United States Patent

[11] 3,556,442

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[21] Appl. No. **833,591**
[22] Filed **June 16, 1969**
[45] Patented **Jan. 19, 1971**

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[32] Priority **June 19, 1968**
[33] **Sweden**
[31] **No. 8331/68**

[54] **SAFETYING DEVICE FOR FIRING MECHANISM FOR AIRCRAFT EJECTION SEATS**
11 Claims, 15 Drawing Figs.

[52] **U.S. Cl.** **244/122**
[51] **Int. Cl.** **B64d 25/10**
[50] **Field of Search** ..... 244/122, 122.11, .12, .13, .14, .15, .17, .18

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ABSTRACT: Ejection seat propulsion mechanism has a firing pin normally held cocked by a latching member that has one lost motion connection with an "eject" handle element, another with an element actuated by jettisoning of a canopy over the seat. Motion of either element alone does not move the latching member but renders the connection operative for firing pin release by subsequent or simultaneous motion of the other element. Canopy jettisoning can be effected by the handle, which actuates a switch, or by a separate canopy jettison knob. Actuation of an auxiliary handle, moved from an inaccessible to an accessible position by actuation of the "eject" handle, gives a second motion to the handle element for ejection through the canopy.

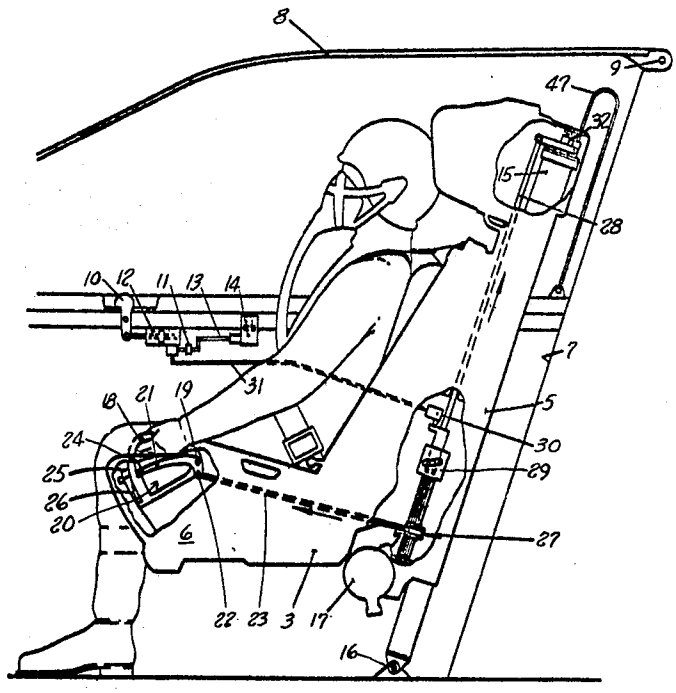

FIG. 1

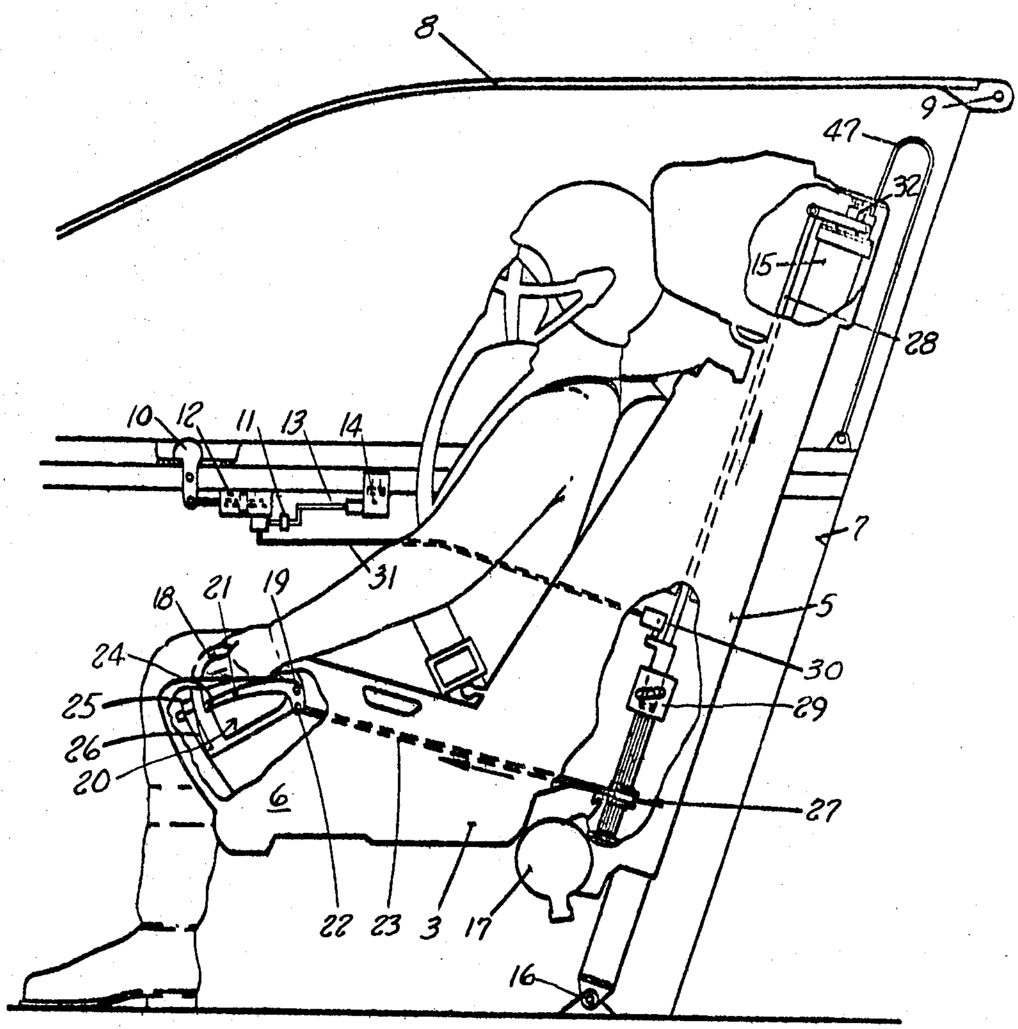

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FIG. 2

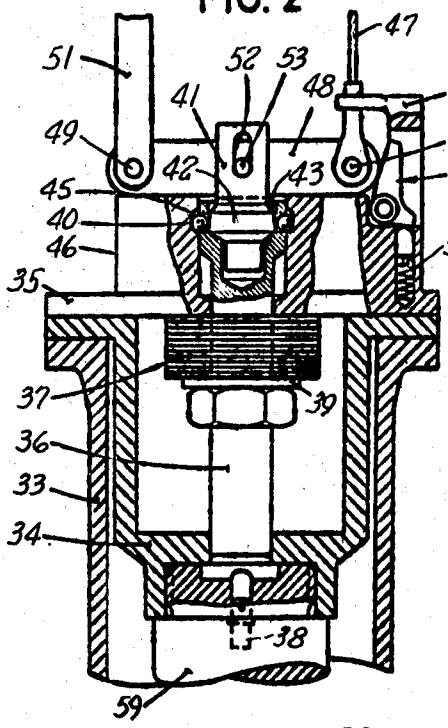

FIG. 3

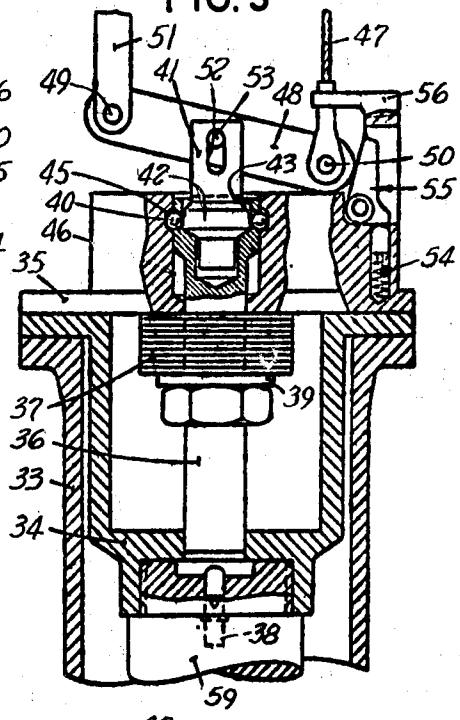

FIG. 4

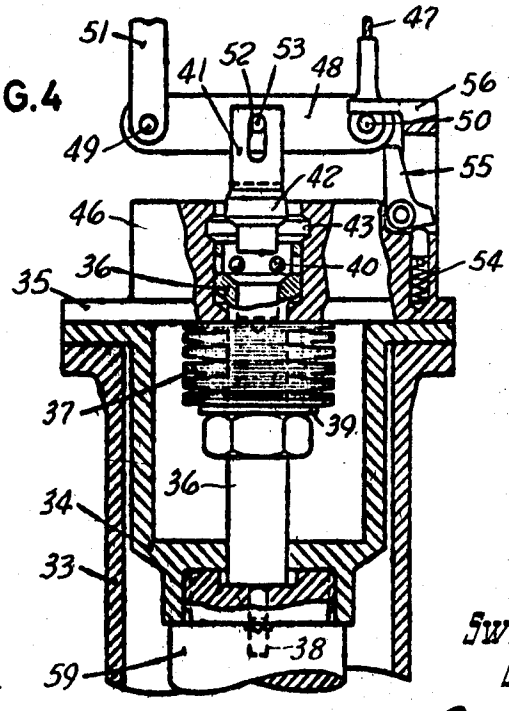

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FIG. 6

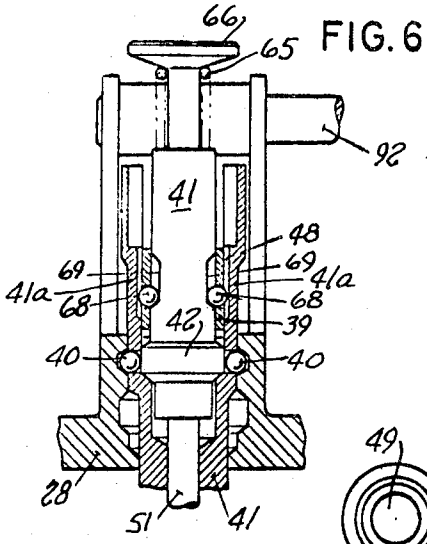

FIG. 5

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FIG. 7

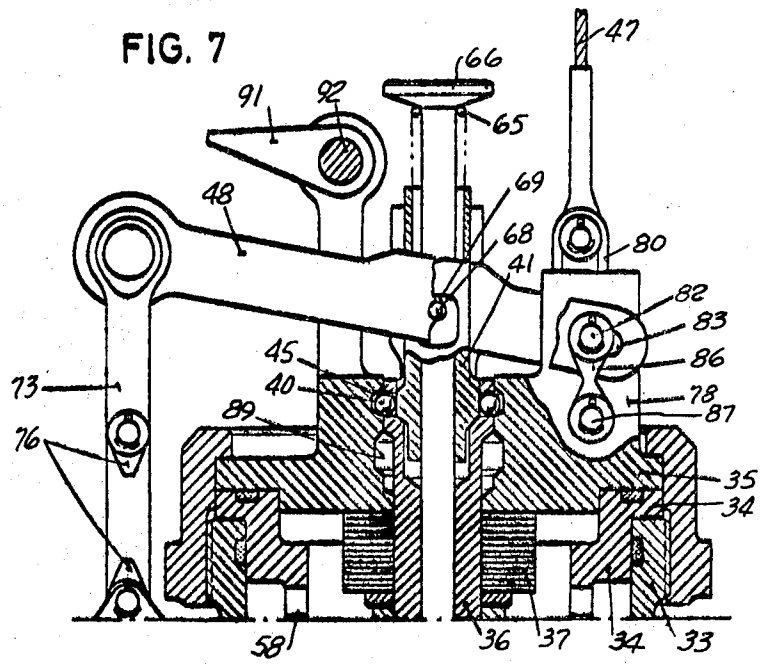

FIG. 8

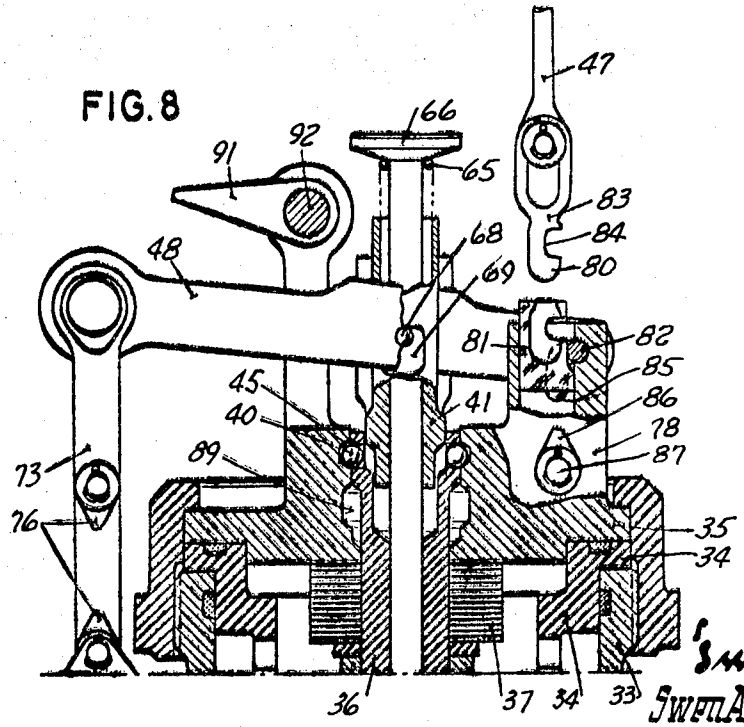

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FIG. 9

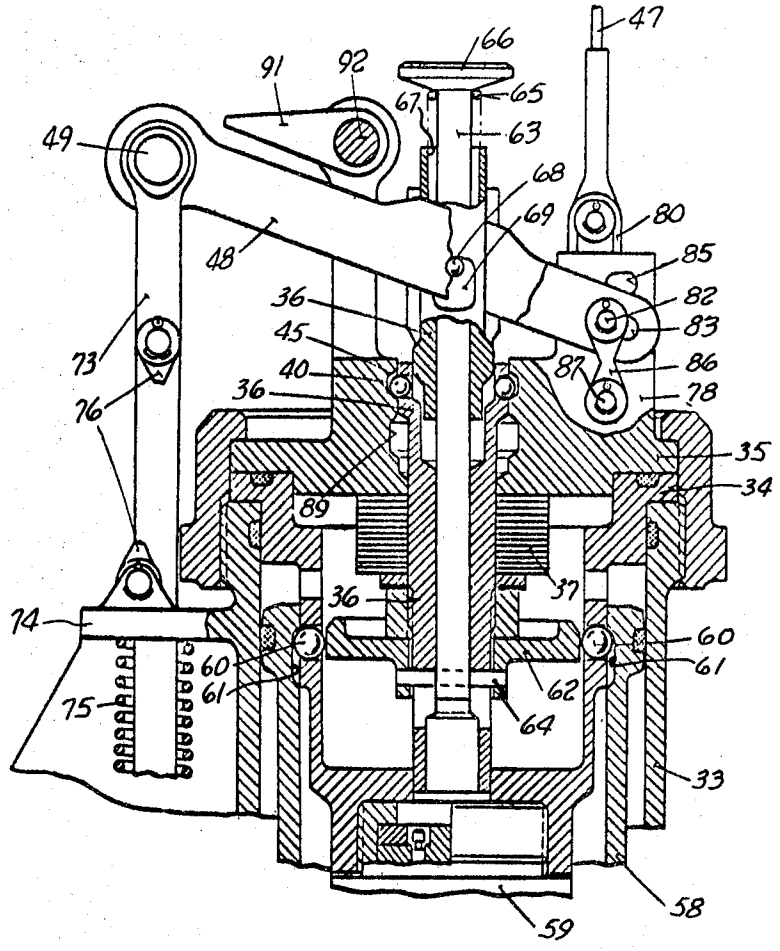

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FIG. 10

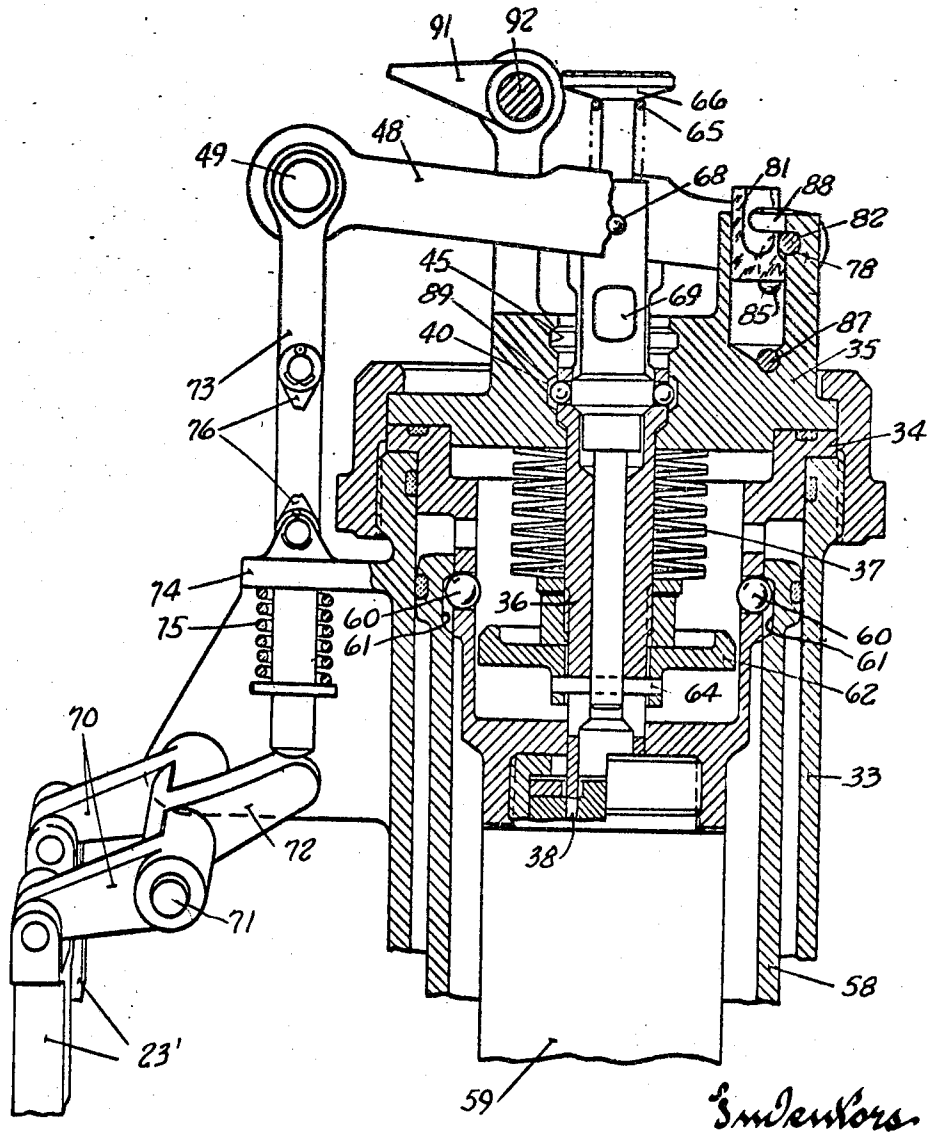

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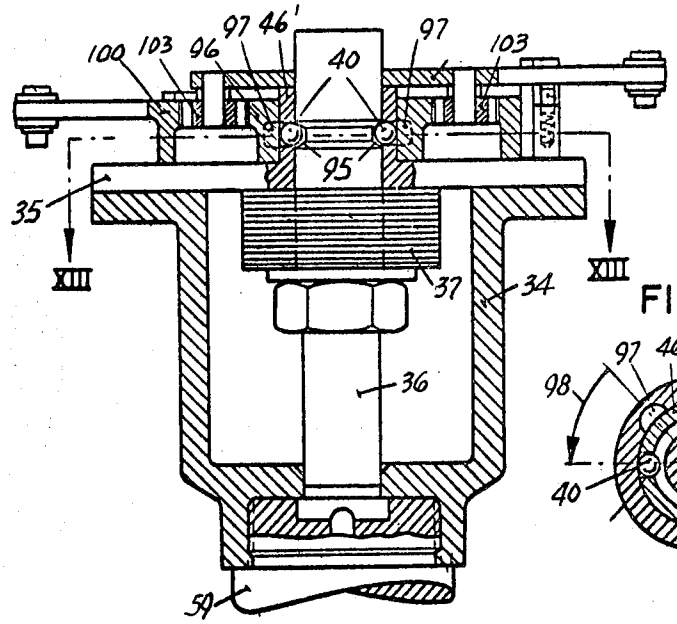
FIG. 11



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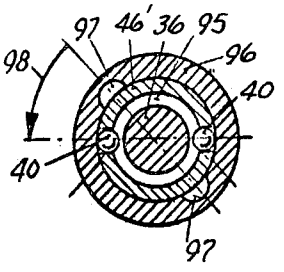

FIG. 12

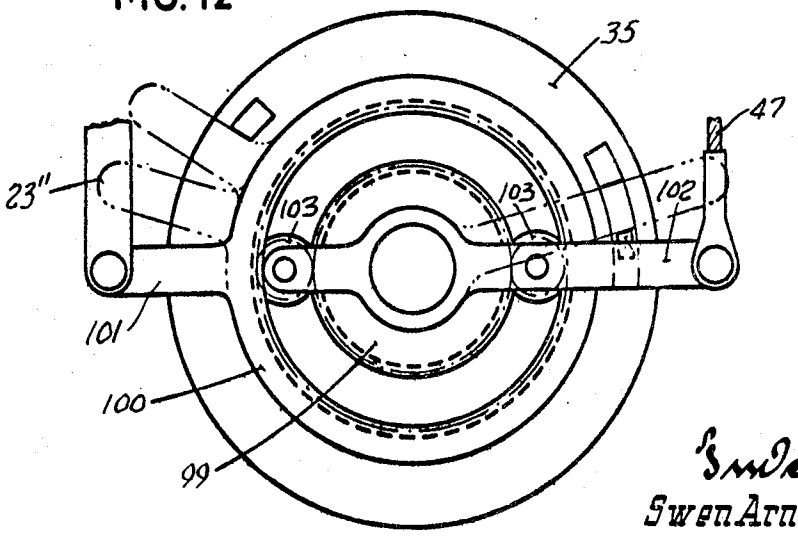

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FIG. 14

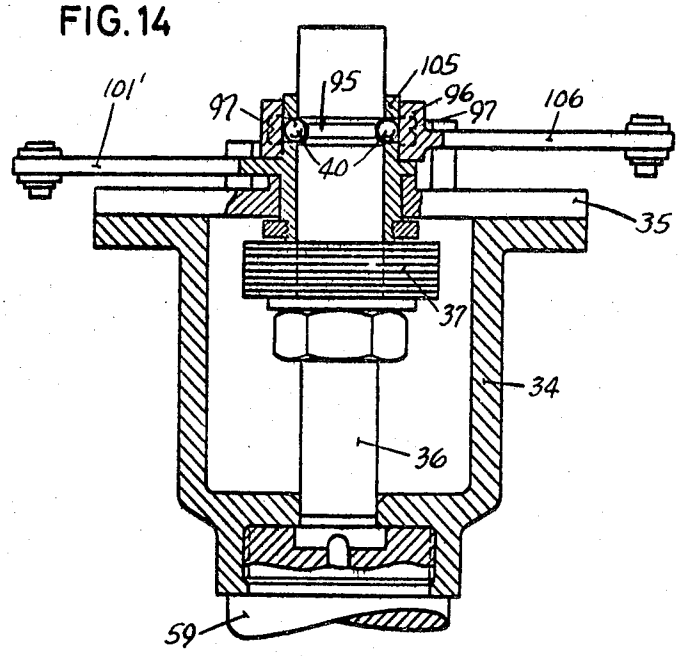
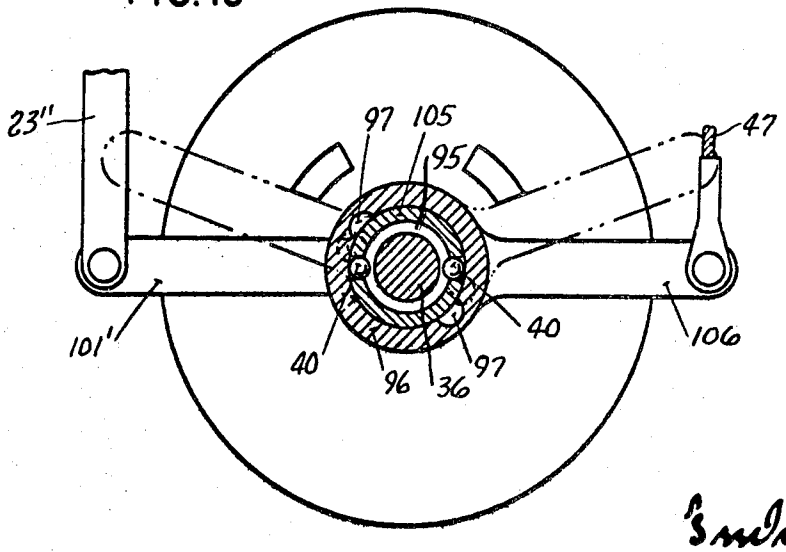


FIG. 15



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SAFETYING DEVICE FOR FIRING MECHANISM FOR AIRCRAFT EJECTION SEATS

This invention relates to ejection seats for emergency escape from disabled aircraft, and it more particularly concerns means for securing an ejection seat against unintentional ejection, and, specifically, for precluding operation of the seat propulsion mechanism until two components associated with the aircraft and seat have undergone motions which are prerequisites to safe seat ejection.

Many high performance military aircraft are now equipped with ejection seats whereby a crew member desiring to abandon the aircraft in an emergency can be accelerated out of it and carried well clear of it. For such ejection the seat is equipped with propulsion means comprising a telescoping tube catapult gun, or a rocket motor, or a combination of these; and the seat is also provided with a parachute that is deployed when the seat and its occupant have arrived at a safe distance from the aircraft.

Usually an ejection seat mechanism includes a member, such as a firing pin, which is movable under bias to initiate seat ejecting propulsion but which is normally held in a cocked position by means of a safetying device that is released by the seat occupant's actuation of a manual control. As a precaution against ejection under unfavorable conditions, it has also been conventional heretofore to provide a connection between the safetying device and a canopy or hatch that normally closes the occupant's cockpit, so that the canopy must be fully opened or jettisoned before the safetying device is disabled to release the biased member and initiate seat ejecting propulsion. With such prior ejection seats, opening or jettisoning of the hatch or canopy was a prerequisite to ejection, and therefore if the canopy remained in place for any reason, the seat would not eject.

By contrast, it is an object of the present invention to provide an ejection seat safetying device of the character described that provides for deliberate ejection through the canopy in the event the canopy cannot be jettisoned, the canopy then being smashed by a portion of the ejection seat that projects above the occupant's head.

Another object of this invention is to provide ejection seat apparatus which is arranged to effect both canopy jettisoning and the initiation of seat ejecting propulsion in response to the actuation of a primary manual control, and whereby propulsion is not initiated until jettisoning of the canopy has been effected, but whereby ejection through the canopy (if it fails to jettison) can be initiated by actuation of an auxiliary manual control which is adjacent to the primary one and which is inaccessible until the primary manual control has been actuated.

In this connection, it is also an object of this invention to provide ejection seat apparatus of the character described whereby the canopy can be jettisoned by actuation of a separate manual control, independent of said primary and auxiliary manual controls, so that the seat occupant can jettison the canopy without initiating seat ejection.

It will now be apparent that it is a general object of this invention to provide ejection seat mechanism which affords several choices to the seat occupant, in that he can: jettison the canopy by the use of an independent control prior to initiating ejection, or without ejecting at all; or cause the canopy to be jettisoned automatically in an ejection sequence that is initiated by the mere actuation of a manual ejection control member; or, if the canopy should fail to jettison, deliberately eject through the canopy by actuating an auxiliary manual control that is not accessible until the ejection control member has been actuated.

It is a further and very important object of this invention to provide a safety device for the firing pin of an ejection seat propulsion mechanism whereby the firing pin is restrained in its cocked position until the prerequisites for safe ejection have been established, which safety device has a lesser number of components than prior devices of the same type, so as to be lower in first cost, less susceptible to malfunctions, and easier to maintain.

With these observations and objects in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and the accompanying drawings. This disclosure is intended merely to exemplify the invention. The invention is not limited to the particular structure disclosed, and changes can be made therein which lie within the scope of the appended claims without departing from the invention.

The drawings illustrate several complete examples of physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is a view in side elevation of an aircraft ejection seat embodying the principles of this invention;

FIG. 2 is a fragmentary vertical sectional view of the upper portion of an ejection seat gun catapult equipped with a safetying device embodying the principles of this invention, shown in its normal condition;

FIG. 3 is a view similar to FIG. 2 but showing the safetying device in its condition after actuation of the manual ejection control but before jettisoning of the canopy;

FIG. 4 is a view similar to FIG. 2 but showing the safetying device in its fully released or unlocked condition, after canopy jettisoning;

FIG. 5 is a vertical sectional view generally similar to FIG. 2 but illustrating a modified version of the embodiment of the invention shown in that FIG;

FIG. 6 is a fragmentary sectional view taken on the plane of the line VI–VI in FIG. 5;

FIG. 7 is a vertical sectional view of a portion of the mechanism illustrated in FIG. 5, shown in its condition after actuation of the manual ejection control but before canopy jettisoning;

FIG. 8 is a view generally similar to FIG. 7 but illustrating the mechanism in its released condition with a normally jettisoned canopy, and at the instant before the firing pin moves down;

FIG. 9 is a view generally similar to FIG. 5 but showing the mechanism in its released condition under circumstances for ejection through an unjettisoned canopy;

FIG. 10 is a view generally similar to FIG. 8 but more particularly illustrating how the firing pin is locked in its firing position after ejection propulsion is initiated;

FIG. 11 is a fragmentary vertical sectional view of a modified safetying device embodying the principles of this invention, shown in its normal condition;

FIG. 12 is a top view of the device shown in FIG. 11;

FIG. 13 is a sectional view taken on the plane of the line XIII–XIII in FIG. 11;

FIG. 14 is a fragmentary vertical sectional view of another modified embodiment of the invention; and

FIG. 15 is a view partially in plan and partially in horizontal section of the embodiment shown in FIG. 14.

Referring now to the accompanying drawings, the numeral 5 designates generally the frame of an aircraft ejection seat, upon which a seat pan 6 is supported for adjusting up and down motion. In an emergency, the frame, with the seat pan, is intended to be propelled out of an aircraft cabin in which the seat is housed, moving upward during ejection, substantially parallel to the rear wall 7 of the cabin, under the guidance of guide means (not shown) with which the frame cooperates.

The upper portion of the aircraft cabin in which the ejection seat is housed comprises a hatch or canopy 8 which is illustrated as connected to the aircraft structure by means of a hinge 9 at its rear that permits the canopy to be swung about a horizontal axis for normal opening and closing. When closed, the canopy is normally held against swinging open by means of latching devices 10 on the aircraft structure that engage lower edge portions of the canopy. On the ground the latching devices can be released by means of a normal actuating handle (not shown). In an emergency the canopy can be jettisoned without effecting seat ejection by actuation of a jettison knob 11 which detonates a powder charge in a release mechanism

12 to disengage the latching devices 10 from the canopy. The release mechanism has an electric connection 13 with canopy ejector means 14, comprising plunger means actuated by a powder charge which is detonated upon disengagement of the latching devices from the canopy.

It will be observed that the seat structure extends a substantial distance above the head of the seat occupant to serve as a ram for smashing through the canopy in the event it cannot be jettisoned and the occupant elects to eject through it, as described hereinafter.

To provide for ejecting propulsion of the seat out of the aircraft, there is a catapult gun 15 of known type, comprising a pair of normally telescoped tubes that provide a cylinder and a piston, one of said tubes being connected to the floor of the aircraft, as at 16, and the other being connected with the seat frame. Upon ejection, a charge of combustible material that is housed in the gun is detonated to produce high pressure gas which reacts between the tubes, forcing them apart and thus accelerating the seat and its occupant out of the cabin. As shown, there is also attached to the seat frame, beneath the seat pan 6, a rocket motor 17 that is ignited during a final portion of the separating motion of the tubes, to provide a second stage of propulsion for the seat.

For initiating seat ejection, the airman manually actuates an ejection control member or "eject" handle 18 which is normally in a partially retracted but accessible position in a side portion of the seat. Preferably the control member 18 is duplicated at opposite sides of the seat, to be accessible to either hand.

The manual ejection control member 18 swings upwardly and rearwardly about a fixed pivot 19 on the seat frame. Associated with each "eject" handle, swingable about its pivot 19, is a bell crank 20 comprising a forwardly projecting leg 21 that provides an auxiliary control handle and a downwardly projecting leg that terminates in a pivotal connection 22 with a rearwardly extending pull rod 23.

When the manual ejection control member 18 is in its normal partially retracted position, the auxiliary control member 21 is inaccessibly housed in the seat frame. However, there is an upwardly facing abutment 24 on the ejection control member 18 that is normally engaged by a front end portion of the auxiliary control member 21, and as the "eject" handle 18 is drawn up from its normal position to a defined ejection position, it draws the auxiliary control member 21 up with it, moving the auxiliary control member to an accessible position. Simultaneously, through such actuation of the auxiliary control member, the manual ejection control member 18 imparts a first forward motion to the pull rod 23. The ejection control member 18 can have its ejection position defined by the engagement of an abutment on it with a suitable abutment 25 on the seat frame, and a spring catch element 26 can be arranged to prevent it from being moved back down out of the ejection position.

The auxiliary control member 21 is intended to be actuated only in the event the canopy fails to jettison after the control member 18 has been actuated and the airman chooses to eject through the canopy. As the auxiliary control member is moved upwardly relative to the primary "eject" handle 18, it imparts a further forward motion to the pull rod 23.

At its rear end the pull rod 23 has a pivotal connection to an arm 27 that is splined to an actuating shaft 28 which extends upwardly along the seat frame substantially parallel to the catapult gun. The splined connection between the arm 27 and the actuating shaft 28 provides for relative up and down motion between them to accommodate heightwise adjustment of the seat, and also serves to translate forward motion of the pull rod 23 into rotation of the shaft 28. Fixed to the seat frame is a cam member 29 that cooperates with a pin through the actuating shaft 28 to provide a sort of screw connection between the seat frame and the actuating shaft by which the latter is caused to move lengthwise downwardly as it rotates.

Movement of the actuating shaft 28 carries an abutment on it into actuating engagement with a fixedly mounted switch 30 that has an electrical connection, indicated by 31, with the canopy release mechanism 12. Thus the airman need not actuate the manual canopy jettison knob 11 prior to actuating the ejection control member 18, but instead can merely actuate the "eject" handle 18 to cause jettisoning of the canopy to occur as an incident to an automatic release sequence that also sets the propulsion mechanism into operation as explained hereinafter.

A firing mechanism, which is generally designated by 32, is located at the top of the gun catapult. It serves to initiate operation of the propulsion mechanism when the "eject" handle 18 has been actuated and either the canopy has been jettisoned or, if it failed to jettison, the auxiliary control member 21 has been actuated for ejection through the canopy.

In the embodiment of the invention illustrated in FIGS. 2—4, the catapult gun tube 33 that is attached to the seat frame has fixed to its upper end a cup-shaped member 34 and a cover 35. The cup-shaped member carries at its bottom a detonator 38 and a combustible propulsion charge 59. Together the members 34 and 35 define a housing for a firing pin 36 which is urged downwardly toward the detonator 38 by an expansion spring 37 that surrounds the firing pin and reacts between the underside of the cover 35 and an upwardly facing shoulder 39 on the firing pin.

The firing pin is releasably retained in its normal cocked position, in which it is spaced above the detonator 38 and the spring 37 is under compression, by latching means comprising a plurality of balls 40 and a movable latching member 41 having an enlarged diameter frustoconical medial portion 42 that is normally engaged with the balls. At its top the firing pin has a coaxial well or cavity 43 in which the latching member 41 is axially slidable, and the wall portion of the firing pin that defines this cavity has holes therethrough in which the balls 40 are received. Portions of the balls normally project radially inwardly of said wall portion and are engaged with the frustoconical medial portion 42 of the latching member, and other portions of them project radially outwardly of said wall portion to be normally received in a radially inwardly opening circumferential groove 45 in the inner surface of an annular boss 46 that projects upwardly on the cover portion 35 of the firing pin housing. The annular boss 46 embraces the upper portion of the firing pin with a close sliding fit to guide the firing pin in its axial downward motion.

The latching member 41 has a motion transmitting connection with the "eject" handle 18, as through a pull rod 51 having a lever connection with the actuating shaft 28, and also has a motion transmitting connection with the canopy, and specifically with a cable 47 that is attached to the canopy to be tensioned by jettisoning motion of the canopy off of the aircraft. These motion transmitting connections comprise a link beam or double-fulcrumed lever 48, one end of which has a pivoted connection 49 with the pull rod 51 and the other end of which has a pivotal connection 50 with the cable 47. The upper end of the latching member 41 is bifurcated, and the link beam 48 extends through the upwardly opening groove defined by its bifurcations. The bifurcations of the latching member have opposite axially elongated slots 52 in which are received a pin 53 that extends transversely through the medial portion of the link beam.

The pin 53 so cooperates with the slots 52 as to provide a lost motion connection, on the one hand between the latching member 41 and the pull rod 51, and on the other hand between the latching member and the cable 47, which connection is incapable of transmitting to the latching member individual motion of either of those components alone, but is rendered operative by motion of either of them so that subsequent movement of the other (or simultaneous motion of both) moves the latching member upwardly out of engagement with the balls 40.

Thus if the "eject" handle 18 is actuated without prior actuation of the canopy jettison knob 11, the pull rod 51 swings the left end of the link beam 48 upwardly about the pivotal connection 50 with the cable 47, and the pin 53 rises to the

top of the slots **52** in the latching member without imparting motion to the latter (see FIG. 3). Then, upon jettisoning of the canopy, tensioning of the cable **47** raises the right hand end of the link beam (see FIG. 4), swinging it about the connection **49** with the pull rod **51** and, through the pin **53**, lifting the latching member **41** to carry its frustoconical medial portion **42** out of engagement with the balls **40**, thus freeing the firing pin **36** to move downwardly under the bias of the spring **37**.

It will be evident that if the cable **47** were actuated by canopy jettisoning before actuation of the "eject" handle **18**, the right-hand end of the link beam **48** would first swing up about the connection **49** with the pull rod **51** without imparting motion to the latching member **41**, and the latching member would be moved to its releasing position by subsequent actuation of the "eject" handle. It will also be evident that the releasing condition illustrated in FIG. **4** could be achieved by simultaneous actuation of the pull rod **51** and the cable **47**.

The cable **47** can have a frangible connection with the canopy whereby the canopy can be separated completely from the aircraft and carried away by the slipstream. To prevent the right-hand end of the link beam from dropping back down after the canopy has been jettisoned by means of the canopy jettison knob **11** and prior to actuation of the "eject" handle **18**, a catch **55**, in the form of a bell crank, is mounted on the exterior of the firing pin housing. It has a normally horizontal leg against which a spring **54** reacts and a normally upright leg that yieldingly bears against the right-hand end of the link beam to engage beneath the link beam when it is raised. If canopy jettisoning occurs after actuation of the "eject" handle **18**, the catch **55**, in engaging under the link beam, prevents the latching member **41** from dropping back down to its normal position before the balls **40** have had enough time to drop out of their pockets and fully release the firing pin.

The upper limit of motion of the right-hand end of the link beam is defined by a downwardly facing fixed abutment **56** on the firing pin housing that is engaged by the pin **50** that comprises the pivotal connection between the cable **47** and the link beam. Therefore if only the cable **47** is actuated, the right-hand end of the link beam will not be raised high enough to impart motion to the latching member **41**.

If for any reason the canopy should not jettison after the "eject" handle **18** has been actuated, the mechanism will be in the condition shown in FIG. **3**. The seat occupant can then actuate the auxiliary manual control member **21** to impart a further motion to the pull rod **51**. This will raise the left-hand end of the link beam beyond the point where it moves relative to the latching member **41** and it will pull up the latching member to its releasing position.

FIGS. **5—10** illustrate a more fully detailed and refined version of the embodiment of the invention just described, wherein the catapult gun **15** comprises an outer tube **33** that is attached to the seat and an inner tube **58** that is closed at its lower end to comprise a piston and is attached to the floor of the cabin. Fixed to the upper end of the outer tube **33** is the coaxial cup-shaped portion **34** of the firing pin housing which extends downwardly into the upper end portion of the inner gun tube **58** and supports at its bottom a combustible charge **59** and, above the charge, a detonator **38**.

In this case the gun tubes are releasably locked in telescoping relation by balls **60** that are normally seated in holes in the wall of the cup-shaped housing member **34** and engaged in a circumferential inwardly opening groove **61** in the inner gun tube **58**, being held in such locking relationship by an annular latching element **62** which is guided on the firing pin **36** for downward motion relative thereto.

In this case the firing pin **36** has a coaxial bore through which extends a manually actuatable plunger **63** by which the balls **60** can be manually released to permit separation of the gun tubes for maintenance without detonation of the combustible charge **59**. The plunger **63** has a transverse pin **64** through it, near its bottom end, that projects through axially elongated slots in the firing pin and has its opposite ends anchored in the annular latching element **62**, to constrain the latter to move up and down with the plunger. The plunger is biased upwardly to a normal position by means of an expansion spring **65** encircling its exposed upper end portion and reacting between an enlarged head **66** on its top and the the bottom of an upwardly opening well **67** in the top of the latching member **41**. With the plunger in its normal position, its transverse pin **64** is engaged with the upper ends of the slots in the firing pin to maintain the annular latching element **62** in locking engagement with the balls **60**.

For disassembly of the gun tubes, the plunger **63** is pushed down against the bias of its spring **65** to carry the annular latching element **62** down out of engagement with the balls **60**, freeing them to drop to the bottom of the cup-shaped housing member **34** and thus release the gun tubes for manual separation. Because the transverse pin **64** on the plunger rides in the slots in the firing pin, such downward actuation of the plunger does not impart motion to the firing pin.

However, when the firing pin is released for seat ejection, it carries the annular latching element **62** down with it, disengaging said latching element from the balls **60** and freeing the tubes for separation.

In this case, as best seen in FIG. **6**, the link beam **48** has its right-hand portion bifurcated, and the latching member **41** that engages the balls **40** which lock the firing pin **36** projects upwardly between its bifurcations. The upper end portion of the firing pin is also bifurcated, and the link beam is received between the bifurcations **41***a* of the firing pin. The lost motion connection between the latching member **41** and the link beam comprises a ball **68** seated in a closely fitting hole in each of the bifurcations of the link beam and received in an axially elongated pocket **69** in the latching member **41**, each ball being retained by its adjacent bifurcation **41***a* of the firing pin, in which there is a vertically milled track for the ball.

The connection between the link beam **48** and the bell crank **20** of the manual actuators **18** and **21** comprises a pair of pull rods **23'**, one for each "eject" handle, each having a pivotal connection with one of a pair of twin lever arms **70** that are fulcrumed on a fixed shaft **71**. On the same shaft **71** is pivoted a lever arm **72** that bears upwardly against the bottom of a plunger **73** that has at its upper end a pivotal connection **49** with one end of the link beam.

The lever comprising the twin arms **70**, the shaft **71** and the arm **72** is so arranged that downward motion of either pull rod **23'** will actuate the lever arm **72** and raise the plunger **73** without actuating the other pull rod **23'**, thus insuring that the unactuated "eject" handle will remain in its normal partially retracted position.

The plunger **73** is guided for up and down axial motion in a bracket **74** that is fixed to the gun tube **33** and projects to one side of the firing mechanism, and it is biased downwardly, to keep it engaged with the lever arm **72**, by means of a compression spring **75** that encircles the plunger and reacts between the bottom of the bracket and an upwardly facing shoulder on the plunger.

To prevent inadvertent actuation of the release mechanism a frangible link **76** is connected between the bracket **75** and the plunger **73**, breakable by the airman's exertion of a predetermined actuating force upon the "eject" handle **18**.

The bifurcated end of the link beam **48** straddles a fixed receptacle portion **78** that projects upwardly from the cover member **35** of the firing pin housing. A terminal member **80** anchored on the canopy cable **47** is received in an upwardly opening well in the receptacle portion, where it is embraced by a sleeve **81** of plastic or the like. The connection between the terminal member **80** and the link beam **48** comprises a cotter **82** that has its end portions received in opposite holes **83** in the link beam bifurcations, which holes are somewhat elongated lengthwise of the link beam. The cotter is also normally seated in a laterally opening slot **84** in the cable terminal **80** (best seen in FIG. **8**), and it extends through opposite inverted L-shaped slots in the receptacle **78**.

As the cable is tensioned, it must first break frangible links 86 before it can raise the link beam. One of the frangible links 86 is located at each side of the link beam, connected between the cotter 82 and a fixed pin 87 on the receptacle portion.

As the terminal member 80 rises upon tensioning of the cable 47, it draws up with it the cotter 82 and hence the right-hand end of the link beam 48, but after it has moved up a distance equal to the relative travel between the link beam and the latching member 41 that is permitted by the axially elongated pockets 49 in the latching member, the pin is cammed into the laterally extending upper portion of the inverted L-shaped slots 85 in the receptacle, and hence out of the slot 84 in the terminal member, thus freeing the cable for continued motion independent of the gun mechanism.

As the terminal member moves up, it draws the sleeve 81 up with it by friction, but after the cotter 82 has been disengaged from the terminal member the sleeve engages against an abutment 88 on the receptacle portion that terminates upward motion of the sleeve and confines it in a position in which it prevents the cotter from backing out of the laterally extending upper portion of the L-shaped slot 85. In this manner the right-hand end of the link beam is held against dropping back down, after the cable is disengaged from the cotter.

In general the operation of the embodiment of the invention illustrated in FIGS. 5—10 is the same as that of the FIGS. 2—4 version, and can be traced through FIG. 5, which shows the apparatus in its normal condition, FIG. 7 which shows conditions immediately after the "eject" handle 18 has been actuated but before jettisoning of the canopy, FIGS. 8 and 10 which show the firing pin released after actuation of the "eject" handle and immediately subsequent canopy jettisoning, and FIG. 9 which shows conditions after the auxiliary control handle 21 has been actuated upon failure of the canopy to jettison. Note the substantial elevation of the left-hand end of the link beam in FIG. 9.

In FIG. 10, which shows conditions immediately after the firing pin 36 has been released, note that downward movement of the firing pin has carried down the annular latching element 62 to release the balls 60 for ejecting separation of the gun tubes. As the firing pin moves downward, it disengages itself from the balls 68 that connect the link beam 48 with the latching member 41, inasmuch as the milled grooves in the bifurcations 41*a* of the firing pin open to the tops thereof, and the balls 68 are thus released from the pockets 49 in the latching member 41, freeing the latching member to move downwardly after the firing pin under the bias of the spring 65 that reacts between the latching member and the plunger 63. When the latching member 41 thus follows the firing pin downwardly, it reengages the firing pin locking balls 40 in a lower circumferential groove 89 in the inner surface of the fixed annular boss 46. This locks the firing pin in its lower position, as illustrated in FIG. 10, so that pressure gases in the gun tubes cannot force the firing pin or the annular latching element 62 back up towards their normal positions at which they might interfere with separation of the tubes.

As a further safety feature, a latch arm 91 is swingably mounted on a strut 92 that is fixed to the cover member 35 of the firing pin housing. The latch arm is located above the end of the link beam that is connected with the plunger 73. In its inoperative horizontal position, in which it is shown, the latch arm 91 is well clear of the link beam 48 and can not interfere with its motion. When the seat is unoccupied, however, the latch arm is swung down to a vertical position, engaging the top of the link beam to prevent upward motion of it. The latch arm can be actuated by means of a suitable handle or the like (not shown) on the seat.

In the embodiment of the invention illustrated in FIGS. 11—13, the locking balls 40 which engage the firing pin 36 are normally seated in holes in the wall of a fixed annular boss 46' that can comprise a part of the cover portion 35 of the firing pin housing. The boss 46' guides the firing pin in its downward motion, and the balls 40 engage in a circumferential groove 95 in the firing pin, being normally confined in such engagement by an annular ball retainer 96 that surrounds the boss 46' and is rotatable relative to it. The ball retainer has inwardly opening pockets 97 which are normally displaced circumferentially from the balls but which can be brought into register with them, to release them from engagement with the firing pin, by rotation of the ball retainer relative to the boss through a predetermined angle designated by the arrow 98 in FIG. 13.

The outer circumference of the annular ball retainer has radially outwardly projecting teeth, to comprise a sun gear 99. A ring gear 100 is mounted for rotation coaxially with the sun gear, and has on it a radially projecting arm 101 that is connected with the "eject" handle 18, as by means of a pull rod 23''. The canopy cable 47 is connected to the radially outer end of an arm 102 that swings about the axis of the firing pin and carries planet gears 103 which mesh with the ring gear and the sun gear.

Referring to FIGS. 12 and 13, it will be apparent that actuation of the "eject" handle 18 will rotate the ring gear 100 clockwise through a predetermined angle, and, through the planet gears 102, such rotation of the ring gear will impart a counterclockwise rotation to the sun gear 99, bringing the pockets 97 in the ball retainer partway around toward register with the balls. Subsequent (or simultaneous) actuation of the canopy cable 47, to effect counterclockwise swinging of the arm 102 that carries the planet gears, will drive the ball retainer 96 through the remaining angular displacement needed to bring it to its ball releasing position. Again, if the canopy does not jettison after the "eject" handle has been actuated, the auxiliary control member 21 can be actuated to impart a further clockwise rotation to the ring gear 100 such as to bring the ball retaining ring all the way to its ball releasing position.

In the embodiment of the invention illustrated in FIGS. 14 and 15, there is an annular ball carrier 105 coaxially rotatably surrounding the firing pin 36 and having holes in its wall in which balls 40 are seated. The balls are normally confined in engagement with a circumferential groove 95 in the firing pin 36 by means of a coaxial annular ball retainer 96 which rotatably embraces the ball carrier 105 and which has radially inwardly opening ball receiving pockets 97 that are normally in circumferentially spaced relation to the balls. The ball carrier 105 is rotatable in the cover member 35 of the firing pin housing and the ball retainer 96 is journaled on the ball carrier.

An arm 101' projects radially from the ball carrier 105 and has a pivotal connection with a pull rod 23'' or the like that is connected with the "eject" handle 18, so that actuation of the "eject" handle imparts clockwise rotation to the ball carrier. The ball retaining ring 96 has a radially projecting arm 106 that is connected at its outer end with the canopy cable 47 whereby jettisoning of the canopy effects counterclockwise rotation of the ball retaining ring.

It will be apparent that actuation of the "eject" handle 18 moves the ball carrier 105 partway to its ball releasing position relative to the ball retaining ring, and that subsequent (or simultaneous) actuation of the cable 47 moves the ball retaining ring relative to the ball carrier through the remainder of the relative travel necessary to bring the balls 40 and the pockets 97 into ball releasing radial alignment. It will also be apparent that if the canopy fails to jettison, actuation of the auxiliary control member 21 will impart a further rotation to the ball carrier 105 that will bring it to its ball releasing position relative to the ball retaining ring.

From the foregoing description taken with the accompanying drawings it will be apparent that this invention provides a simple and dependable safetying device for the firing mechanism of an aircraft ejection seat whereby ejection is normally prevented until a canopy over the ejection seat has been jettisoned, but whereby the seat occupant can elect to eject through the canopy, in the event it fails to jettison, by actuation of a normally inaccessible auxiliary control, and whereby the seat occupant is also given the choice of jettisoning the canopy by actuation of a separate manual control, with or without subsequent ejection.

We claim:

1. In an ejection seat for an aircraft in which there is a component member that does not render seat ejection impossible by remaining in a normal position, but is preferably moved out of its normal position prior to ejection, said ejection seat having a propulsion mechanism, a biased part associated with the propulsion mechanism that is urged towards a propulsion initiating position, and a control member that must be manually actuated for ejection:

A. latching means movable relative to the biased part from a normal locking position in which the latching means holds the biased part cocked, to a releasing position in which the biased part is free to move to its propulsion initiating position;

B. means providing a motion transmitting connection between each of said members and the latching means, arranged to permit either of said members alone to move without bringing the latching means to its releasing position, but to effect motion of the latching means to its releasing position in consequence of movement of both of said members;

C. an auxiliary control movable successively from a normal inaccessible position, to an accessible position, and to an actuated position;

D. means providing a motion transmitting connection between the control member and the auxiliary control whereby actuation of the control member for ejection moves the auxiliary control from its normal inaccessible position to its accessible position; and

E. means providing a motion transmitting connection between the auxiliary control and the latching means, associated with the first mentioned motion transmitting connection and rendered operative by actuation of the control member for ejection, whereby motion of the auxiliary control from its accessible position to its actuated position moves the latching means from its locking position to its releasing position.

2. In an ejection seat for an aircraft in which there is a component member that does not render seat ejection impossible by remaining in a normal position but is preferably moved out of its normal position prior to ejection, said ejection seat having a propulsion mechanism, a firing pin associated with the propulsion mechanism that is biased towards a detonator and is normally held in a cocked position, spaced from the detonator, and a control member that must be manually actuated for initiating ejection:

A. latching means for normally holding the firing pin in its cocked position comprising:

1. a ball, and

2. a ball retainer cooperable with another part to normally hold the ball in latching engagement with the firing pin, said ball retainer being movable to a releasing position at which the ball is freed and the firing pin can move under its bias toward the detonator;

B. means providing a motion transmitting connection between each of said members and the ball retainer, arranged to permit either of said members alone to move without bringing the ball retainer to its releasing position but to effect motion of the ball retainer to its releasing position in consequence of movement of both of said members, the last named means comprising:

1. a pair of elements, one for each of said members, each having a connection with its member, and each movable in the opposite direction form the other, and

2. means providing a connection between said elements;

C. an auxiliary control movable successively from a normal inaccessible position, to an accessible position, and to an actuated position, said auxiliary control comprising a part of said connection of the control member with its element;

D. means providing a motion transmitting connection between the control member and the auxiliary control whereby actuation of the control member for ejection moves the auxiliary control from its normal inaccessible position to its accessible position and moves said element connected with the control member to a first position; and

E. means providing a motion transmitting connection between the last mentioned element and the ball retainer, rendered operative by motion of the last mentioned element to its first position to effect motion of the ball retainer to its releasing position in consequence of movement of the auxiliary control to its actuated position.

3. The ejection seat of claim 2, wherein said ball retainer is movable axially relative to the firing pin and cooperates with a fixed part to normally hold the ball engaged with the firing pin, further characterized by:

A. said pair of elements comprising the opposite arms of a link beam, each having at its free end a connection with one of said members; and

B. said link beam having medially of its ends a lost motion connection with the ball retainer.

4. The ejection of seat of claim 2, further characterized by:

A. said latch means being further characterized by:

1. the ball retainer comprising a ring part having a radially opening pocket, and

2. said other part comprising a ball carrier radially intermediate the ring part and the firing pin, one of said parts being rotatable relative to the other to bring the ball and said pocket from normal circumferentially spaced relative positions to relative positions in which the pocket is radially aligned with the ball to receive the same;

B. said motion transmitting connection means comprising:

1. a sun gear,

2. a coaxial ring gear, and

3. means coaxially securing one of said gears to said rotatable part for coaxial rotation therewith, the other gear being fixed;

C. one of said elements comprising an arm rigidly attached to said one gear; and

D. the other of said elements comprising an arm pivoted to swing about the axis of said one gear and carrying planet gear means constrained to rotation relative to the arm in meshing engagement with the sun gear and the ring gear.

5. The ejection seat of claim 2, further characterized by:

A. said latch means being further characterized by:

1. the ball retainer comprising a rotatable ring having a radially inwardly opening pocket, and

2. said other part being an annular ball carrier radially intermediate the firing pin and the ball retainer and rotatable relative positions in which the pocket is circumferentially spaced from the ball but being rotatable to relative positions in which the pocket is radially aligned with the ball to receive the same;

B. one of said elements comprising means providing an eccentric connection between one of said members and the ball retainer; and

C. the other of said elements comprising means providing an eccentric connection between the other of said members and the ball carrier.

6. An aircraft ejection seat having propulsion means for forcefully expelling the seat out of an aircraft in which it is normally installed, a firing pin biased toward a detonator that is associated with the propulsion means, a control member which is manually movable from a normal to an ejection position for initiating operation of the propulsion means, and safetying means for normally holding the firing pin against its bias in a cocked position spaced from the detonator, said safetying means being of a type that requires that both of two members connected therewith be moved out of normal positions to effect release of the firing pin, one of said members being the control member, said ejection seat being characterized by:

an auxiliary control handle on the ejection seat, normally in an inaccessible position and movable successively to an accessible position and to an actuated position;

B. means providing a motion transmitting connection between the control member and the auxiliary control handle whereby actuation of the control member from its normal to its ejection position moves the auxiliary control handle from its inaccessible position to its accessible position; and

C. means providing a connection between the auxiliary control handle and the safetying means.

7. The aircraft ejection seat of claim 6, wherein the control member and the auxiliary control handle are movable in the same direction out of their normal positions, further characterized by:

A. cooperating abutment means on the control member and on another part of the ejection seat, engageable to define the ejection position of the control member; and

B. said means providing the motion transmitting connection between the control member and the auxiliary control handle comprising opposing normally engaged abutment means on the control member and on the auxiliary control handle which are disengaged upon movement of the auxiliary control handle out of its accessible position in the direction toward its actuated position.

8. The aircraft ejection seat of claim 7, further characterized by:

A. the connection between the control member and the safetying means comprising the auxiliary control handle; and

B. means connected with the control member for initiating jettisoning of a canopy on the aircraft in consequence of movement of the control number from its normal position to its ejection position.

9. The aircraft ejection seat of claim 6, further characterized by:

means for connecting with said safetying means a jettisonable canopy on the aircraft so that the canopy and the auxiliary control handle comprise alternative other members which can be moved to effect release of the firing pin, the auxiliary control handle providing for ejection through the canopy in the event it fails to jettison.

10. In an aircraft ejection seat having propulsion means for forcefully expelling the seat out of an aircraft in which it is normally installed, a firing pin biased towards a detonator that is associated with the propulsion means, and latching means normally holding the firing pin against its bias in a cocked position spaced from the detonator and which latching means comprises a part that must be moved out of a latching position to effect release of the firing pin for bias propelled motion toward the detonator, means for effecting movement of said part out of its latching position only in consequence of both manual actuation of a control member from a normal to an ejection position and movement of another member in the seat carrying aircraft out of a normal position, said last named means comprising:

a pair of movable elements, one for each of said members, each having a normal position and each connected with its member to be moved thereby in one direction away from its normal position in consequence of movement of its member out of the normal position thereof; and

B. connecting means cooperating with the elements and with said part, said connecting means permitting each of said elements to move in its said direction relative to the other and being operative upon movement of either element through a limited distance in its said direction to cause subsequent movement of either element in its said direction to effect movement of said part out of its latching position.

11. The aircraft ejection of seat of claim 10, further characterized by:

A. an auxiliary control member on said seat, movable from a normal inaccessible position successively to an accessible position and to an actuated position;

B. a motion transmitting connection between the control member and the auxiliary control member by which the latter is moved from its inaccessible to its accessible position in consequence of motion of the control member from its normal to its ejection position;

C. means for connecting a jettisonable canopy member on an aircraft that carries the seat with one of said movable elements, to provide for movement of the last mentioned element in its said direction in consequence of jettisoning of the canopy; and

D. means providing a connection between the auxiliary control member and one of said movable elements, which connection is operative to effect motion of the last mentioned element in its said one direction in consequence of movement of the auxiliary control member from its accessible position to its actuated position, to provide for ejection through the canopy in the event it fails to jettison.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,556,442 Dated January 19, 1971

Inventor(s) Swen Arne , Arnekull

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 6 Line 5 "the" after "the" deleted

Col. 9 Line 65 "form" should read "from"

Claim 5, Par. A(2)
Col. 10 Line 50
insert -- to them to carry the ball circumferenti said ball carrier and said ball retainer being normally in-- after "relative"

Signed and sealed this 8th day of June 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents