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(54) **Title:** A MINIATURE, GUIDED MISSILE WITH CONTROL ACTUATION SYSTEM

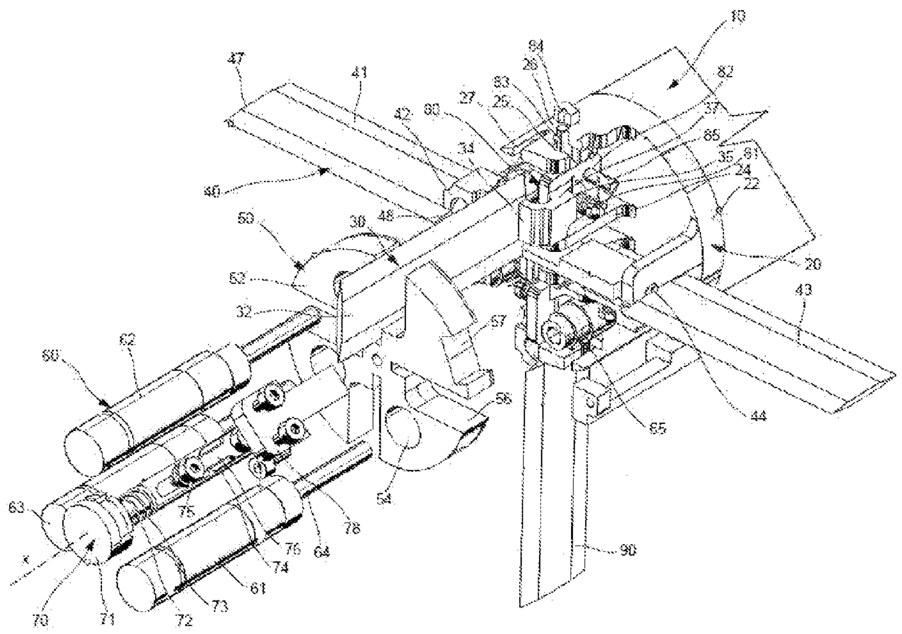

Figure – 1

(57) **Abstract:** The present invention relates to a control actuation assembly for a miniature, guided missile comprising a seat (20) having a support plate (22) that is transversally mounted to an inner chamber limited by a hollow, elongated main body (10); and at least one wing pair (40) having first and second aerodynamic control members (41, 43) that are adjacent to one another such that a distal end (47) thereof is seated into the inner chamber when it is in a folded position, and that are opposite to one another, that are supported by the seat (20) by means of respective pins (44) fixing them on an extension axis from a proximal end (46) thereof such that it extends outward from the main body (10) when in a deployment position. Control actuation system comprises a threaded rod member (65) that is arranged in close proximity of the wing pair (40) and that converts the shaft (64) linear motion of motor (60), which comprises a shaft (64) that extends towards the wing pair (40) inside the inner chamber, to rotational motion on the shaft (64) axis; and a pendulum

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arm (82) that is adapted on the wing pair (40) such that it rotates on the pin (44) axis on one hand and that it is seated therein so as to rotate a protrusion (66) of the threaded rod member (65), which extends outwards radially on the other hand.

A MINIATURE, GUIDED MISSILE WITH CONTROL ACTUATION SYSTEM

TECHNICAL FIELD OF THE INVENTION

The present invention relates to guided missiles with control actuation system, particularly, to miniature missiles.

STATE OF THE ART

The control method implemented by creating aerodynamic forces by means of the motions of control surfaces is one of the most commonly known flight control methods. Aerodynamic forces created by means of control surfaces are utilized in almost all types of aircraft. Various control actuation systems are used for moving these control surfaces.

There are different solution methods that may be used in the design of control actuation system mechanism. These solution methods include crank-connecting rod mechanism, slider-crank mechanism, and scotch-yoke mechanism.

The publication numbered US8921749 discloses a perpendicular drive mechanism for a missile control actuation system that utilizes an electric motor and power shaft operatively coupled to a spur gear. A lead screw is coupled to a second spur gear. The lead screw is oriented parallel to the motor and perpendicular to a central longitudinal axis. The first and second spur gears meshingly engage such that the second spur gear rotates in the opposite direction as the first spur gear. A lead nut threadingly engages with and is configured to move linearly along the central axis of the lead screw. A crank arm is coupled on one end to the lead nut and on the other end to the canard shaft of a canard assembly. As the lead nut moves linearly along the central axis of the lead screw, the crank arm follows the lead nut and causes the canard assembly to actuate.

BRIEF DESCRIPTION OF THE INVENTION

The object of the present invention is to provide a guided, miniature missile system that comprises a compact and operationally reliable control actuation mechanism.

To achieve the object mentioned above, the present invention comprises a control actuation assembly for a miniature, guided missile comprising; a seat having a support plate that is transversally mounted to an inner chamber limited by a hollow, elongated main body; at least one pair of wings having first and second aerodynamic control members that are adjacent to one another such that a distal end thereof is seated into the inner chamber when it is in a folded position, and that are opposite to one another, that are supported by the seat by means of respective pins fixing them on an extension axis from a proximal end thereof such that it extends outward from the main body when in a deployment position. Control actuation assembly further comprises a threaded rod member that is arranged in close proximity of the wing pair and that converts the shaft linear motion of motor, which comprises a shaft that extends towards the wing pair inside the inner chamber, to rotational motion on the shaft axis; and a pendulum arm that is adapted on the wing pair such that it rotates on the pin axis on one hand and that it is seated therein so as to rotate a protrusion of the threaded rod member, which extends outwards radially on the other hand. In a possible embodiment, a guide section is provided wherein said guide section rotates the pendulum arm while the protrusion moves linearly on the pendulum arm. Preferably, the motor is fixed inside the inner chamber. Thus, the necessary rotational motion is provided for the respective first and/or control member over the pendulum arm, i.e. the wing body, by means of a short stroke of the shaft that serves as an actuator.

A preferred embodiment of the present invention comprises a bridging piece that is mounted on the opposite ends of the first and the second control member such that said bridging piece extends therebetween in order to ensure that they rotate together. Said bridging piece connects aerodynamic first and second control members and ensures that they move together once it is driven by the movement of the pendulum arm following the deployment position of the wing pair.

In a preferred embodiment of the present invention, the motor and the shaft extend coaxially such that they are parallel to a central axis. In that case, it is ensured that the shaft efficiently transfers torque to the pendulum arm, while a compact structure is maintained within the inner chamber.

In a preferred embodiment of the present invention, the first and the second control members extend adjacent to and parallel with the shaft in the folded position. Thus, the first and the second control member and the shaft occupy the least amount of space within the inner chamber such that they can extend in the gaps therebetween.

A preferred embodiment of the present invention comprises an integrated sleeve that extends inwards from the outer periphery of the support plate and on which the pin is seated. The sleeve, preferably, has a structure that extends perpendicularly from the outer periphery to inwards. Having the pin seated on the sleeve allows for rotatably mounting the first and the second control member on the sleeve without a seating piece.

In a preferred embodiment of the present invention, the threaded rod member comprises a slot that is created on the corresponding position of the sleeve and in which the protrusion thereof is seated. Said slot not only creates a guide that limits the linear motion for the protrusion but also allows the protrusion to transfer the weight of the threaded rod to the sleeve. In this way, the threaded rod member can be directly mounted on the sleeve without a seating assembly.

A preferred embodiment of the present invention comprises a slit that extends from outside to inside and in which the corresponding first and the second control member are seated on the sleeve in a deployment position.

A preferred embodiment of the present invention comprises a connection adapter that extends integratedly and perpendicularly such that it is spaced from the outer periphery of the support plate and on which the corresponding first and second control members are jointed foldably from the proximal end thereof such that they can rotate around a rotation axis perpendicular to a central axis.

BRIEF DESCRIPTION OF THE FIGURES

FIGURE 1 illustrates a perspective view of a representational embodiment of the inventive control actuation system for a guided missile system.

FIGURE 2 illustrates a front view of a folded state of the control actuation system shown in Figure 1.

FIGURE 3 illustrates the close-up view of the wing pair on the seat.

DETAILED DESCRIPTION OF THE INVENTION

In the detailed description provided herein, the inventive innovation is described only to provide a better understanding of the subject matter by examples and references and without constituting any limiting effect.

Figure 1 illustrates a perspective view of a representational embodiment of the control actuation system of a miniature missile. A control actuation system and various functional units are located on a main body (10), which serves as a hollow, cylindrical, elongated outer shell for the miniature missile. The control actuation system is mounted on a seat (20) that comprises a support plate (22) in the shape of a circular metal plate that extends such that it transverses in the inner volume of the main body (10). A sleeve (26) is formed by perpendicularly extending the support plate's (22) outer periphery inwards. Four keys (24) extend on the support plate (22) such that they are perpendicular to one another. Each key (24) is arranged such that it is perpendicular to an axis on which a corresponding wing (30, 40, 90) is located.

There are four wings (30, 40, 90) in the embodiment illustrated in the respective figure. Two of said wings form a wing pair (40) in which wings are interdependent, and the other two wings (30, 90) form wing pairs that are independent, foldable and rotatable. In different embodiments, the number of wings and wing pair structures may be arranged differently. For example, six, five, three, or two wings may be preferred. Wing pairs (40) may be configured such that each wing are completely dependent on or independent from one another.

The wing (30) located on top and the wing (90) located at the bottom are symmetrically identical to one another on a central axis (x) that is the extension axis of the main body (10). The wing (30) has a flat, long and solid form, and an aerodynamic control surface (32) is created on the outer section thereof. After the missile is launched, aerodynamic forces are created by moving the control surface (32), thereby making sure that the missile follows the desired path. A retaining piece (34) is located at the lower end of the wing (30). The retaining piece (34) has a U-shaped section and forms a connection adapter (37, 42) by proceeding straight afterwards. The connection adapter (37) is positioned on the pendulum arm (82), which stands on the key (24) and is a flat plate having an L-shape, from the top edge thereof. A portion of the flat top extension of the pendulum arm (82) is inserted into the gap that is located between the lower edge of the wing (30) and the retaining piece (34). A planar stopping edge (35) is located between the retaining piece (34) and the connection adapter (37). When it is in a folded position, said stopping edge (35) extends distanced to and in parallel with a stopping member (85) in the form of a pin that stands on the upper planar extension of the pendulum arm (82). When it is in a deployment position, the wing (30) is dislocated outwardly and rotates by 90°. In that case, the stopping edge (35) abuts the stopping member (85) and supports the weight oppositely in the direction of rotation.

The wing pair (40) extends perpendicular to the wing (30). The wing pair (40) is structurally identical to the wing pair formed by the wing (30) and the lower wing (90). The wing pair (40) is positioned such that it is perpendicular to the wing (30) by 90°. In the wing pair (40), the first wing, i.e., the first control member (41), and the second wing, i.e., the second control member (43), are attached to one another from a proximal end (46) thereof by means of bridging (86) piece. The bridging piece (86) is in the form of a flat and stepped sheet bar. It connects the first and the second control member (41, 43), which extend on the same axis, as a wing pair (40) by extending from one end to another within the inner chamber. The wing pair (40) is illustrated in the deployment position in Figure 1. In this case, the first and the second control member (41, 43) which extend from the distal ends thereof (47) in opposite directions to one another, extend perpendicularly to the seat (20). The bridging piece (86) is connected to the first and the second control member (41, 43) by means of a pin (44) positioned therebetween. The pin (44) is positioned inside a hole made in close proximity of the end of the sleeve (26) and is rotatably seated therein. An end of the pin (44) is fixed to one of the corresponding first or second control member (41, 43), while the other end thereof is fixed to the bridging piece (86) from the corresponding part. A cylindrical threaded rod member (65) located below the bridging piece (86) is mounted on the seat (20) such that it is axially rotatable. Said threaded rod member (65) comprises a protrusion (66) in the form of a nut that radially faces outwards. The protrusion (66) engages the pendulum arm (82) from a fork end thereof. The pendulum arm (82) is fixed to the bridging piece (86) from the upper end thereof. Threaded rod member (65) and the pendulum arm (82) form a Scotch-Yoke mechanism. Thus, the threaded rod member (65), when rotated, the protrusion (66) transfers the rotational motion to the fork section and rotates the pendulum arm (82) together with the bridging piece (86) attached therewith on the pin (44) axis.

A shaft (64) that is connected to an electric motor (60) providing stroke from an end thereof engages to the threaded rod member (65) from a free end thereof in order to provide the rotational motion. The motor (60) is connected to the main body (10) by means of a retaining body (50). The retaining body (50) is a thick, circular plate. A hole (54) having an appropriate diameter is created so as to accommodate the corresponding motor (60) that extends cylindrically over the retaining body (50). Said hole (54), from one end to the other, is in the form of a circular bore. The motor (60) comprises a wing pair motor (62) that is connected to a wing pair (40), and respectively, a first independent wing motor (61) and a second independent wing motor (63) provided such that they transfer motion to a wing (30) and a lower wing (90) that are capable of rotating independently. Said motors (60) are identical and adapted to the retaining body (50) such that they are positioned inside respective holes (54) that correspond to a central axis (x) in parallel. In return, four recesses (56) are created on the retaining body (50) such that they are perpendicular to one another, thereby limiting four support sections (52). Said recesses (56) extend such that they are in close proximity of the radial center. Each recess (56) is formed suitable to the wing (30) section so as to ensure that a wing (30, 41, 43, 90) corresponding to an inside portion thereof in a folded position is seated therein. A channel (57) is created on the outer periphery of the retaining body (50), and a seating plate (78) is engaged thereto.

Moreover, a small hole is created in the retaining body's (50) middle section, which runs through the central axis (x), and a rod (72) of the wing deployment assembly

(70) is inserted therethrough. In the middle of the motors (60), a wing deployment assembly (70) is cylindrically positioned in the extension direction of the central axis (x). Said wing deployment assembly (70) comprises a cap (71) in the form of a plug, and a pressure spring (73) wrapped around a rod (72) that extends from the center thereof. Said rod (72) runs through the retaining body (50) and induces a triggering action, and the wings (30, 40, 90) are deployed by being rotated by means of a spring pin (81) through which they are maintained in a pretensioned state as well as by means of the compression spring (73). Spring pin (81) is provided on the pendulum arm (82) that corresponds to each wing (30, 40, 90). A thermoplastic piece (76) hinders the movement of the rod (72). To that end, said rod (72) is inserted into a pipe on which a gap is created and the thermoplastic piece (76) that blocks the rod (72) is attached by means of a connection member (75). As shown in Figure 2, a current wire (74) extends from the seating plate (78) to the thermoplastic piece (76). When a current is provided to the current wire (74) over an electrical connection (not shown), said current wire heats up, thereby melting the thermoplastic piece (76) such that it breaks off. In this case, the rod (72) proceeds on the central axis (x) by means of the pretension of the pressure spring (73) as it is released, thereby providing the necessary triggering action in order to move the wings (30, 40, 90) into the deployment position. Transition of the wings (30, 40, 90) from the folded position illustrated for the wing (30) in Figure 2 and Figure 1 to the deployment position exemplarily illustrated for the wing pair (40) and the lower wing (90) is performed by means of the spring pins (81) provided on each one of them. The connection adapter (37) of the wing (30) is rotatably supported on the spring pin (81) that is fixed on the upper planar section of the pendulum arm (82). Once the rotational motion is complete, the stopping edge (35) of the wing (30) abuts the stopping member (85), thereby moving into the deployment position. In the meantime, the wing (30) gets seated into a suitable slit (27) that goes inwards from the outer edge on the sleeve (26). Subsequently, the motor (60) is driven by means of an electrical signal received from a flight controller (not shown) and the control actuation system is controlled by rotating the corresponding wing (30) on a spring ping (81) by means of the pendulum arm (82). A retaining pin (83) radially extends outwards from the side wall of the pendulum arm (82). The retaining pin (83) runs through a pin hole (25) that extends inwards from the outer edge of the sleeve (26) and is positioned such that it extends outwards radially. Said retaining pin (83)

allows for attaching the sleeve (26) to the body (10) through a corresponding hole or a support section (not shown). Positioning a cover (84) on the retaining pin (83) prevents the pin from coming out of the pin hole (26) in the axial direction and allows for protecting the retaining pin (83) from external factors.

Figure 3 illustrates a close-up view of an actuation assembly (80) for a wing pair (40). As it can be seen in the respective Figure, radial protrusion (66) of the threaded rod member (65) is inserted into a guide seat (87) of the pendulum arm (82) such that it not only transfers the rotational motion but also moves forward. Limiting of the stroke is ensured by means of the distance of a slot (28). The protrusion (66) may move in forward and backward directions inside the slot (28) with the operation of the motor (60). When the torque of the motor (60) is converted to linear motion by means of the threaded rod member (65), the outer shell of the threaded rod member (65) allows the protrusion (66) to move inside the slot (28) by means of axial feed. Meanwhile, the protrusion (66) rotates the pendulum arm (82) that is connected to the first control member (41) by means of the pin (44) from the guide seat (87) having a form of a fork. The bridging piece (86) transfers the rotational motion from the corresponding pendulum arm (82) to the second control member (43) in a synchronized manner over the opposite pin (44). Thus, the wing pair (40) is rotated in proportion to the torque from a single point through the rotation of the wing pair motor (62).

REFERENCE NUMERALS

10 Main Body

20 Seat

22 Support Plate

24 Key

26 Sleeve

25 Pin Hole

27 Slit

62 Wing Pair Motor

63 Second Independent Wing Motor

64 Shaft

65 Threaded Rod Member

66 Protrusion

70 Wing Deployment Assembly

71 Cap

28 Slot

30 Wing

32 Control Surface

34 Retaining Piece

35 Stopping Edge

37 Connection Adapter

40 Wing Pair

41 First Control Member

42 Connection Adapter

43 Second Control Member

44 Pin

46 Proximal End

47 Distal End

50 Retaining Body

52 Support Section

54 Hole

56 Recess

57 Channel

60 Motor

61 First Independent Wing Motor

72 Rod

73 Pressure Spring

74 Current Wire

75 Connection Member

76 Thermoplastic Piece

78 Seating Plate

80 Actuation Assembly

81 Spring Pin

82 Pendulum Arm

83 Wing Pin

84 Cover

85 Stopping Member

86 Bridging Piece

87 Guide Seat

90 Lower Wing

x Central Axis

CLAIMS

1- A control actuation assembly for a miniature, guided missile comprising a seat (20) having a support plate (22) that is transversally mounted to an inner chamber limited by a hollow, elongated main body (10); and at least one wing pair (40) having first and second aerodynamic control members (41, 43) that are adjacent to one another such that a distal end (47) thereof is seated into the inner chamber when it is in a folded position, and that are opposite to one another, that are supported by the seat (20) by means of respective pins (44) fixing them on an extension axis from a proximal end (46) thereof such that it extends outward from the main body (10) when in a deployment position, characterized in that, it comprises; a threaded rod member (65) that is arranged in close proximity of the wing pair (40) and that converts the shaft (64) linear motion of motor (60), which comprises a shaft (64) that extends towards the wing pair (40) inside the inner chamber, to rotational motion on the shaft (64) axis; and a pendulum arm (82) that is adapted on the wing pair (40) such that it rotates on the pin (44) axis on one hand and that it is seated therein so as to rotate a protrusion (66) of the threaded rod member (65), which extends outwards radially on the other hand.

2- A control actuation assembly according to Claim 1, characterized in that, it comprises; a bridging piece (86) that is mounted on the opposite ends of the first and the second control members (41, 43) such that said bridging piece extends therebetween in order to ensure that they rotate together.

3- A control actuation assembly according to any one of the preceding claims, characterized in that, motor (60) and shaft (64) extend coaxially in parallel with central axis (x).

4- A control actuation assembly according to Claim 3, characterized in that, first and second control members (41) are adjacent to and extend parallel with shaft (64) when in a folded position.

5- A control actuation assembly according to any one of the preceding claims, characterized in that, it comprises; an integrated sleeve (26) that extends inwards from the outer periphery of the support plate (22) and on which pin (44) is seated.

6- A control actuation assembly according to Claim 5, characterized in that, it comprises; a slot (28) that is created on the corresponding portion of the sleeve (26) and in which the protrusion (66) of the threaded rod member (65) is seated.

7- A control actuation assembly according to Claims 5-6, characterized in that, it comprises a slit (27) that extends from outside to inside such that the corresponding first and the second control member (43) is seated on the sleeve (26) when in a deployment position.

8- A control actuation assembly according to any one of the preceding Claims, characterized in that; it comprises a connection adapter (42) that extends integratedly and perpendicularly such that it is spaced from the outer periphery of the support plate (22) and on which the corresponding first and second control members (41, 43) are jointed foldably from the proximal end (46) thereof such that they can rotate around a rotation axis perpendicular to central axis (x).

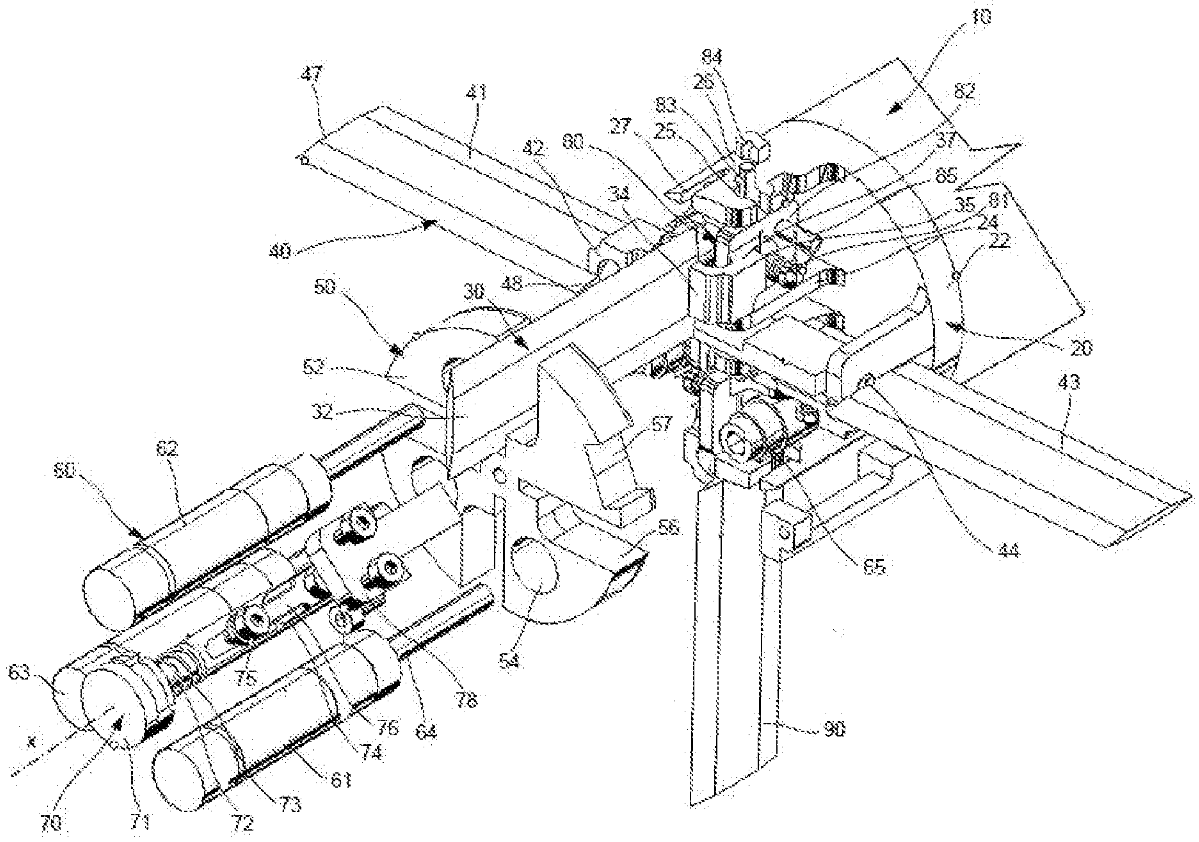

Figure – 1

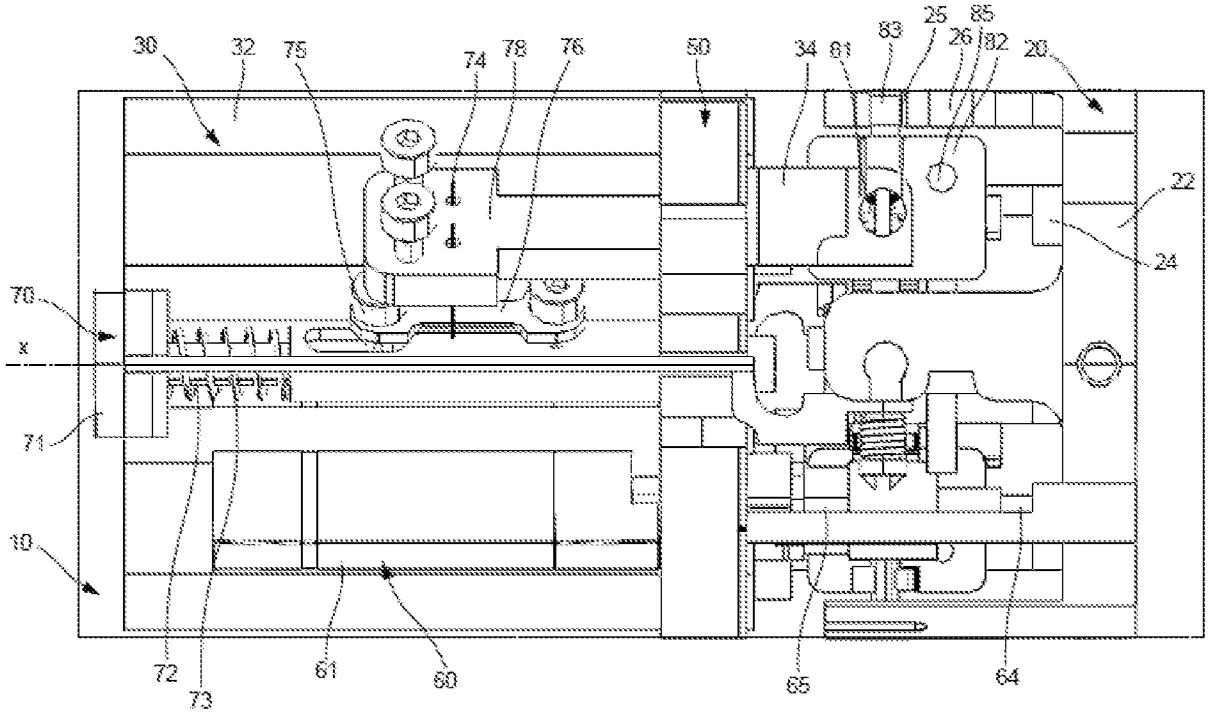

Figure – 2

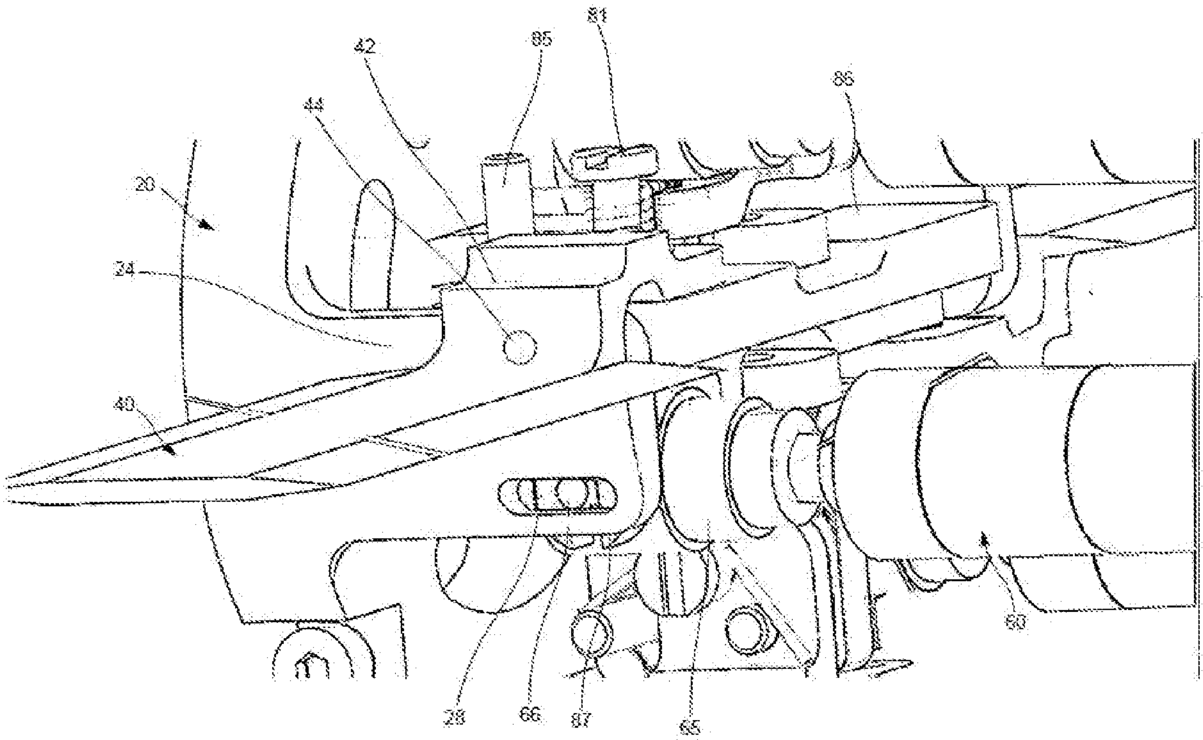

Figure – 3