May 24, 1960 H. E. SENFT 2,937,574

ERECTOR-LAUNCHING APPARATUS

Filed Nov. 9, 1956 4 Sheets-Sheet 1

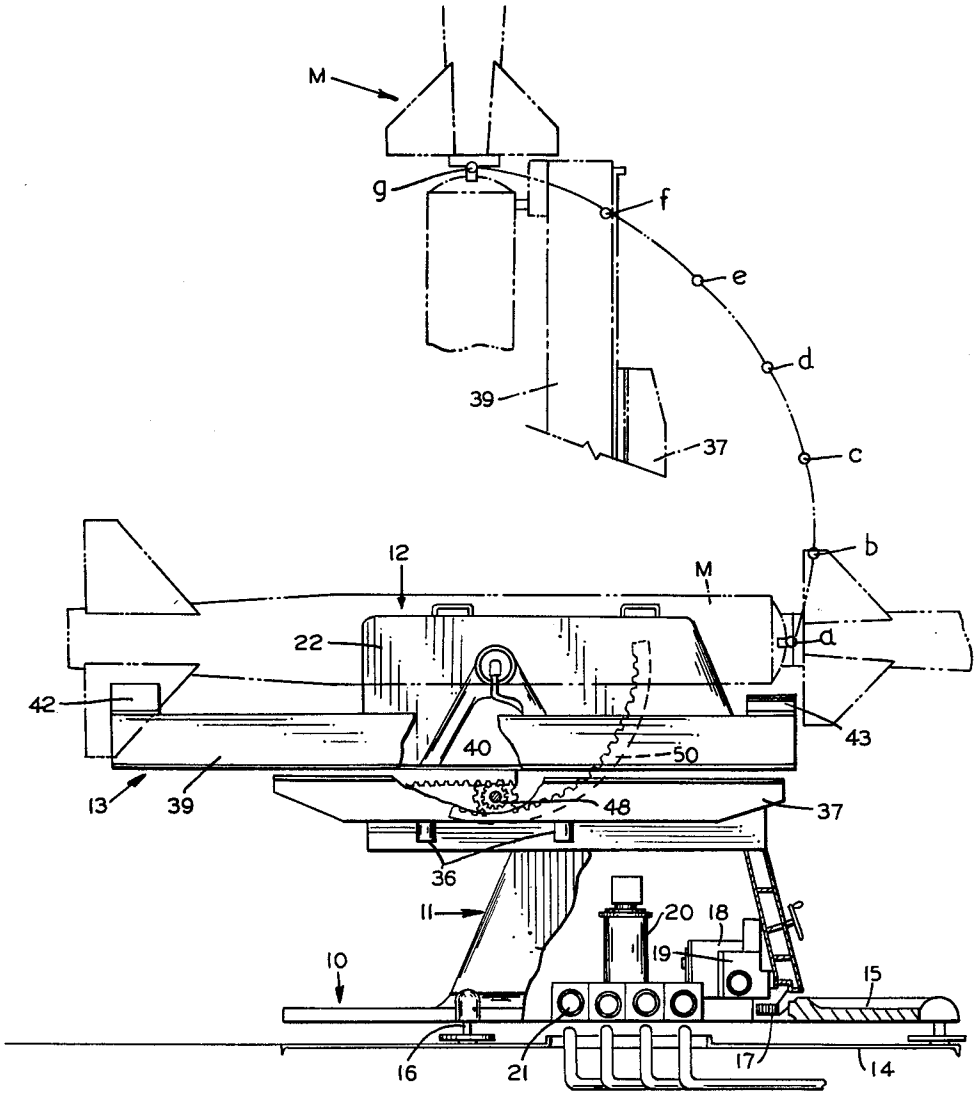


FIG. 1

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ERECTOR-LAUNCHING APPARATUS

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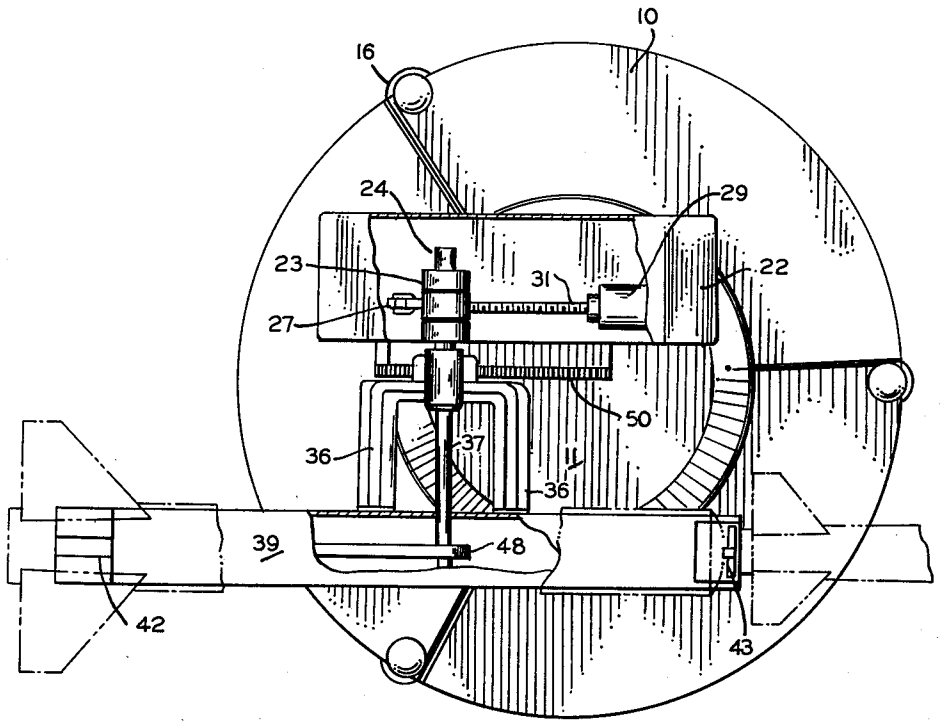


FIG. 2

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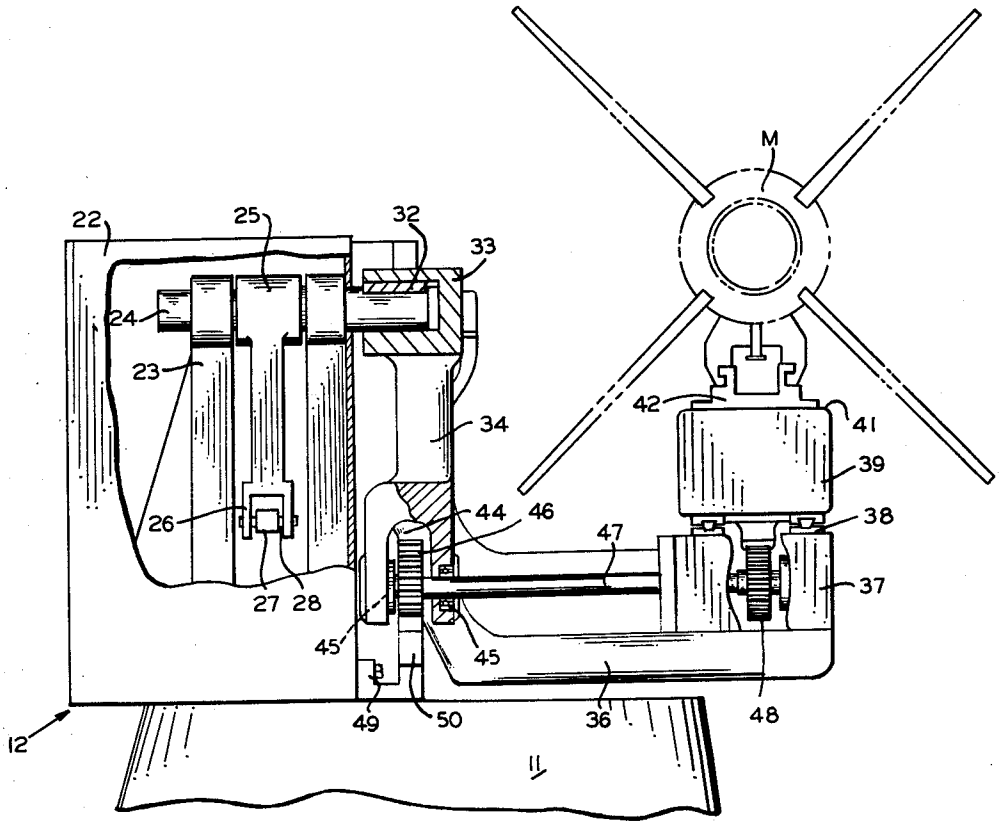


FIG. 3

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ERECTOR-LAUNCHING APPARATUS

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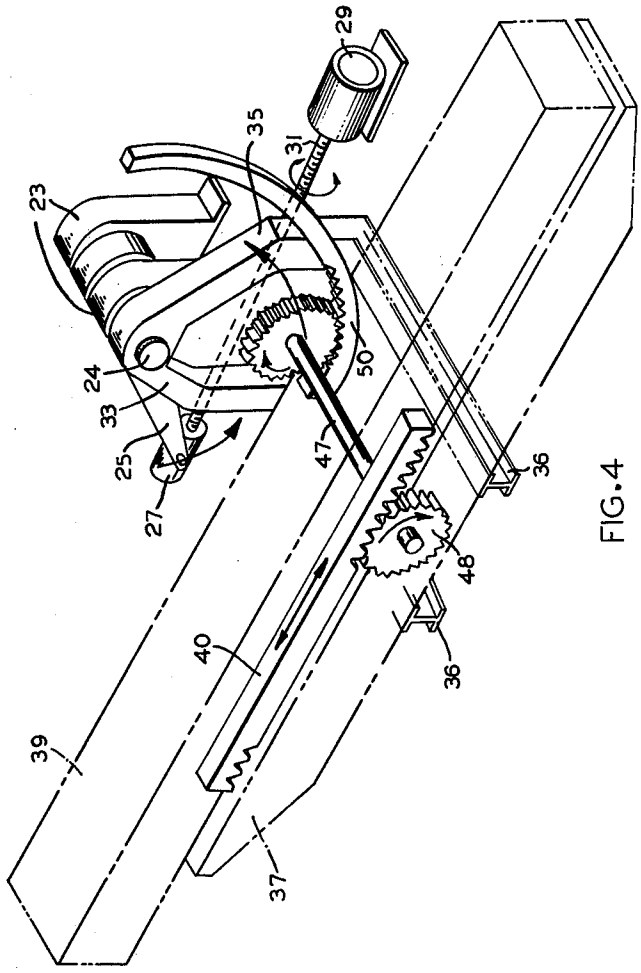


FIG. 4

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ERECTOR-LAUNCHING APPARATUS

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3 Claims. (Cl. 89—1.7)

This invention relates to erecting apparatus and more particularly to an erector-launcher for missiles.

One of the steps in launching a guided missile, under present practice, is to rotate it from stored position, which is normally horizontal, to its firing position, which is normally vertical. Because of the great length of the missile, it is not practical to arrange its axis of rotation at the center of gravity. The axis would have to be disposed too far above the ground in order to provide clearance for the trailing end. It has therefore been the practice to position the missile on the launcher so that its axis of rotation is between the center of gravity and its trailing end. The launching apparatus need not be of impractical height. But there then arises a problem of torque requirements. In order to elevate the missile from such a position, the torque requirements are great during the first part of its rotation and gradually diminish as the missile approaches erect position. Since the missile is of considerable weight, the power necessary to move it through the early stages of its elevational rotation requires large and heavy hydraulic equipment. The apparatus of the invention is designed to provide for uniform torque requirements throughout the rotation so that the conventional cumbersome hydraulic equipment may be replaced by electric power equipment of simple design.

The principal object of this invention, therefore, is to provide launching apparatus to rotate a missile from stored or horizontal position to vertical or firing position in which the torque requirements to effect such elevation remain substantially constant regardless of the angular position of the missile.

Another object is to provide such launching apparatus which stores a missile of relatively great length in a horizontal position close to the ground or base of the apparatus, such apparatus including novel means to elevate the missile to a vertical or firing position.

Another object is to provide launching apparatus which stores such a missile, the apparatus including novel elevating means in which the missile is moved axially forward during its elevation so that its trailing end clears the ground or the base of the apparatus when it is being rotated upwardly to firing position.

Still another object is to provide launching apparatus which stores such a missile, the apparatus including novel elevating means which rotates the missile from horizontal or stored position to vertical or firing position which simultaneously moves it axially forward so that its trailing end clears the ground or base of the apparatus during elevation.

A further object is to provide such apparatus including a stand having a segment gear, a rotatable carrier upon which is positioned a rail and rack assembly, a first gear engaging the rack, and a second gear operatively connected to the first gear by a shaft and engaging the segment gear so that when the carrier is rotated in reference to the stand, the segment gear causes rotation of the second gear, which in turn rotates the first gear, causing the rail and rack assembly to move axially in reference to the carrier.

Referring now to the drawings,

Fig. 1 is a side view of the apparatus of the invention showing in phantom a fragment of a missile in horizontal position and in vertical position with the arcuate course of rotational elevation described.

Fig. 2 is a top view of the apparatus illustrated in Fig. 1.

Fig. 3 is an end view, partially in section, of the carrier and rails of the apparatus of the invention.

Fig. 4 is a view, partially in phantom, illustrating the operation of the carrier of the apparatus of the invention.

Referring now to the drawings, the invention is shown embodied in a launcher having four basic unit packs demountable for transportation. These packs, generically indicated, are a base 10, a lower stand 11, an upper stand 12, and a rail assembly 13. The base has a double platform consisting of lower and upper elements 14 and 15 respectively, the lower element providing flotation for the entire assembly. Leveling jacks 16 are spaced 120° apart on the perimeter of the platform.

The lower stand 11 (Fig. 1) is a hollow structure roughly in the shape of a truncated cone. Contained within the stand is an azimuth race ring 17, transverse gearbox 18, motor 19, slip ring 20, slip ring junction box 21, and other equipment necessary to rotate the stand in relation to the base. Neither the base nor azimuth rotation apparatus forms part of the invention herein so no further detailed description is felt to be necessary.

The upper stand 12, which is supported by the lower stand, has a casing 22 oblong in cross section in which are disposed a pair of spaced upright bearings 23 for for the crankshaft 24. Shaft 24 carries a crank 25 the end of which has a clevis 26 to support a ball nut 27 by means of trunnions 28. A reversible servo motor 29 equipped with trunnions (not shown), is mounted in the casing to rotate screw 31 which extends into engagement with ball nut 27. The motor rotates the screw one way or the other, as the operator desires, to move the ball nut and hence to rotate the crank one way or the other through a predetermined arc. Shaft 24 of course is rotated correspondingly. Shaft 24 projects through the side wall of the upper stand casing 22 and rigidly mounted on its end and secured against rotation on the shaft by key 32 is the head 33 of carrier 34. Carrier 34 has a pair of diverging legs 35 extending downwardly from its head 33. A pair of arms 36 project horizontally from the ends of the legs. Rigidly secured to the arms and supported thereby is a hollow lower rail 37 on top of which is mounted a pair of parallel longitudinal ways 38. The bottom wall of the upper rail 39 is equipped with a pair of parallel slots shaped to engage the ways 38; and centrally of the ways 38 and secured to the bottom wall of the rail 39 is a rack 40. The upper rail is thus held in parallelism with the lower rail and is adapted to slide longitudinally along said rail. The upper rail has secured to the opposite ends of its top face 41 supporting blocks 42 and 43 for the reception of a guided missile assembly M.

Carrier 34 has a transmission unit including a gear box 44 and a pair of bearings 45 for the mounting of gear 46 and shaft 47. Shaft 47 extends horizontally between carrier legs 36 into the hollow lower rail 37 and has a second gear 48 upon its outer end within the lower rail. Gear 48 meshes with rack 40. Rigidly fixed to the side wall of the stationary upper stand 22 by conventional means such as bolts 49 and extending along the side of the stand parallel to the rails is a gear sector 50 which meshes with gear 46.

In operation, motor 29 is conventionally rotated in one

direction or the other, as desired, to turn screw **31** which moves ball nut **27** toward or away from motor depending upon the direction of motor rotation. Crank **25** is moved correspondingly to rotate crank shaft **24**. Carrier **34** is in turn rotated by the crankshaft to swing in an arcuate course along the side wall of the stationary upper stand **22**. Gear **46**, carried by carrier **34**, is in turn rotated because of its engagement with the stationary gear sector **50**. Gear **46** rotates shaft **47** to rotate gear **48** which, because of its engagement with rack **40**, moves the upper rail **39** forwardly or rearwardly in relation to the lower rail **37** depending upon the direction of rotation of gear **48**. Thus it can be seen that the missile is rotated from horizontal position toward vertical position, as carried by the rails, and it simultaneously is moved forwardly or axially in relation to the bottom rail. It is a matter of simple mechanical principles so to dimension the rails that the trailing end of the missile will be moved forwardly sufficiently to clear the ground or base of the apparatus as the arms swing the rails to upright position. The ultimate result of this arrangement is that the torque requirements remain substantially constant regardless of the angular position of the rail and missile assembly.

The arcuate course of movement of the missile is described by points *a*—*g* in Fig. 1. The torque requirements to rotate the missile from horizontal to vertical position remain substantially equal during rotation along this course. That is to say, the torque requirements to move the missile from point *a* to *b* is substantially equal to the requirement from *b* to *c*, *c* to *d*, etc.

While there has been hereinbefore described an approved embodiment of this invention, it will be understood that many and various changes and modifications in form, arrangement of parts, and details of construction thereof may be made without departing from the spirit of the invention, and that all such changes and modifications as fall within the scope of the appended claims are contemplated as a part of this invention.

What I claim is:

1. A missile launcher comprising a stand; a base for the stand; a rotatable shaft mounted in the stand; means to rotate the shaft; a missile carrier engaging said shaft and rotatable about the axis of the shaft, said carrier including a lower and upper rail, the upper rail being adapted to support a missile and being movable in reference to the lower rail to move the missile in relation to the lower rail; a rack on the upper rail; a stationary segment gear fixedly mounted on the stand; and a transmission unit mounted on the carrier and rotatable therewith about the axis of the shaft, said unit including a first gear engaging the segment gear, a second gear engaging the rail rack, and a shaft operatively connecting said gears, the arrangement of the parts being such that when the carrier is rotated about the axis of the shaft the transmission unit is actuated by the engagement of its first gear with the stationary segment gear to transmit motion through the second gear and rail rack to the upper rail thereby to move the upper rail and supported missile forwardly in relation to the bottom rail.

2. A missile launcher comprising a stand; a base for the stand; a missile carrier rotatably mounted on the stand, said carrier including two rails, one of which is adapted to support a missile and is movable in relation to the other to move such missile in relation to the other; a segmental gear fixedly mounted on the stand; a rack on the movable rail; a transmission unit mounted on the carrier to rotate therewith in relation to the stand, said unit having a first gear engaging the segmental gear and a second gear engaging the rack; and means to rotate the carrier in relation to the stand, the arrangement of the parts being such that as the carrier rotates, the first gear of the transmission unit engages the segmental gear to transmit motion through the second gear and rail rack to the upper rail thereby to move the upper rail and supported missile forwardly in relation to the bottom rail so that the trailing end of the missile will clear the base of the carrier as the carrier moves the missile from horizontal to vertical position.

3. An erector-launcher comprising a stand; a shaft mounted on the stand; a crank secured to the shaft; a motor operatively engaging the crank to rotate the shaft; a carrier secured to the shaft and rotatable therewith; a rack and rail assembly on the carrier, said assembly rotatable with and movable in reference to the carrier; a gear segment fixedly mounted on the stand; and a transmission unit on the carrier, said unit having a first gear engaging the gear segment, a second gear engaging the rack and a shaft operatively connecting said first and second gears, the arrangement of the parts being such that as the motor moves the crank to rotate the shaft and carrier, the first gear of the transmission unit engages the gear sector to transmit motion through the second gear and rack to the upper rail thereby moving the upper rail in relation to the carrier during rotation of the carrier to provide for substantially constant torque requirements for rotation of the carrier regardless of the angular position of the rail and to move the rail forwardly in relation to the carrier so that its trailing end will clear the base of the stand during such rotation.

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