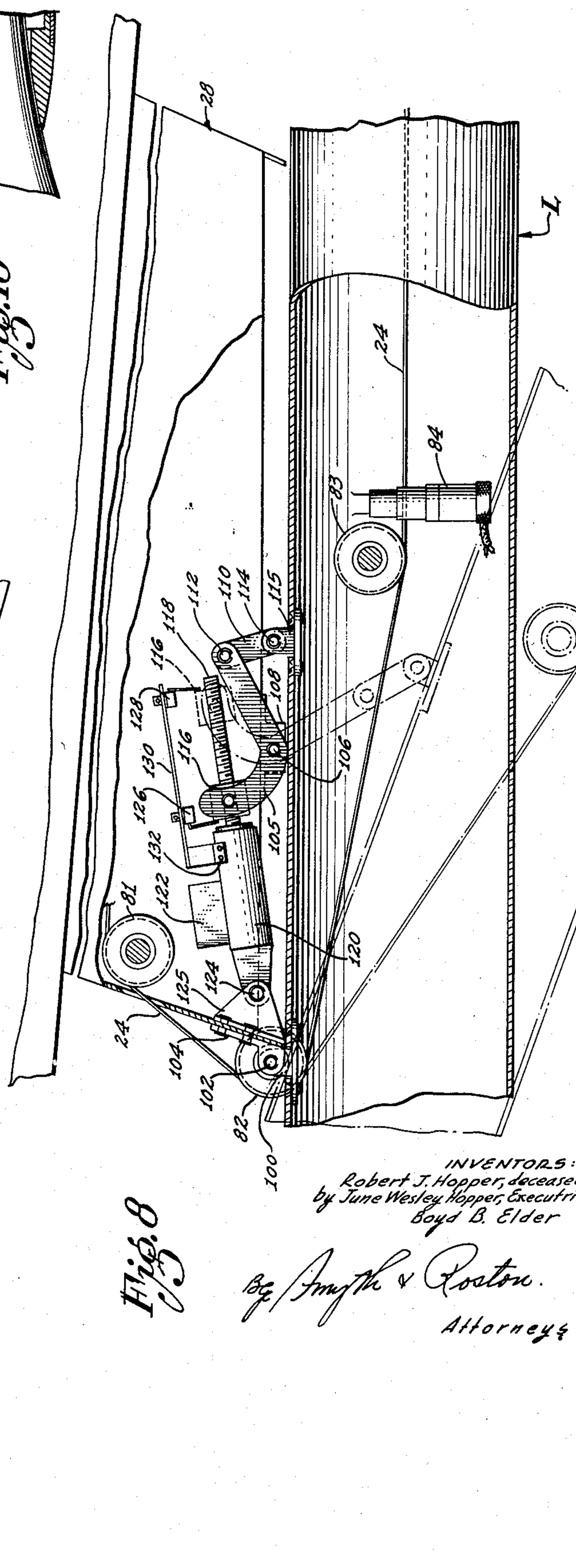

Fig. 10

Fig. 7

Fig. 8

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TOW TARGET APPARATUS FOR HIGH SPEED FLIGHT

Filed Oct. 22, 1956 3 Sheets-Sheet 3

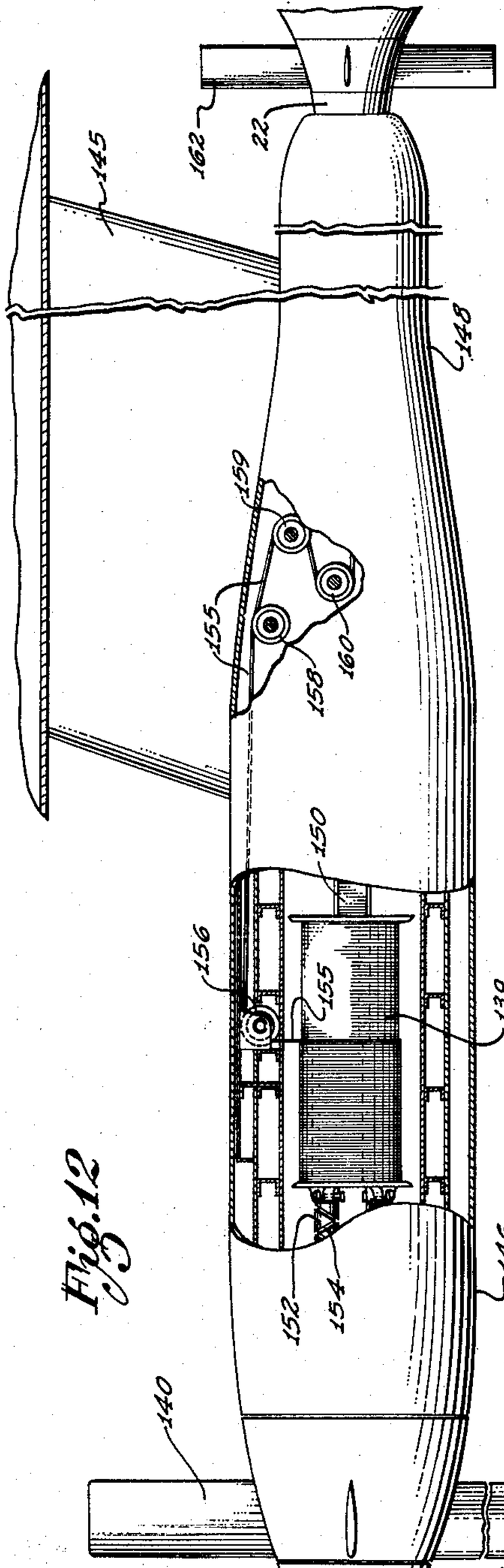

Fig. 12

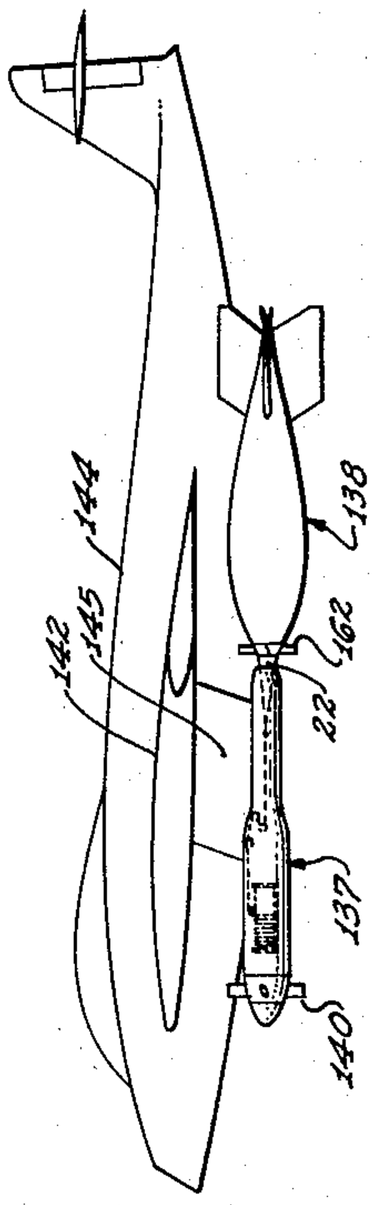

Fig. 11

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TOW TARGET APPARATUS FOR HIGH SPEED FLIGHT

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Filed Oct. 22, 1956, Ser. No. 617,569

21 Claims. (Cl. 273—105.3)

This invention relates to apparatus for aerial target practice, and, more particularly, relates to the combination of a tow target and a launcher for use on an aircraft to transport the tow target in stowed position to a practice area and to launch the tow target on a tow cable for a target run.

One problem to which the invention is directed is to provide such a combination that may be used advantageously with a towing aircraft that flies at high speeds in or near the supersonic range. Heretofore, the launcher and the stowed tow target carried thereby for transportation to and from a practice area have provided a composite configuration having too much drag for use on an exceptionally high speed aircraft; even the launcher alone as heretofore constructed has had too much drag and too much flutter vibration for an exceptionally high speed aircraft; and the usual tow target flying at the end of a long tow cable has been characterized by drag that is excessive for exceptionally high speed target runs. The invention meets this problem by providing a low drag composite configuration for the combined launcher and stowed target, by providing a low drag configuration for the launcher alone and by providing a low drag configuration for the tow target alone.

A feature of the invention is that a number of different purposes, all working together to make high speed target runs feasible, are accomplished by providing the tow target with a slender, tapered, elongated probe-like nose member that is rigidly united with the tow target and with the cooperation of the launcher is capable of supporting the tow target body.

With reference to the configuration of the tow target alone, the addition of the slender, tapered elongated nose probe is an addition to the area of the tow target that, considered alone, increases the skin friction, but this drag-increasing factor is more than offset by other drag-reducing factors. One of the offsetting factors is that the lengthening of the tow target by the addition of the nose probe increases the distance of the tow cable connection from the center of gravity of the tow target, and thus increases the inherent stability of the tow target to such an extent that the size of the stabilizing tail fins of the tow target may be substantially reduced. The reduction in skin friction by reduction of the size of the tail fins is much greater than the skin friction added by the nose probe. Another offsetting factor is that moving the tow cable connection forward to a greater distance from the center of gravity decreases the departure angle of the tow cable relative to the axis of the tow target and thus reduces the drag of the tow cable. For these reasons, the addition of the nose probe reduces the over-all drag to make the tow target suitable for exceptionally high speed flight.

With reference to the configuration of the launcher alone, the fact that the slender nose probe is capable of supporting the tow target body makes it possible to dimension the launcher to engage only the nose probe

of the tow target. Thus, the launcher may be of the general character of a cylinder of relatively small diameter having a suitable streamlined nose. The slender launcher may be mounted on a slender streamlined pylon to provide a low drag arrangement that is highly satisfactory for aircraft designed for supersonic flight.

With reference to the composite configuration of the launcher and the tow target when the tow target is in stored position, the launcher telescopes over the nose probe of the tow target and merges with the configuration of the tow target body. Since the launcher is substantially smaller in cross section than the tow target body, it forms, in effect, a nose for the tow target. For these reasons, the composite configuration has relatively low drag in the range of high speed flight.

Further aspects of the invention relate to the solution of certain problems that arise in the use of a launcher of the character described with a tow target of the character described. One of these problems is that the optimum angle of the launcher relative to the aircraft for normal cruising flight is different from the optimum angle for either launching or retrieving a tow target. During launching and retrieving the launcher should be in approximate alignment with the inclined position the tow target takes when it is airborne. Such alignment minimizes stressing the tow target in flexure during a launching operation and facilitates guiding the tow target nose probe into the launcher during a retrieving operation. In this regard, an important feature of the preferred practice of the invention is the mounting of the launcher on the tow aircraft to tilt by remote control from a normal position to a target-retrieving position, the target-retrieving position being inclined in accord with the angle of attack of the tow target.

Another problem is that the tow target rotates on its longitudinal axis for stability in flight and excessive stress in torque in the nose probe structure may be incurred by snubbing the nose probe in the launcher. A feature of one practice of the invention in this regard is, in effect, to make at least the trailing portion of the launcher of rotary construction to permit free rotation of the snubbed target. Another solution is the provision of a noncircular portion of the launcher for engagement with a noncircular portion of the tow target in the region of the base of the nose probe to immobilize the tow target against rotation without stressing the nose probe itself.

Still another problem arises in those instances in which the tow target has forward turbine blades to derive power from the air stream for various purposes. The problem is to avoid damage to these blades by impact with the launcher, especially during the operation of retrieving a tow target when the tow target tends to over run the launcher. Fortuitously the provision of the nose probe solves this problem by making it possible to space the turbine blades a substantial distance rearward from the connection with the tow cable.

As will be explained, other features of the invention relate to the problem of automatically and releasably latching the tow target in its stored position and the problem of providing expelling force for launching the tow target at the beginning of a target run.

The various features and advantages of the invention will be apparent in the following detailed description considered with the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

Figure 1 is a side elevation of a high speed jet aircraft equipped with a selected embodiment of the invention with the reel for the tow cable at a location on the aircraft outside the launcher;

Figure 2 is an enlarged longitudinal sectional view of the launcher and the leading end of the tow target

with the tow target engaged and supported by the launcher;

Figure 3 is a transverse section taken as indicated by the line 3—3, showing how an elongated launching means inside the launcher is guided by a forward set of rollers;

Figure 4 is a similar cross section taken along the line 4—4 of Figure 2, showing a second rearward set of guide rollers;

Figure 5 is a view partly in side elevation and partly in section, showing the construction of the elongated launching means;

Figure 6 is a transverse section of the launching means taken as indicated by the angular line 6—6 of Figure 5;

Figure 7 is a side elevational view similar to Figure 1, showing how the launcher may be tilted relative to the aircraft for launching or retrieving the tow target;

Figure 8 is a fragmentary view partly in side elevation and partly in section, showing the remotely controlled mechanism for tilting the launcher;

Figure 9 is a fragmentary perspective view illustrating a second practice of the invention in which the launcher holds the stored tow target against rotation;

Figure 10 is a fragmentary sectional view taken as indicated by the line 10—10 of Figure 9, showing how the leading end of the tow target engages the trailing end of the launcher;

Figure 11 is a side elevational of a high speed air craft embodying a form of the invention in which the reel for the tow cable is incorporated in the launcher itself and is capable of retrieving the tow target; and

Figure 12 is an enlarged portion of Figure 11 with parts broken away.

Figure 1, illustrating a selected practice of the invention, shows a tow target, generally designated by the letter T, in snubbed position on a high speed jet aircraft 20 for transportation to and from a target practice area. As best shown in Figure 7, the tow target T has a slender, tapered, elongated nose probe 22 to which the tow cable 24 is connected and this nose probe is of sufficient strength and rigidity to support the streamlined body of the tow target. A slender, elongated launcher, generally designated by the letter L, having a tapered streamlined nose 25, is fixedly mounted on the under side of the aircraft wing 26 by a slender streamlined pylon 28. In the stowed position of the tow target T, the nose probe 22 is telescoped into and engaged by the launcher L for cantilver support of the tow target, as shown in Figure 1.

It is to be noted that the launcher L is only as large in cross section as needed for telescopic engagement with the nose probe 22. Thus, the concept of employing a slender, elongated nose probe for support of the tow target in stored position makes it possible to use a relatively slender launcher suitable for high speed flight, and also makes it possible for the stored tow target to combine with the launcher to provide a composite streamlined configuration for high speed flight.

The tow target T has a set of tail fins 30 which are preferably of slightly angular configuration to cause the tow target to rotate on its longitudinal axis for increased stability in flight. The configuration of the tow target T, separate and apart from the launcher L, is suitable for high speed flight, the provision of the nose probe 22 being of primary importance in accounting for the exceptional aerodynamic efficiency of the configuration, as heretofore explained.

In the initial embodiments of the invention, the diameter of the base portion of the nose probe 22 is of the order of magnitude of 15 to 20% of the maximum diameter of the tow target. For example, a tow target used successfully at flight speeds somewhat under the supersonic range has a body of 18 inches maximum diameter and a nose probe 3 inches in diameter at its base. For flights at supersonic speeds the tow target

may have a maximum body diameter of 15 inches and a nose probe of 3 inches diameter at its base. It has been found to be satisfactory to use a nose probe as long as one and one-half times the maximum body diameter of the tow target.

As indicated in Figure 2, the body of the tow target T may be in the form of a shell having a thin wall 32. Such a shell may be made in sections, each section being of molded paper construction of relatively light weight.

The nose probe 22 may be the exposed forward portion of a thin-walled tubular aluminum member 34 that extends into the interior of the tow target body and is supported therein in a manner for distributing the towing stresses to the thin wall 32 of the body. For this purpose, the concealed base portion of the tubular member 34 may be connected to ring-shaped members or bulkheads that are bonded to the thin wall 32. Thus, Figure 2 shows a tapered internal reinforcement ring 35 that embraces the tubular member 34 and is bonded to the inner surface of the thin body wall 32. For increased rigidity, the tubular aluminum member 34 has a core 36 of suitable material, which, in this instance, is a foamed cellular plastic.

Since the tow target T spins on its longitudinal axis for stability, the cable 24 is connected to the nose probe 22 by means of a rotary joint. In the construction illustrated by Figure 2, the tapered forward end of the tubular member 34 fixedly embraces a fitting 38 having a threaded extension 40 of reduced diameter. A tapered sleeve 42 is screwed onto the threaded extension 40 and secured thereon by a pair of dowels or crosspins 44, the purpose of the tapered sleeve being to mount a pair of ball bearings 45. A clevis member 46 for attachment to the cable 24 has an axial stem 48 journaled in the ball bearings 45. Preferably, the tow cable 24 is provided at its end with an eye fitting 50 that is connected to the clevis member 46 by a crosspin 52.

The launcher L has a cylindrical body shell 54 which is formed with the previously mentioned streamlined nose 25. Rotatably mounted on the trailing end of this body shell is a rotary ring member 55 which is internally tapered, as shown, to nest or seat the forward end of the tow target in the region of the base portion of the nose probe 22. In the construction shown, the rotary ring seat 55 is journaled in a ball bearing 56 inside a bearing ring 58 that telescopes into the body shell 54 and is secured thereto by fastening elements 60.

Mounted inside the launcher shell 54 is an elongated means 62 which may be termed a launcher or carriage member. This launcher or carriage member has a rearwardly directed socket 64 to serve as seating means for the clevis member 46 at the tip of the nose probe 22, and is formed with a rearwardly directed bell mouth 65 to guide the clevis member into the socket. The launcher or carriage member 62 is guided longitudinally with minimum friction by suitable rollers that track in longitudinal guide grooves 66 (Figure 3) in the launcher member. In the construction shown, there are four guide grooves that are engaged by a forward set of four rollers 68 in forward brackets 70 and are also engaged by a rearward set of four rollers 72 in rearward brackets 74.

The launcher member 62 is shown in its forward retracted position in Figure 2 and is movable to a rearward extended position at which the bell mouth 65 is at the rear open end of the launcher, as indicated in dotted lines at 75. The launcher member 62 is continuously urged towards its rearward extended position by suitable yielding means which may take the form of four longitudinal coil springs 76. These springs may be connected at their rearward ends to the rearward brackets 74 and connected at their forward ends to a radial flange 78 on the forward end of the launcher member.

In this embodiment of the invention, the tow cable 24

is wound onto a suitable reel **80** outside of the launcher L, the reel being mounted inside the narrow pylon **28**. As best shown in Figure 8, the cable **24** engages two guide pulleys **81** and **82** carried by the pylon **28** and passes under a third guide pulley **83** inside the launcher L, the tow cable extending rearward from the third guide pulley through the tubular launcher member **62** to its connection with the clevis member **46**. The tow cable **24** also passes through a normally open cable cutter, generally indicated **84**, which is of well known type that contains an explosive charge to generate cutting force. The explosive charge may be detonated electrically by remote control.

It is apparent that the tow cable **24** may be placed under tension to hold the tow target T in engagement with the launcher L in the manner shown in Figure 2, with the clevis member **46** in the socket **64** and with the launcher member **62** in its forward fully retracted position. A feature of this particular embodiment of the invention, however, is the provision of suitable latch means to retain the clevis member **46** in the socket **64** and the further provision of suitable latch means to retain the launcher member **62** in its forward retracted position.

The first latch means for engaging the clevis **46** may be in the form of a latch member **85** positioned in a longitudinal slot **86** of the launcher member **62** and mounted on a suitable pivot pin **88**. The latch member **85** is formed with a nose **90** to engage the rear shoulder **92** of the clevis member, as shown in Figure 2, and the latch member is further formed with a forwardly extending finger **94** that engages the inner surface of the launcher member to keep the latch member from swinging downward from the position shown. Thus, with the latch member **85** maintained in this position, the entrance of the clevis member **46** into the socket **64** causes the rounded leading end of the clevis member to lift the latch member with a camming action, the nose of the latch falling behind the clevis shoulder **92** when the clevis member is fully seated in the socket **64**. This entrance of the clevis member into the socket **64** occurs when the launcher member **62** is at its rearward extended position where the latch member **85** is free to swing upward. When the launcher member **62** is in its forward fully retracted position, however, the latch member **85** is positioned under the uppermost guide roller **72**, as shown in Figure 2, and is thereby immobilized to lock the clevis member in the socket **64**.

The second latch means for releasably holding the launcher member **62** in its fully retracted forward position may comprise a pawl **95** in the form of the armature of a remotely controlled solenoid **96**. The pawl **95** is urged to the effective position shown in Figure 2, by a concealed spring and is formed with an inclined end face **98**. When the launcher member **62** is retracted forward by the cable **24** after the clevis member **46** seats in the socket **64**, the radial flange **78** of the launcher member, moving against the inclined end face **98**, retracts the pawl **95** and the pawl subsequently drops into its effective position behind the radial flange.

While the launcher L may be fixedly mounted on the pylon **28**, an important feature of this particular embodiment of the invention is that the launcher may be tilted by remote control from the normal flight position shown in Figure 1, in which the longitudinal axis of the launcher is substantially parallel to the fore and aft axis of the aircraft, to the inclined position shown in dotted lines in Figure 7, the purpose of the inclined position being to facilitate the retrieving of the tow target T after a target practice run. The means for mounting and controlling the launcher L with respect to tilt may be constructed as indicated in Figure 8.

The launcher L has a forward upper hinge fitting **100** that is concentric to the guide pulley **82** and is connected by a hinge pin **102** to a second hinge fitting **104** on the forward wall of the pylon **28**. A suitable bellcrank **105** is mounted by a pivot pin **106** on a bracket **108** on the under side of the pylon **28** and one arm of the bellcrank is connected to one end of a link **110** by a pivot pin **112**. The second end of the link **110** is connected by a pivot pin **114** to a bracket **115** on the upper side of the launcher. The second arm of the bellcrank **105** is pivotally connected to a traveling nut **116** on a power-actuated screw **118**. The screw **118** extends from a cylindrical gearcase **120** containing suitable reduction gearing driven by a remotely controlled motor **122**. The cylindrical gearcase **120** is swingly mounted by a pivot pin **124** on a bracket **125** on the inner wall of the pylon **28**.

Normally, the launcher L is held in its upper position against the undersurface of the pylon **28** by the described mechanism in the manner shown in Figure 8, with the traveling nut **116** at its retracted forward position to cause the short link **110** to be held in an upper position inside the pylon. Actuation of the screw **118** by remote control of the motor **102** shifts the traveling nut **116** to a position on the screw to extend the described linkage for tilting the launcher downward as indicated by the dotted lines in Figure 8.

In the preferred practice of the invention, a pair of limit switches **126** and **128** are adjustably mounted on a support bar **130** that is parallel with the screw **118** and is supported by a suitable bracket **132** on the cylindrical gearcase **120**. Thus, when the motor **122** is energized in either direction, it is automatically cut off at a limit position by the movement of the traveling nut **116** against one of the two limit switches. With the air speed of the aircraft **20** known in advance, the angle of attack of the tow target T may be ascertained for that air speed and the rearward limit switch **128** may be adjusted on the support bar **130** to de-energize the motor **122** when the launcher L reaches the angle of inclination corresponding to the angle of attack of the tow target.

The manner in which the described apparatus operates for its purpose may be readily understood from the foregoing description. In preparation for a target flight, the tow target T is pulled into the launcher L by winding rotation of the reel **80** to latch the clevis member **46** in the socket **64** and to latch the launcher member **62** at its forward retracted position. With the tow target T engaging the launcher L in this manner, the combined or composite configuration formed by the launcher and tow target is an air-streamed configuration having sufficiently low drag to make it possible for the airplane to fly at relatively high speed to the practice area where a target run is to be commenced.

When the practice area is reached, it is desirable to tilt the launcher as heretofore explained. Then the solenoid **96** is energized by remote control from a control station on the aircraft **20** to retract the pawl **95**, and the reel **80** permits the tow cable **24** to slacken sufficiently to permit the launching of the tow target. The four coil springs **76** thrust the launching member **62** rearward to its limit position with the radial flange **78** against the roller brackets **70** to carry the tow target rearwardly and to thrust the same fully into the air stream. As the launcher member **62** moves initially out of its normally forward retracted position, the latch member **85** moves out from under the associated guide roller **72** and is thereby freed for release movement. When the launcher member **62** reaches its fully extended rearward position, the nose **90** of the latch member **85** is cammed by the clevis member **46** out of engagement with the clevis member shoulder **92** to avoid interference with the launching operation. Once the tow target is completely disengaged from the launcher L, it assumes its normal angle of attack and the reel **80** may play out the tow cable **24** to position the tow target at the desired distance from the towing aircraft **20**. The tow target T is caused to spin about its longitudinal axis by the slight angularity

of the tail fins **30** and the rotary swivel **46** permits this rotation of the tow target independently of the tow cable **24**.

If, for any reason, it is desirable to jettison the tow target T at any time when the tow target is being towed, the cable cutter **83** may be energized by remote control to sever the tow cable **24**. In some instances the reel **80** is a one-way reel which functions during flight only to unreel the cable **24** in a controlled manner, and in such instances, the cable cutter is used as a matter of routine. In other instances, the reel **80** is a two-way reel capable of winding in the cable during flight to retrieve the tow target.

In a retrieving operation, as the reeling in of the tow cable **24** brings the tow target T near the aircraft **20**, the motor **122** is energized by remote control to tilt the launcher L downward, as shown in dotted lines in Figure 7, the inclination of the launcher approximating the angle of attack of the tow target. With the launcher L inclined in this manner, the nose probe **22** is at least approximately axially aligned with the launcher L and readily enters the launcher without being subjected to any substantial bending stress.

Initially, the clevis member **46** makes contact with the rearwardly extending bell mouth **75** of the launcher member **72** and is guided thereby into the socket **64**, the spring-loaded launcher member **72** acting as a shock absorber to decelerate the tow target. As the clevis member **46** reaches its completely seated position in the socket, the nose of the latch member **85** drops behind the shoulder **92** of the clevis member. The continued reeling of the tow cable **24** causes forward retraction of the launcher member **62** in opposition to the springs **76** to carry the target inwardly of the launcher shell until the radial flange **78** of the launcher member is automatically engaged by the pawl **98**. As the launcher member **62** reaches its fully retracted forward position for complete seating of the tow target, the latch member **85** is immobilized by the associated guide roller **72**, as heretofore explained.

The tow target T rotates about its longitudinal axis as it approaches the launcher L and it continues to rotate after it is fully engaged by the launcher. Normally, the clevis member **46** is sationary in the socket **64** when the parts are positioned as shown in Figure 2, the rotary mounting of the clevis member permitting the tow target to continue to rotate. The rotary seat **55** snugly engages the forward end of the tow target in the region of the base of the nose probe **22**, and thus engages and supports the nose probe region of the tow target at a second point without interfering with the freedom of the tow target to rotate about its longitudinal axis. It is apparent that this provision of a rotary swivel member **46** in combination with a rotary seat **55** at the trailing end of the launcher eliminates the possibility of the tow target being subjected to excessive stress in torque by its supporting engagement with the launcher.

If desired, the rotary seat **55** at the trailing end of the launcher L may be omitted. Thus, as indicated in Figures 9 and 10, the trailing end of a launcher L′ may be provided with a fixed circular seat **134** for supporting engagement with the tow target in the region of the base of the nose probe **22**. The tow target is immobilized by the launcher against rotation by engagement of a noncircular portion of the tow target with a noncircular portion of the fixed seat **134**. For this purpose, the tow target T′ may be formed with a radial lug **135** and the fixed circular seat **134** may be formed with a radial recess **136** to receive the radial lug. As the rotating tow target T′ is drawn into the launcher L′ by reeling in the tow cable **24**, the tow target continues to rotate until it makes frictional contact with the circular seat **134** and until the radial lug **135** is drawn into the radial recess **136**. In all other respects, this modified form of the invention is constructed and operated in the manner heretofore described.

Figures 11 and 12 show an embodiment of the invention comprising the combination of a two-way launcher **137** and a tow target **138**. The two-way launcher **137** is self-contained in that it not only includes a reel **138** but also contains power means in the form of an air turbine **140** for actuating the reel. The reel **139** and the air turbine **140** are of the same general construction and arrangement set forth in the Hopper et al. Patent 2,751,167, issued June 19, 1956 and entitled, Reeling Apparatus for Controlling a Tow Cable From an Aircraft, which disclosure is hereby incorporated in the present disclosure by reference.

The housing of the launcher **137** is mounted on the wing **142** of an aircraft **144** by the usual pylon **145** and comprises an enlarged forward housing portion **146** and a trailing housing portion **148** of smaller diameter. The forward housing portion **146** includes the reel **139** and its mechanism. The trailing portion **148** is of the same general construction as the previously described launcher L.

As shown in Figure 12, the reel **139** may be in the form of a spool that is slidingly mounted on a square shaft **150** for rotation therewith. The reel is reciprocated on the square shaft by a level wind mechanism which includes at least one shaft **152** with a continuous helical thread **154** thereon. The tow cable **155** passes from the reel **139** around an adjacent guide pulley **156** and then passes around three rearward guide pulleys **158**, **159** and **160** to enter the trailing housing portion **148** axially thereof.

The tow target **138** to which the tow cable **155** is attached, is of the same general character as the previously described tow target T, but is equipped with an air turbine **162** for energizing certain devices in the tow target that are utilized in target practice but need not be described. The tow target **138** is of the usual configuration with the usual nose probe **22** by means of which it may be releasably supported by the trailing housing portion **148**.

Since the two-way launcher is employed to retrieve the tow target **138** after a target run by winding in the tow cable **155**, it is highly improbable that in the retrieving operation the tow target will over run the rear housing portion of the launcher. A highly important advantage of the new tow target configuration, however, is that the air turbine **162** is located near the base end of the nose probe **22**. As the target is retrieved, the tow cable will be coaxially drawn into the launcher to insure that the leading end of the probe is first introduced into the launcher and before any other portion of the target is brought into close proximity with the launcher. In this manner, the air turbine is spaced sufficiently rearward from the point of connection of the tow cable **155** to the leading end of the probe to keep the air turbine from making damaging contact with the launcher when the tow target over runs, the launcher. The possibility of damage to the air turbine **162** is further reduced by mounting the launcher **137** on the pylon **145** to tilt into general alignment with the return path of movement of the tow target during the retrieving operation, the tilting mechanism being concealed in Figure 12.

Our description in specific detail of the selected embodiments of the invention will suggest various changes, substitutions and other departures from our disclosure within the spirit and scope of the appended claims.

What is claimed is:

1. In an aerial target apparatus, the combination of: a tow target having a tapered nose portion; a tow target launcher for mounting on an aircraft for supporting the target for transportation in stored position on said launcher to the area of a target run, said launcher having a rotary trailing portion to seat said nose por-

tion at the stored position of the target and to permit the stored tow target to rotate; a tow cable for extension from the interior of the launcher to tow said target on a target run; and connecting means rotatably mounted on the leading end of said nose portion for attaching said tow cable to the nose portion and to permit rotation of the stored tow target in said rotary trailing portion of the launcher relative to the cable.

2. A combination as set forth in claim 1 in which the internal structure of said launcher includes latch means to engage said rotary connecting means to hold the tow target in stored position.

3. In an aerial target apparatus, the combination of: a tow target having a nose portion; a tow target launcher for mounting on an aircraft for transportation of the tow target in stored position to the area of the practice run; a tow cable for extension from the launcher to said nose portion to tow said target on a target run; means included in the internal structure of said launcher to seat said nose portion, said seating means being movable relative to the fixed structure of the launcher from a rearward extended position to receive said nose portion to a forward retracted position for holding said target body in stored position; and latching means on said seating means for positive engagement with said tow target in response to the forward retraction of the seating means.

4. A combination as set forth in claim 3 in which said latching means includes a latch member movably mounted on said seating means; and which includes means fixedly mounted on the launcher to lock said latch means at the forward retracted position of the seating means, and to release the latch means when the latch means is extended rearward.

5. In an aerial target apparatus, the combination of: a tow target; a tow target launcher for mounting on an aircraft for transportation of the tow target in stored position to the area of a target run; and rotary means connecting said tow cable to the leading end of said tow target, said launcher having a rotary portion to seat the forward end portion of said tow target to permit rotation of the tow target about its longitudinal axis when the tow target is supported by said launcher.

6. A device for releasably supporting an aerial tow target on an aircraft fitted with a tow cable and reel for reeling the tow target in and out relative to the aircraft, comprising: a hollow body for mounting on the aircraft longitudinally thereof, said hollow body being open at its trailing end to form a seat for a portion of said tow target that is spaced rearwardly from the leading end of the tow target; carriage means mounted inside said hollow body for movement longitudinally thereof between a rearwardly extended position with the rear end of the carriage means at said trailing end of the hollow body and a forwardly retracted position, the rear end of said carriage means being hollow to receive the leading end of said tow target; yielding means urging said carriage means towards its rearward extended position; means to automatically latch the leading end of the tow target to said carriage means in response to retraction of the carriage means by said tow cable pulling the leading end of the tow target against the carriage means; and remotely releasable latch means to hold said elongated means in its retracted position.

7. A combination as set forth in claim 6 in which said automatic latching means comprises: a latch member on said carriage means to engage said leading end; and means at a fixed position inside said hollow body to immobilize said latch means in response to the retraction movement of the elongated means.

8. A device for releasably storing an aerial target on an aircraft and for launching the target from the aircraft during flight, comprising: a hollow body for mounting on the aircraft longitudinally thereof, said body being open at its trailing end to form a first seat for engaging a portion of said target that is spaced rearward from the

lead end of the target; elongated means mounted inside said hollow body for movement longitudinally thereof between a rearward extended position with the rear end of the elongated means at said trailing end of the hollow body, and a forward retracted position, the rear end of said elongated means forming a second seat to receive the leading end of the target; means to thrust said elongated means rearward from its forward retracted position thereby to thrust said target from its stored position into the air stream; a first latch means to hold the leading end of the target in said second seat for storing the target, and a second latch means to hold said elongated means at its forward retracted position for storing the target.

9. A combination as set forth in claim 8 in which said thrusting means is a spring means normally restrained by said second latch means.

10. An aircraft aerial tow target system, comprising: an elongate rigid tow target including a body member having a forwardly tapered streamlined configuration; an elongate nose probe coaxially projecting forwardly beyond said forwardly tapered configuration, said nose probe being rigid for cantilever support of said body member; a reel apparatus to be carried by the aircraft for controlling a tow cable secured to the free end of said probe; an open-ended hollow support member substantially longer than said nose probe to be secured to the aircraft with the open end facing rearwardly thereof for telescopically receiving said probe; a rearwardly facing seat carried by said support member at the open end thereof within the cross-sectional dimensions of the support member and adapted to supportingly nest at least the forward portion of the target; cable guide means mounted for movement within said support member relative to said seat coaxially thereof and passing said cable longitudinally of said support member, said cable guide being dimensioned to telescope over the leading end of said nose probe for positive engagement therewith; and resilient means normally urging said cable guide means to a position adjacent the open end of said support member, whereby said guide means is adapted to engage with the probe of said target and to retractingly move coaxially of said support member to center and to absorb the impact of said tow target relative to said support member as the nose probe of the target is drawn into said support member and the forward portion of said target engages said seat as the cable is wound on said reel apparatus to draw said target to said support member.

11. A device for releasably holding an aerial tow target having an elongate probe coaxially projecting forwardly of the nose thereof to an aircraft fitted with a reel apparatus carrying a tow cable to which the probe of said target is affixed and operable to play out said cable, comprising: a support member including an elongated, hollow body open at one end thereof; means for mounting said hollow body to the aircraft with the open end thereof facing rearwardly of the aircraft whereby said probe may be telescopically received therein; said hollow body providing at the open end thereof a ring element within the cross sectional dimensions of the body to form an annular seat for nestingly engaging a portion of the target spaced rearwardly from the leading end of the probe of said target; carriage means coaxially mounted within said hollow body for movement longitudinally thereof between a rearwardly extended position in which the rear end of the carriage means is adjacent and coaxially disposed relative to said seat and a forwardly retracted position, said carriage means being hollow for passing said cable and for telescopically receiving the leading end of the probe of said tow target for positive engagement therewith; means carried by the rearward end of the carriage means for engaging the leading end of said probe; and resilient means urging said carriage means towards its rearwardly extended position, whereby a resilient thrust is applied to said nose probe to

eject the target from said support member when the reel apparatus is operated to play out said cable.

12. A device for releasably holding an aerial tow target having a substantially long probe coaxially projecting forwardly of the nose thereof to an aircraft fitting with a reel apparatus carrying a tow cable to which said target is affixed and selectively operable to play out and retrieve said cable, comprising: a support member including an elongated hollow body open at one end thereof; means for mounting said hollow body to the aircraft with the open end thereof facing rearwardly of the aircraft; a ring element at the open end of the body within the cross-sectional dimensions of the body and forming an annular seat for nestingly engaging a portion of the target spaced rearwardly from the leading end of the probe of said target; elongate tubular means coaxially mounted within said hollow body for passing said cable longitudinally of said support member; support and guide means associated with said tubular means for mounting said tubular means within said support member for movement longitudinally thereof between a rearwardly extended position in which the rear end of the elongated means is adjacent and coaxially disposed relative to said seat and a forwardly retracted position with the range of longitudinal movement substantially entirely within the interior of said support member; means carried by the rearward end of said tubular means for telescopically receiving the leading end of said probe having positive engagement therewith; resilient means urging said elongated means towards its rearwardly extended position, said last named means yielding as said probe is telescopically passed into said support member to engage the target with said seat and operable to apply a thrust to said tubular means as the cable is played out from said reel apparatus, thereby ejecting said target from said support member for tow by said cable.

13. A device for releasably holding an aerial tow target having an elongate probe coaxially projecting forwardly of the nose thereof to an aircraft fitted with a reel apparatus carrying a tow cable to which said target is affixed and operable to play out said cable, comprising: a support member comprising an elongated hollow body member open at one end thereof; means for mounting said body member to the aircraft with the open end thereof facing rearwardly of the aircraft; a ring element coaxially carried by the open end of the body member within the cross-sectional dimensions of the body member and forming an annular seat for nestingly engaging a preselected portion of the target spaced rearwardly from the leading end of the probe of said target; a tubular element dimensioned to telescopically receive the leading end of said nose probe for positive engagement therewith; support and guide means, including a plurality of roller members, for coaxially mounting said element within said hollow body member for passing said cable longitudinally of said support member; said support and guide means mounting said tubular element for movement longitudinally of said body member between a rearwardly extended position in which the rear end of the elongated means is adjacent and coaxially disposed relative to said seat and a forwardly retracted position with the range of longitudinal movement substantially entirely within the interior of said support member; resilient means normally urging said tubular element towards its rearwardly extended position and yielding as said probe is engaged with the rear end of said tubular element and telescopically nested within said body member for engagement of the preselected portion of the target by said seat; said resilient means applying an ejecting force to said tubular element as said cable is played out from said reel apparatus, whereby the tubular element forces said probe outwardly of said body member to eject the target from said support member.

14. In an aircraft tow target installation including a reel apparatus for controlling a cable to which the target is secured, a combination of: a streamlined tow target body having low drag aerodynamic characteristics for high speed flight having a relatively long nose probe projecting coaxially forward of the target body, said nose probe being rigid for cantilever support of the tow target body and being connected to said cable; a support member to be secured rigidly to the aircraft with said cable extending through the support member, said support member being smaller in cross-sectional dimension than said target body and having a rearwardly facing open end of a larger cross-sectional dimension than said nose probe for telescopically admitting said nose probe into said support member to rigidly support said target body for transit to the area of the target practice area; said support member being of an elongated streamlined configuration for relatively low drag during flight and being of substantially a smaller cross-sectional dimension than the tow target to merge rigidly with the tow target body configuration to form therewith a composite streamlined configuration of relatively low aerodynamic drag when said nose probe is telescopically nested within said support member and the target body is supported by said support member.

15. A device for releasably holding an aerial tow target having an elongate probe coaxially projecting forwardly of the nose thereof to an aircraft fitted with a reel apparatus carrying a tow cable affixed to the leading end of said probe and selectively operable to play out and retrieve said cable, comprising: a launcher including an elongate streamlined, hollow body member open at one end thereof; means for mounting said launcher to the aircraft with the open end of said launcher facing rearwardly of said aircraft, said mounting means including means for moving said launcher between a normal support position for transporting the tow target in the flight of the aircraft and a downwardly angled second position for retrieving the tow target as the cable is wound upon said reel apparatus after a towed flight of the target, said downwardly inclined second position approximating the course of the target as it is drawn into the launcher thereby facilitating entry of said nose probe into said launcher; a seat element carried at the open end of said launcher for receiving and supporting at least the forward portion of said tow target contiguous to said nose probe; and means carried within said launcher, including a cable guide element movable relatively to said seat element coaxially thereof for passing the cable longitudinally of said body member and for holding the cable out of engagement with said launcher, said guide element centering the course of the cable as it is drawn into said launcher and thereby centering said nose probe of the target as it is drawn into said launcher under the urging of the cable as the latter is reeled in by said reel apparatus to telescopically fit the nose probe within said launcher and to supportingly nest the forward portion of said tow target against said seat element.

16. A combination as set forth in claim 15 in which said moving means includes means for varying the angle of inclination of said launcher in the said second position whereby said launcher may be caused to assume a predetermined angle of inclination in accord with an anticipated angle of attack of the tow target as it is drawn toward said launcher under the urging of the cable as the same is wound upon the reel apparatus.

17. A device for releasably holding an aerial tow target having an elongate probe coaxially projecting forwardly of the nose thereof to an aircraft fitted with a reel apparatus carrying a tow cable to which said target is affixed and operable to play out said cable, comprising: a hollow body member open at one end thereof; means for mounting said body member to the aircraft with the open end thereof facing rearwardly of the aircraft for telescopically receiving the forwardly projecting probe of the tow target; an annular seat element carried by the body member at the open end thereof for nestingly supporting the forward

portion of said target; and resilient ejector means mounted within said body member for movement substantially coaxially of said body member and adapted to engage with the nose probe of said target for resiliently urging said nose probe outwardly of said body member when said cable is played out from said reel apparatus, said mounting means including means for moving said body member from a position in which the longitudinal axis of the body member is substantially parallel with the fore and aft axis of the aircraft to an alternate position in which the body member is downwardly and rearwardly inclined relative to the fore and aft axis of the aircraft.

18. A device for releasably holding an aerial tow target carrying spin-producing fin elements and having an elongate probe coaxially projecting forwardly of the nose thereof to an aircraft fitted with a reel apparatus carrying a tow cable to which said target is affixed and selectively operable to play out and retrieve said cable, comprising: a launcher including an elongate hollow body member open at one end thereof; means for mounting said launcher means to the aircraft with the open end of said launcher facing rearwardly of said aircraft; a seat element at the open end of said launcher within the cross-sectional dimensions of the launcher for receiving and supporting at least the forward portion of said tow target contiguous to said nose probe; and means carried within said launcher, including a cable guide element movable relatively to said seat element coaxially thereof for holding the cable out of engagement with said launcher, said guide element centering the course of said cable as it is drawn into said launcher and thereby centering the course of said nose probe as it is drawn into said body member of the launcher under the urging of the cable as the latter is reeled in by said reel apparatus to telescopically fit the nose probe within said launcher and to supportingly nest the forward portion of said tow target against said seat element, said seat element being rotatably carried by said body member and rotatable with said target as the latter is rotated by the action of the airstream on the fin elements thereof in the flight of the aircraft.

19. An aerial tow target installation, comprising: an aerial tow target having an elongate rigid probe coaxially projecting forwardly of the nose thereof of strength for cantilever support of the tow target; a launcher open at the rear end thereof for mounting on the aircraft in the air stream thereof, said launcher being substantially longer than said nose probe and the open end of said launcher being of a larger cross-sectional dimension than the nose probe of said target whereby said nose probe may be telescopically received into the launcher for support of said target thereon for transport to the area of a tow target practice run, said launcher being of a streamlined, elongate configuration having low drag aerodynamic characteristics and being of substantially smaller cross-sectional dimension than the tow target to merge with the tow target configuration to form therewith a composite streamlined configuration of relatively low drag when said nose probe is telescopically received within the launcher for cantilever support of the tow target; a reel apparatus for mounting to the aircraft; and a tow cable carried by said reel apparatus and passed longitudinally of said launcher, the reel apparatus being selectively operable to play out and retrieve said cable; said tow cable being connected to the leading end of said nose probe whereby said nose probe may be telescopically drawn into the open end of said launcher as the cable is wound upon said reel apparatus and released therefrom as said cable is unwound from said reel apparatus.

20. A device for releasably holding an aerial tow target carrying fins for aerodynamically rotating said target and having an elongated probe coaxially projecting forwardly of the nose thereof to an aircraft fitted with a reel apparatus carrying a tow cable to which the probe of said target is affixed and operable to play out said cable, comprising: a support member including an elongate hollow body open at one end thereof; means for mounting said hollow body to the aircraft with the open end thereof facing rearwardly of the aircraft, whereby said probe may be telescopically received therein; said hollow body providing at the open end thereof a ring element within the cross sectional dimensions of the body to form an annular seat for nestingly engaging a portion of the target spaced rearwardly from the leading end of the probe thereof and including means co-acting with the said portion of the target, as the latter moves into a preselected position relative to said seat, for holding said target against rotation; carriage means mounted within said hollow body for movement longitudinally thereof between a rearwardly located position in which the rear end of the carriage means is adjacent and coaxially disposed relative to said seat and a forwardly retracted position, said carriage means being hollow for passing said cable and for telescopically receiving the leading end of the probe of said tow target; means carried by the rearward end of the carriage means for engaging the leading end of said probe; and resilient means urging said carriage means toward its rearwardly located position whereby a resilient thrust is applied to said nose probe to eject the target from said support member when the reel apparatus is operated to play out said cable.

21. A device for releasably holding an aerial tow target having an elongated probe coaxially projecting forwardly of the nose thereof to an aircraft fitted with a reel apparatus carrying a tow cable to which the probe of said target is affixed and operable to play out said cable, comprising: a support member including an elongate hollow body open at one end thereof; means for mounting said hollow body to the aircraft with the open end thereof facing rearwardly of the aircraft whereby said probe may be telescopically received therein, said mounting means operable to tilt said support member relative to said aircraft from a normal position for normal flight to a second position in which the rearwardly facing end of the hollow body is below the forwardly facing end as the cable is wound upon the reel apparatus for facilitating retrieving of the tow target; said hollow body providing at the open end thereof a ring element within the cross sectional dimensions of the body to form an annular seat for nestingly engaging a portion of the target spaced rearwardly from the leading end of the probe thereof; carriage means movably mounted within said hollow body for movement longitudinally thereof between a rearwardly located position in which the rear end of the carriage means is adjacent and coaxially disposed relative to said seat and a forwardly retracted position, said carriage means being hollow for passing said cable and for telescopically receiving the leading end of the probe of said tow target for positive engagement therewith; means carried by the rearward end of the carriage means for engaging the leading end of said probe; resilient means urging said carriage means toward its rearwardly located position whereby a resilient thrust is applied to said nose probe to eject the target from said support member when the reel apparatus is operated to play out said cable.

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CERTIFICATION OF CORRECTION

Patent No. 2,953,442 September 20, 1960

Robert J. Hopper et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 9, lines 62 and 69, for "elongated" read -- carriage --.

Signed and sealed this 25th day of April 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents