PCT WORLD INTELLECTUAL PROP
International I

INTERNATIONAL APPLICATION PUBLISHED UNDEI WO 9606005A1

(51) International Patent Classification 6 :		(11) International Publication Number: WO 96/06005
B64C 1/06, 1/12, 13/20, 25/52, 27/04	A1	(43) International Publication Date: 29 February 1996 (29.02.96)

(21) International Application Number: PCT/US95/10489

(22) International Filing Date: 17 August 1995 (17.08.95)

(30) Priority Data:
08/292,718 18 August 1994 (18.08.94) US

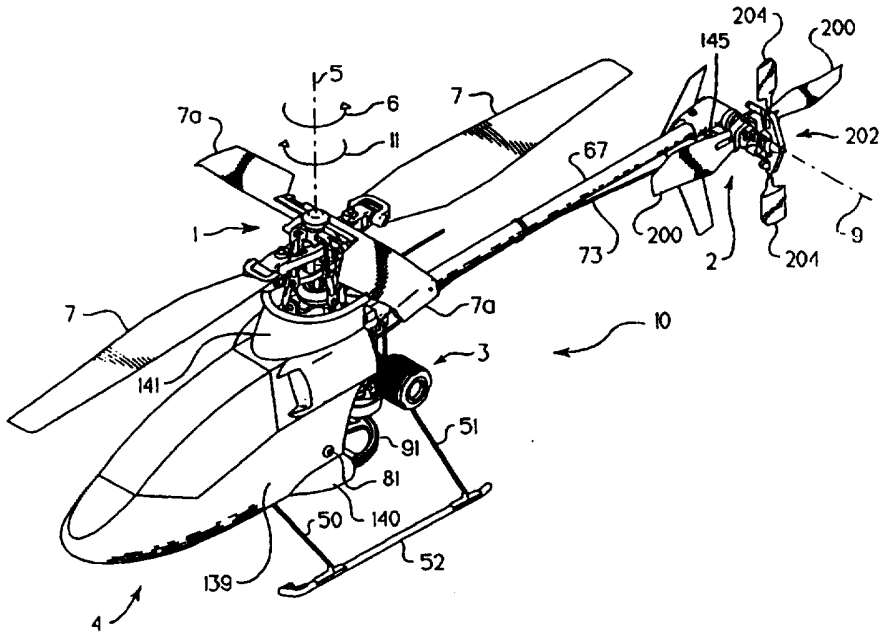
(71)(72) Applicants and Inventors: ARLTON, Paul, E. [US/US]; 1132 Anthrop Drive, West Lafayette, IN 47906 (US). ARLTON, David, J. [US/US]; 1132 Anthrop Drive, West Lafayette, IN 47906 (US). KLUSMAN, Paul [US/US]; 1308 Castle, Lafayette, IN 47905 (US).

(74) Agent: REZEK, Richard, A.; Barnes & Thornburg, 1313 Merchants Bank Building, 11 South Meridian Street, Indianapolis, IN 46204 (US).

(81) Designated States: AU, CN, JP, RU, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: MODEL HELICOPTER



(57) Abstract

The invention discloses a model helicopter (10) which includes an improved fuselage (19) having a central keel structure (20), supporting radio control system components (12), mechanical drive train components including a source of motive power (3), landing gear (50, 51, 52), canopy (4), and a tail rotor (2). The improved fuselage (139) provides a simplified structure for model helicopters. The fuselage (19) also includes a canopy support frame (128, 129) attached to the keel (20). The canopy (4) fits over and attaches to the canopy support frame (128, 129) to cover the radio-control system components (12). The fuselage further includes landing gear (50, 51, 52).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CS	Czechoslovakia
CZ	Czech Republic
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgystan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakhstan
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SI	Slovenia
SK	Slovakia
SN	Senegal
TD	Chad
TG	Togo
TJ	Tajikistan
TT	Trinidad and Tobago
UA	Ukraine
US	United States of America
UZ	Uzbekistan
VN	Viet Nam

MODEL HELICOPTER

Background and Summary of the Invention

This invention relates to the configuration and construction of model helicopters. More particularly, this invention relates to a model helicopter fuselage, landing gear, and power train elements that simplify construction and reduce manufacturing costs.

Helicopters are flying machines having the ability to hover and fly forwards, backwards, and sideways. This agility stems from the multiple capabilities of the main rotor system. Since the invention of helicopters in the 1930's considerable effort has been expended advancing helicopter technology, with a substantial percentage of that effort concentrated on main rotor systems.

While the technology of full-size helicopters progressed for decades, model helicopters remained impractical for lack of suitable engines, radio control equipment, and construction materials. Model helicopter designers often copied the designs of full-size helicopters without understanding the basic differences between full size and model aircraft. As a result, scaled-down model helicopters were typically unstable and underpowered.

In the 1970's hobbyists developed the first practical model helicopters. Lighter radio control equipment, more powerful engines, and systematic engineering all contributed to early successes. Much of model helicopter design, however, is rooted in tradition. Even though helicopter technology has advanced considerably since that time, the designs and design philosophies of that era are still in widespread use.

Model helicopters currently available are typically complex and expensive. As a result, the market for model helicopters is relatively small. Many helicopter manufacturers cater to wealthy and sophisticated hobbyists

in order to sell their products. Although many less affluent hobbyists are interested in helicopters, helicopters are usually beyond their economic means and skill level. Reducing the overall cost and complexity of model helicopters would bring them within reach of a large group of hobbyists.

Much of the complexity and cost of helicopters is concentrated in the main rotor system, but a great deal is added by the basic fuselage structure. The structure of a typical model helicopter fuselage is a framework stamped from aluminum sheet metal or molded of reinforced plastic, and assembled with nuts and bolts. Radio control components such as the battery, receiver, and servos bolt onto shelves or extensions of the framework. Mechanical components such as the engine and drive train are usually mounted inside the framework. Landing gear is typically constructed of aluminum and plastic. All-aluminum landing gear is relatively weak and easily damaged, while plastic landing gear is typically thick and bulky.

While structurally strong, traditional model helicopter fuselage construction often involves assembling many separate pieces with a multitude of fasteners and sometimes adhesives. A particular drawback of metal framework is the tendency of the framework to bend when the model helicopter crashes. Since the fuselage usually must be entirely disassembled to straighten bent framework, repairs to the model helicopter can be very time consuming. Simplified model helicopter fuselage structure has the triple benefit of reducing manufacturing cost, assembly time, and repair time.

Simplified fuselage structure also leads to simplified mounting of the various mechanical components attached to the fuselage. Simplified fuselage structure combined with a well-planned layout for radio system components and engine drive train components can greatly

reduce the number of parts in the helicopter and consequently manufacturing cost and assembly time.

Given the cost and complexity of model helicopters currently available, what is needed are simple, sturdy, and light-weight elements for model helicopter structures and drive train components.

In accordance with the present invention, there is provided a model helicopter including an improved fuselage having a central keel structure supporting radio-control system components, mechanical drive train components including a source of motive power, landing gear, canopy, and a tail rotor. This improved fuselage provides a simplified structure for model helicopters.

In preferred embodiments, the fuselage includes a canopy support frame attached to the keel. The canopy fits over and attaches to the canopy support frame to cover the components supported by the keel including the radio-control system components, and the mechanical drive train components.

Advantageously, the fuselage further includes landing gear supports attached to the keel. These landing gear supports are also attached to front and rear landing gear struts which support the model helicopter when it is resting on the ground.

In preferred embodiments of the present invention, the mechanical drive train components include an engine assembly, a gear assembly, and a main rotor shaft for driving a main rotor. It will be understood that the onboard model helicopter engine is started by transferring rotation from a separate starter motor to the model helicopter engine.

Advantageously, the drive train includes an improved starter cone linked to the model helicopter engine that engages the starter motor and transmits the rotation of the starter motor to the engine. This improved starter

cone includes a concave side wall capable of centering the starter cone in the starter motor while the starter motor is providing power to the engine.

Additional objects, features, and advantages of the invention will become apparent to those skilled in the art upon consideration of the following detailed description of preferred embodiments exemplifying the best mode of carrying out the invention as presently perceived.

Brief Description of the Drawings

The detailed description particularly refers to the accompanying figures in which:

Fig. 1 is a perspective view of a model helicopter in accordance with the present invention showing a main rotor, tail rotor mounted at one end of the tail boom, canopy, and landing gear;

Fig. 2 is a perspective view of the model helicopter shown in Fig. 1 with the canopy removed to show a fuselage including an elongated, flat, vertically oriented keel having radio-control and servo-control elements appended to it;

Fig. 3A is a side elevation view of the elongated, flat keel included in the model helicopter of Figs. 1 and 2 showing various slots and apertures formed in the keel for holding various helicopter radio, control, and drive train components;

Figs. 3B-3F are views of various pieces that mount onto the keel to support the canopy and the landing gear in the manner shown in Figs. 2 and 5;

Fig. 3B is a plan view of a floor that attaches to a bottom side of the keel;

Fig. 3C is a side elevation view of a bulkhead reinforcement;

Fig. 3D is a side elevation view of a landing gear bulkhead that attaches to the bottom side of the keel

and showing (in phantom) where the bulkhead reinforcement shown in Fig. 3C is appended to the landing gear bulkhead;

Fig. 3E is a side elevation view of first and second bulkhead firewalls that are mounted to opposite sides of the elongated, flat keel and are positioned to lie at the rear edge of the canopy and adjacent to the model helicopter engine;

Fig. 3F is a side elevation view of a landing gear bracket that attaches to the bottom side of the elongated, flat keel;

Fig. 4 is a perspective view of the elongated, flat keel showing the placement of stiffeners on the keel, with all other parts of the helicopter removed for clarity;

Fig. 5 is a view similar to Fig. 4 showing the orientation of the various fuselage structural elements shown in Figs. 3B to 3F in relation to the keel and to each other;

Fig. 6 is an exploded perspective view of the canopy of Figs. 1 and 2 showing two canopy halves prior to assembly and showing the position of canopy mounting supports and mounting grommets;

Fig. 6A is a cross-sectional view of a mounting grommet installed in the canopy of Figs. 1, 2, and 6;

Fig. 7 is an enlarged perspective view of a canopy mounting support in accordance with the present invention;

Fig. 7A is a sectional view taken along line 7A-7A of Fig. 7 showing a mounting groove that functions to attach the canopy mounting support to the model helicopter fuselage;

Fig. 8 is a perspective view showing attachment of the canopy to a keel carrying various fuselage structural elements, a portion of the fuselage structural elements which are assembled and mounted on the flat keel to act as a canopy support frame;

Fig. 8A is an enlarged perspective view of one part of the model helicopter of Figs. 1, 2, and 8, with a portion of the canopy removed, showing the canopy attached to the canopy support frame;

Fig. 9 is an exploded perspective view of the keel and canopy-supporting and landing gear-supporting fuselage structural elements mounted on the keel showing the attachment of the landing gear elements to the landing gear-supporting portion of the fuselage, with all other parts of the helicopter removed for clarity;

Fig. 10 is an enlarged side elevation view of a landing gear skid and a lower foot portion of a landing gear strut that attaches to the landing gear skid;

Fig. 10A is a sectional view taken along lines 10A-10A of Fig. 10 showing a hollow area formed in the landing gear skid;

Fig 10B is a sectional view taken along lines 10B-10B of Fig. 10 showing a boot portion of the landing gear skid and a slot formed in the boot portion;

Fig. 10C is a sectional view taken along lines 10C-10C of Fig. 10 showing a slot formed in the landing gear skid;

Figs. 11-11C illustrate a preferred assembly sequence of the landing gear struts and landing gear skids for the model helicopter of Figs. 1 and 2;

Fig. 11 is a perspective exploded view of the landing gear struts and the landing gear skids;

Fig. 11A is a perspective exploded view of the lower foot portion of a landing gear strut sliding into the slot of the landing gear skid;

Fig. 11B is a perspective exploded view of the lower foot portion situated in the slot of the landing gear skid and sliding into the hollow area of the landing gear skid;

Fig. 11C is a perspective exploded view of the

skid being rotated 90° so that the boot of the landing gear skid engages the lower foot portion of the landing gear strut;

Fig. 12 is a left side elevation view of the model helicopter of Figs. 1 and 2 showing the elongated, flat, vertical keel and relative positions of radio system components, drive train components and structural components along with the vertical main rotor shaft, horizontal tail boom, and landing gear wherein the engine heat sink is shown in partial cutaway to expose throttle pushrod detail and electrical wiring between radio components is omitted for clarity;

Fig. 13 is a right side elevational view of the model helicopter of Figs. 1 and 2 showing relative positions of radio system components, drive train components, structural components, and fuel system components, wherein electrical wiring between radio components is omitted for clarity and landing gear attachment detail is also removed for clarity;

Fig. 14 is a perspective view of a linkage system in accordance with the present invention showing elements of the radio system, swashplate (main rotor head control system), engine, and tail rotor, with all structural elements removed for clarity;

Fig. 15A is an enlarged perspective view of a rear section of the model helicopter of Fig. 1 showing installation of the engine and fuel tank on the keel, with the engine heat sink and all parts forward of the engine and fuel tank removed for clarity;

Fig. 15B is a side elevation view of the engine and fuel tank of a model helicopter in accordance with the present invention, with the engine heat sink and all other parts of the present invention omitted for clarity;

Fig. 16A is a side elevational view of the present invention showing application of an electric hand-

held starting motor to an engine starter cone to start the model helicopter engine;

Fig. 16B is a perspective view of the electric hand-held starting motor;

Fig. 17 is an enlarged side elevation view of a portion of the model helicopter shown in Fig. 16A, with starter motor elements shown in cut-away, and a landing gear strut and skid removed for clarity;

Fig. 18A is a side elevational view of a conventional starter cone; and

Fig. 18B is a top plan view of the conventional starter cone of Fig. 18A.

Detailed Description of the Drawings

A model helicopter in accordance with the present invention includes an improved fuselage having a longitudinally extending keel. The keel supports radio control units, servo control units, drive train mechanisms, and other components necessary for helicopter operation. The fuselage further includes a canopy support frame for supporting a canopy and landing gear supports for supporting a landing gear assembly attached to the keel.

A model helicopter 10 in accordance with the present invention is shown in Fig. 1. Helicopter 10 is commonly designed to include large main rotor 1 which rotates about main rotor axis 5 and which lifts helicopter 10 into the air, and smaller tail rotor 2 which rotates about tail rotor axis 9 to counteract the torque produced by main rotor 1 and steer helicopter 10. Illustratively, main rotor 1 includes a pair of rotor blades 7 and a pair of shorter subrotor blades 7a, and tail rotor 2 includes a pair of tail rotor blades 200. A gyro stabilizer 202 including a pair of aerodynamic gyro paddles 204 is mounted on tail rotor 2 as shown in Fig. 1.

Tail rotor 2 is mounted at a rear end of tail

boom 67 as shown in Figs. 1 and 2. Both main rotor 1 and tail rotor 2 are driven by an engine 3 usually located within the helicopter fuselage (body) near the vertical main rotor shaft.

A streamlined canopy 4 covers a front portion of helicopter 10 and includes a body 139, gear shroud 140, and main rotor shroud 141 as shown in Fig. 1. A radio-controlled command unit and other drive mechanisms are contained inside canopy 4 as shown in Fig. 2. Canopy 4 is designed for use on a model helicopter such as helicopter 10 to protect the radio-control unit and provide the appearance of a pilot-carrying portion of helicopter 10. Canopy 4 does not extend back to tail rotor 2 on some helicopters 10. When sitting on the ground, helicopter 10 is supported by front landing gear strut 50 and rear landing gear strut 51 attached to spaced-apart skids 52 with one skid 52 positioned on each side of helicopter 10.

In operation, main rotor 1 rotates rapidly about main rotor axis 5 in rotation direction 6. As it does so, main rotor blades 7 act like propellers or fans moving large amounts of air downward thereby creating a force that lifts helicopter 10 upward. The torque (reaction force) created by rotating main rotor 1 in rotation direction 6 tends to cause the body of helicopter 10 to swing about main rotor axis 5 in direction 11 as shown in Fig. 1. When trimmed for steady hovering flight, tail rotor 2 creates enough thrust force to cancel exactly the torque produced by main rotor 1 so that helicopter 10 can maintain a constant heading. Decreasing or increasing the thrust force of tail rotor 2 causes helicopter 10 to turn (rotate about axis 5) in the desired direction.

Components used to control main rotor 1, tail rotor 2, and engine 3 are shown in Fig. 2 which shows helicopter 10 of Fig. 1 with canopy 4 removed. To control model helicopter 10, a pilot manipulates small joysticks on

a hand-held radio transmitter (not shown) to send commands to radio receiver 12 through antenna 17 and antenna wire 18. Radio receiver 12 is usually wrapped in vibration-absorbing foam 13. Radio receiver 12 relays these commands to electro-mechanical servo actuators 15 (hereinafter called servos) to control main rotor 1, tail rotor 2, and engine 3. Battery 14 provides the electrical power necessary to operate radio receiver 12 and servos 15. Rubber bands 16 encircle battery 14 and receiver 12 and secure them to helicopter 10.

The four basic control functions required to fly a model helicopter 10 (fore-aft cyclic, right-left cyclic, tail rotor 2, and throttle/collective) each require a separate servo 15. Push-pull rods 73-76 and bellcranks 145 connect servos 15 to main rotor 1, tail rotor 2 and engine 3. Fore-aft cyclic servo 71 and right-left cyclic servo 72 control main rotor 1 and cause helicopter 10 to tilt forward or backward, and right or left respectively as shown in Figs. 12-14. Tail rotor servo 69 rotates helicopter 10 about rotation axis 5 like a steering wheel on a car. Throttle/collective servo 70 controls the altitude and speed of helicopter 10 by adjusting the speed of engine 3 and/or the pitch of main rotor blades 7.

Fuselage 19 forms the structural backbone of helicopter 10. All mechanical and electronic systems of helicopter 10 are mounted to and almost completely obscure fuselage 19 as shown in Fig. 2. Fuselage 19 includes forward section or portion 84 supporting radio receiver 12 and servos 15, middle section or portion 85 having the canopy support frame, and rear section or portion 86 supporting engine 3. To better understand the fuselage structure of helicopter 10, it is easiest to look at individual pieces of fuselage 19 separated from the rest of helicopter 10.

Figs. 3A-3F show fuselage 19 structural elements

comprising keel 20, landing gear bracket 21, firewall left and right halves 22 and 23, landing gear bulkhead 24, bulkhead reinforcement 25, and floor 27. Floor 27 includes a forward end 28 facing toward the front section 84 of keel 20 and a rearward end 29 facing toward the rear section 86. Keel 20 is formed to include several apertures to reduce the weight of helicopter 10 and accommodate various mechanical and electronic system components. More specifically, keel 20 is formed to include weight-reduction holes 30, 31, and 32; servo bays 33 and 34; gear-clearance hole 35; engine cutout 36; and multiple bolt and alignment holes 37.

Bulkhead reinforcement 25 shown in Fig. 3C is glued to and reinforces bulkhead 24 as shown in phantom in Fig. 3D. In preferred embodiments of the present invention, all structural elements of fuselage 19 shown in Fig. 3 are made of aircraft-grade plywood. Keel 20, landing gear bracket 21, and landing gear bulkhead 24 are approximately three times as thick as the remaining elements to carry higher structural loads. In alternative embodiments of the present invention, composite materials such as fiber-reinforced plastics could be substituted for plywood.

Fuselage 19 further includes keel stiffeners 42, 43, and 44 and servo risers 45 and 46 attached to keel 20 as shown in Fig. 4. Stiffeners 42, 43, and 44 primarily stiffen keel 20 longitudinally, while servo risers 45 and 46 provide raised mounting surfaces receptive to self-tapping screws used for mounting servos 15. In a preferred embodiment of the present invention, keel stiffeners 42, 43, and 44 and servo risers 45, 46 are strips of spruce wood and are attached to keel 20 with glue.

The components of fuselage 19 are assembled as shown in Fig. 5. Landing gear bracket 21 is fixed (as by

gluing) to keel 20 by inserting landing gear bracket 21 into alignment slot 47 formed in keel 20 until keel 20 extends completely into bracket slot 39 formed in landing gear bracket 21. In a similar fashion, landing gear bulkhead 24 is secured to keel 20 by connecting interlocking bracket slot 40 and alignment slot 48 formed in keel 20. Floor 27 is attached to landing gear bulkhead 24, keel 20, and firewall halves 22 and 23 which are also affixed to keel 20. Floor 27 is situated perpendicular to keel 20. After assembly, the structural elements shown in Fig. 5 are collectively referred to as fuselage 19. Alternate embodiments of the present invention are envisioned wherein fuselage 19 is made of plastic such as nylon or polycarbonate with bulkhead 24, firewalls 22, 23 and/or floor 27 elements molded integrally to keel 20, or attached with adhesives or mechanical fasteners.

The firewalls 22, 23, and floor 27 form a canopy support frame to which canopy 4 attaches as shown in Figs. 8 and 8A. Canopy 4 includes canopy halves 126, 127 as shown in Fig. 6. Canopy mounting supports 128, 129 are secured to the inside of each canopy half 126 and 127 to reinforce canopy 4 and act as mounting and alignment brackets for canopy 4 when attached to the canopy support frame.

Canopy mounting supports or doublers 128, 129 include alignment detent 131 and mounting ridges 134. Alignment detent 131 of canopy mounting support 128 engages a matching detent 150 formed in body 139 of canopy half 126. Alignment arrow 132 on mounting support 128 aligns with alignment mark 130 on the inside of canopy half 126 when mounting support 128 is properly aligned on the inside of canopy half 126 as shown in Fig. 7. Mounting ridges 134 form mounting grooves 135 receptive to floor 27 and firewall halves 22, 23 of the canopy support frame. Mounting grommet 133 is installed in each of alignment

detents 131 as shown in Fig. 6A. In preferred embodiments of the present invention, mounting supports 128 are formed of sheet plastic identical to that of canopy 4, and can be manufactured in one forming operation along with canopy 4.

Canopy attachment blocks 80 are attached to the canopy support frame as shown in Figs. 8 and 8A. More specifically, canopy attachment blocks 80 are situated at the junction of firewall halves 22, 23 and floor 27 to receive canopy attachment bolts 81 which secure canopy 4 to the canopy support frame as shown in Figs. 1, 8, and 8A. Canopy 4 is slid over the front of fuselage 19 until mounting grommets 133 pass over the tops of attachment bolts 81. Grommets 133 are then pressed onto bolts 81 until the edges of floor 27 and firewall halves 22 and 23 seat firmly within mounting grooves 135 in mounting supports 128, 129.

Canopy 4 can be removed from canopy support frame by slowly pulling the rear of canopy 4 outward until grommets 133 slip off of attachment bolts 81, or by removing attachment bolts 81 from attachment blocks 80.

Landing gear bracket 21 and landing gear bulkhead 24 support landing gear assembly 53 as shown in Fig. 9. Landing gear assembly 53 includes front struts 50, rear struts 51, and spaced-apart skids 52. Landing gear assembly 53 is rigidly mounted to fuselage 19 with cable ties 54. Central landing gear vertex 55 formed between two front struts 50 abuts the rearward face of landing gear bulkhead 24 and the lower edge of bulkhead reinforcement 25 attached to landing gear bulkhead 24 as shown in Fig. 3D. Central section 56 joining rear struts 51 is held firmly against the bottom edge of bracket 21 by cable ties 54.

It is understood that landing gear bulkhead 24, floor 27, keel 20, and firewall halves 22, 23 form a series of mutually supporting structural elements which greatly increase the strength and stiffness of fuselage 19. These

structural elements also separate and protect forward section 84 of fuselage 19 inside canopy 4 from oily engine exhaust and airborne debris as shown in Figs. 1 and 2. This is advantageous because radio receiver 12, battery 14, and servos 15 are housed in forward section 84.

The details of landing gear skid 52/strut 50, 51 attachment is illustrated in Figs. 10-11C. Each strut 50, 51 terminates in angled landing gear leg 57 and angled landing gear foot 58. Each skid 52 includes two spaced-apart landing gear strut attachment areas 61. Each landing gear strut attachment area 61 includes slot 59, hollow area 63, and boot-neck 64 having boot-neck slot 65 as shown in Figs. 10-10C. Fig. 11A shows landing gear foot 58 inserted in direction 66 into skid slot 59. Landing gear foot 58 slides in direction 62 into hollow area 63 as shown in Fig. 11B. Landing gear skid 52 is then rotated 90° in direction 68 about landing gear foot 58 in hollow area 63 as shown in Fig. 11C. This 90° rotation 69 forces landing gear leg 57 into skid boot-neck 64. Boot-neck slot 65 expands slightly to accommodate entry of landing gear leg 57 then closes securely around landing gear leg 57 to rigidly secure strut 50 to skid 52. Alternatively, hollow area 63 can be configured with a slot similar to boot-neck 64 to expand slightly and then close securely around landing gear foot 58, in which case a separate skid slot 59 would not be necessary. In preferred embodiments of the present invention, skid 52 is made of a rigid, impact resistant plastic material such as nylon.

The location of radio system 12 and engine drive train components on fuselage 19 is shown in Figs. 12-13, with electric wiring between radio system 12 components removed for clarity. Servos 15 include tail rotor servo 69, throttle servo 70, fore-aft cyclic servo 71, and roll cyclic servo 72. All of servos 69-72 are positioned in forward section 84 of fuselage 19. Pushrods 73-76 and

bellcrank 145 connecting the servos 69-72 with swashplate 78, engine 3, and tail rotor 2 are shown more clearly in Fig. 14. Tail rotor servo 69 is located within servo bay 33 in keel 20 with tail rotor pushrod 73 running nearly parallel to tail boom 67 back to the pitch control linkages of tail rotor 2 as shown in Figs. 12-14. Throttle servo 70 is also located in servo bay 33 with throttle pushrod 74 operably connected to the speed controls of engine 3. Fore-aft cyclic servo 71 and roll cyclic servo 72, which are operably connected to swashplate 78 and control the tilt of main rotor 1, are located in servo bay 34 in close proximity to swashplate 78 so that fore/aft pushrod 75 and right/left pushrod 76 are short and direct.

The power train of helicopter 10 includes clutch assembly 89 having clutch pinion 92 and starter cone 90 mounted to engine 3 and driving main gear 91 secured to the lower end of main shaft 93. Main shaft 93 extends through ball bearings in lower ball-bearing block 94 and upper ball bearing block 95 and is operably connected at its upper end to main rotor 1. Ball-bearing blocks 94, 95 are secured to keel 20 in rear portion 86 of fuselage 19.

Main shaft 93 transfers rotation for the power train to main rotor 1 and tail rotor 2. Main rotor 1 is directly connected to main shaft 93 thereby rotating with main shaft 93. Rotation is transferred from main shaft 93 to tail rotor 2 by crown gear 96, tail rotor pinion gear 97, and a tail rotor drive shaft (not shown). Crown gear 96 is securely fastened to main shaft 93 and engages tail rotor pinion gear 97 which is affixed to the tail rotor drive shaft (not shown) inside tail tube 67. The drive shaft is connected to tail rotor 2 thereby transmitting rotational motion of main shaft 93 to tail rotor 2. In operation, excess oil from engine 3 drips into clutch assembly 89 thereby lubricating interior clutch elements including the interior of clutch pinion 92. In preferred

embodiments of the present invention, the engine is a COX TD .049/.051.

Fuel tank 103 is secured to keel 20 in rear section 86 of fuselage 19 as shown in Fig. 15A. Straps 104 made of long cable ties surround fuel tank 103 and pass through holes in keel 20 to secure fuel tank 103 to keel 20. Head portions 112 of additional cable ties 109 attach to the ends of straps 104 that extend through the holes in keel 20. After head portions 112 are attached to straps 104, tail portions 113 are removed. Fuel tank 103 has integral sump 106, filler tube 110 extending through the interior of fuel tank 103 into sump 106, standoffs 107, and is connected to engine 3 by fuel tubing 108 and fuel filter 111. In the preferred embodiment, fuel tank 103 is molded of fuel-proof plastic material such as polyethylene and straps 103 are made of plastic material.

Engine 3 is typically started with electric starter motor 121. Figs. 16 and 17 illustrate starting procedures for engine 3 and show an operator holding helicopter 10 and applying electric starter motor 121 (with the motor shaft rotating in starter rotation direction 123) firmly to starter cone 90 with force applied in the direction of contact arrow 122. Starter cone 90 is operably connected to the crankshaft of engine 3 so that rapid rotation of starter cone 90 causes engine 3 to start. Starter cone 90 has cylindrical portion 118 for centering soft rubber insert 124 of starter motor 121 onto starter cone 90 and concave surface 117 against which rubber insert 124 can apply the torque necessary to start engine 3. Conventional conical starter cone 115 as shown in Fig. 18 has no centering feature thereby allowing rubber insert 124 to track off-center and reducing the operator's ability to hold starter motor 121 firmly against starter cone 115 to transmit starting torque to engine 3. It will be understood that starter cone 115 can be advantageously

employed to start engines in other applications that require transferring rotation from a starter motor such as for model cars and model boats.

Although the invention has been described and defined in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of the invention as described and defined in the following claims.

CLAIMS:

1. A fuselage structure for use on a model helicopter, the fuselage structure comprising

a longitudinally extending elongated keel having a front, middle, and rear portion and means for supporting a canopy, landing gear, flight control system, and drive train.

2. The fuselage structure of claim 1, wherein the elongated keel is offset from the longitudinal axis of the helicopter.

3. The fuselage structure of claim 1, wherein the elongated keel is a flat plate.

4. The fuselage structure of claim 3, wherein the elongated keel is made substantially of plywood.

5. The fuselage structure of claim 1, wherein the canopy and landing gear support means comprise a support frame having a laterally extending floor arranged to lie perpendicular to the elongated keel, the floor further having a forward end facing toward the front portion of the elongated keel and a rearward end facing toward the rear portion of the elongated keel respectively, a front bulkhead appended to the elongated keel and the forward end of the floor, and a firewall appended to the elongated keel and the rearward end of the floor.

6. The fuselage structure of claim 5, wherein the landing gear support means further includes a rear bracket appended to the elongated keel.

7. The fuselage structure of claim 1, wherein the keel is formed to include at least one aperture for securing at least one flight control system component.

8. A landing gear assembly for use on a model helicopter, the helicopter including a fuselage having a landing gear support, the landing gear assembly comprising

at least one strut linked to the landing

gear support, the at least one strut having a leg portion extending downward away from the fuselage to an angled foot portion, and

spaced-apart skids attached to the angled foot portion of the at least one strut, each spaced-apart skid being formed to include at least one slot receptive to the angled foot portion.

9. The landing gear assembly of claim 8, wherein each of the spaced-apart skids is formed to include a hollow area configured to receive an angled foot portion, the angled foot portion of the at least one strut engaging the hollow area.

10. The landing gear assembly of claim 9, wherein each of the spaced-apart skids further includes at least one boot, the slot is L-shaped and extends through the at least one boot, and the leg portion engages the portion of the L-shaped slot extending through the boot when the angled foot portion is engaged in the hollow area.

11. The landing gear assembly of claim 8, wherein at least two struts are appended together at their upper ends to form a single strut unit having at least two leg portions extending downward away from the fuselage and terminating in an angled foot portion.

12. The landing gear assembly of claim 11, further comprising a second strut unit spaced apart from the first strut unit.

13. The landing gear assembly of claim 11, wherein the angled foot portion of the strut unit engages at least one of the spaced-apart skids.

14. A canopy for use on a model helicopter, the helicopter including a fuselage structure having a canopy support frame, the canopy comprising

a body portion having an inside surface and at least one mounting support appended to the inside surface, the mounting support having at least one mounting

groove receptive to a canopy support frame to hold the canopy in the proper angular orientation relative to a fuselage structure.

15. The canopy of claim 14, wherein the mounting support further includes means for holding the canopy in the proper lineal spatial position relative to the fuselage structure.

16. The canopy of claim 15, further comprising a flexible grommet that is receptive to bolt means attached to the canopy support frame to hold the body portion against the canopy support frame when the canopy is in an installed position.

17. The canopy of claim 14, wherein the body portion includes means for aligning at least one mounting support on the inside surface of the body portion.

18. The canopy of claim 14, wherein the canopy includes two separate halves joined along a seam line.

19. A starting device for use in starting a model engine, the starting device comprising

means for engaging a starter motor to acquire rotational motion from the starter motor, the engaging means having a generally concave outer surface, and

means for activating the engine by transmitting rotational motion of the engaging means to the engine.

20. The starting device of claim 19, wherein the engaging means further comprises means for centering the starter motor on the engaging means so that the starter motor maintains contact with the engaging means while transferring rotation to the engaging means.

21. The starting device of claim 20, wherein the engaging means includes a first end appended to the activating means and a second end appended to the centering means and has a circular cross-section that decreases in

diameter from the first end to the second end.

22. The starting device of claim 20, wherein the centering means is generally cylindrical in cross-section.

23. The starting device of claim 20, wherein the activating means includes a shaft appended to the engaging means and operably connected to the engine.

24. A model helicopter comprising

a fuselage structure including a longitudinally extending keel having a front, middle, and rear portion, canopy support frame, front bulkhead, and rear bracket,

a canopy mounted to the canopy support frame to cover the front portion of the elongated keel, and

a tail boom attached to the rear portion of the elongated keel and arranged to extend in a rearward direction away from the canopy.

25. The helicopter of claim 24, further comprising a landing gear assembly attached to the front bulkhead and rear bracket.

26. The helicopter of claim 24, further comprising a radio receiver and servo controllers and at least one of the radio receiver or servo controllers being attached to the front portion of the keel.

27. The helicopter of claim 24, further comprising an engine attached to the rear portion of the keel.

28. A model helicopter comprising

a fuselage structure including a landing gear support, and

a landing gear assembly appended to the landing gear support, the landing gear assembly including at least one strut linked to the landing gear support, the at least one strut having a leg portion extending downward away from the fuselage to an angled foot portion, and spaced-apart skids attached to the angled foot portion of

the at least one strut, each spaced-apart skid being formed to include at least one slot receptive to the angled foot portion.

29. The helicopter of claim 28, further comprising at least one cable tie connecting the landing gear assembly to the landing gear support.

30. A model helicopter comprising

a fuselage structure having a canopy support frame, and

a canopy appended to the canopy support frame, the canopy including a body portion, an inside surface, and at least one mounting support appended to the inside surface, the mounting support having at least one mounting groove receptive to the canopy support frame to hold the canopy in the proper angular orientation relative to the fuselage structure.

31. A model helicopter comprising

a fuselage structure having an engine support,

an engine appended to the engine support, and

a starting device appended to the engine, the starting device including means for engaging a starter motor to acquire rotational motion from the starter motor, the engaging means having a generally concave outer surface, and means for activating the engine by transmitting rotational motion of the engaging means to the engine.

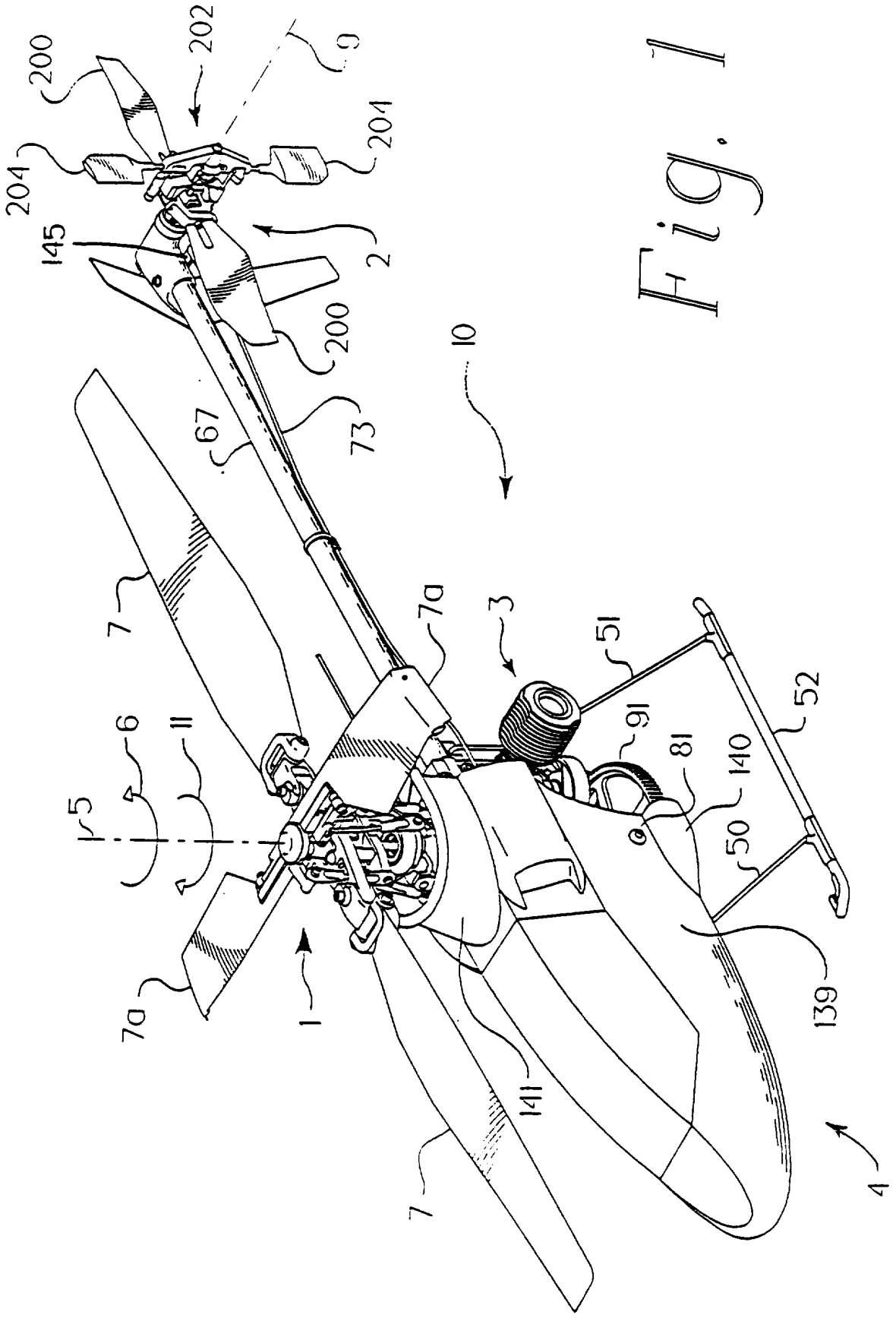

202
9
200
204
204
201
145
2
200
67
73
10
7
7a
3
51
52
91
81
140
50
6
11
5
7a
1
139
141
7
4

Fig. 1

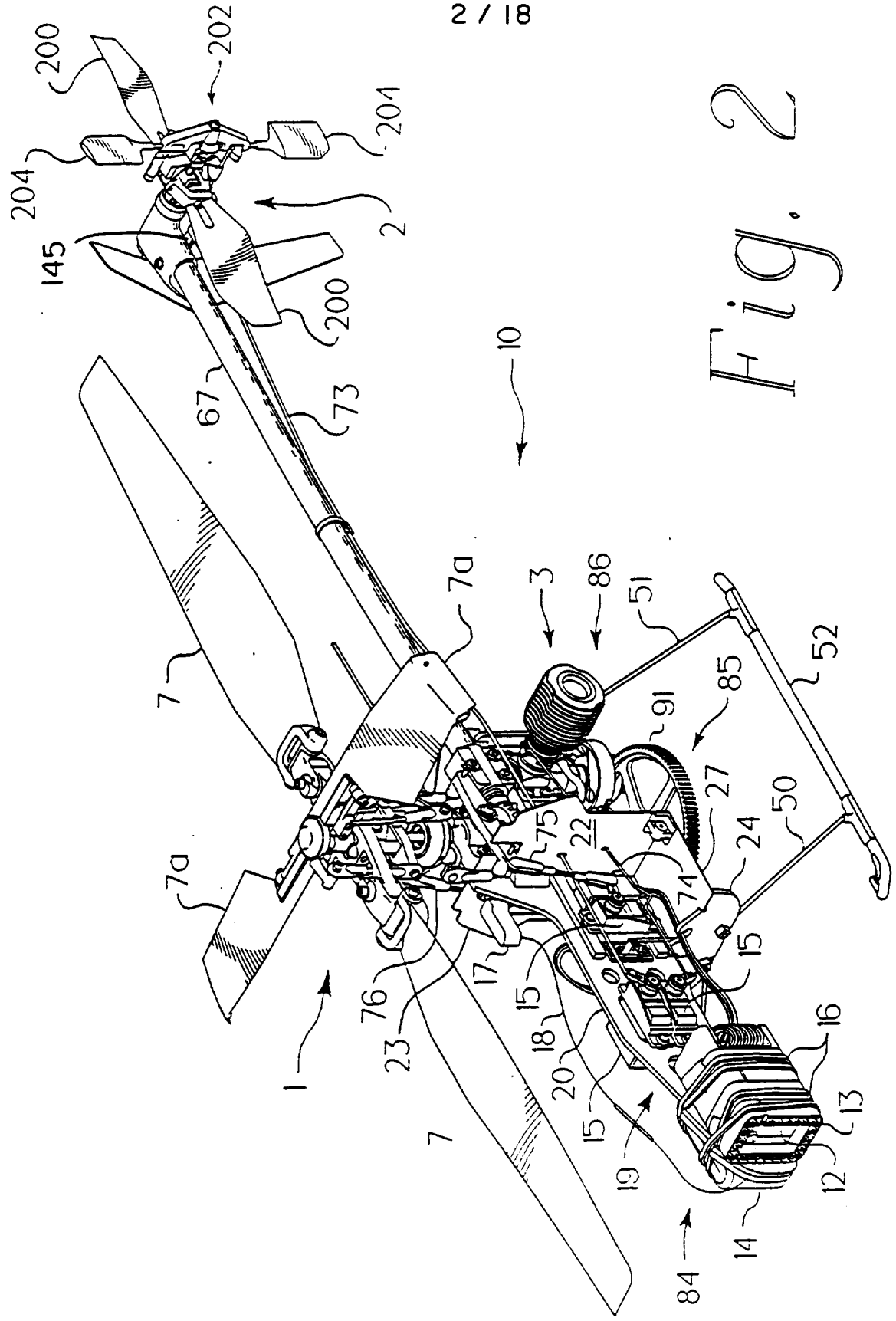

200
202
204
204
145
2
200
67
73
10
7a
3
86
51
52
7
85
91
27
50
75
22
24
7a
74
15
17
15
76
23
16
18
20
15
19
13
12
14
84
1
7

Fig. 2

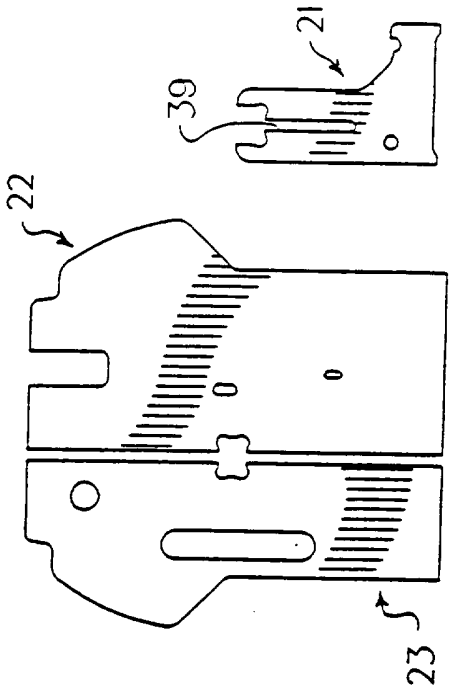


Fig. 3F

Fig. 3E

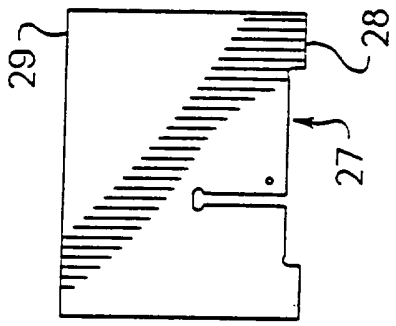


Fig. 3B

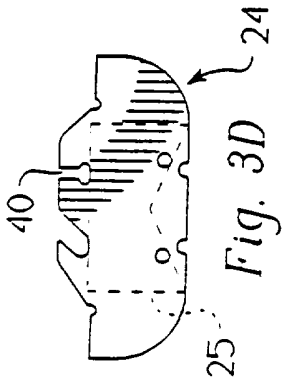


Fig. 3D

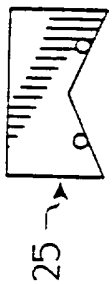


Fig. 3C

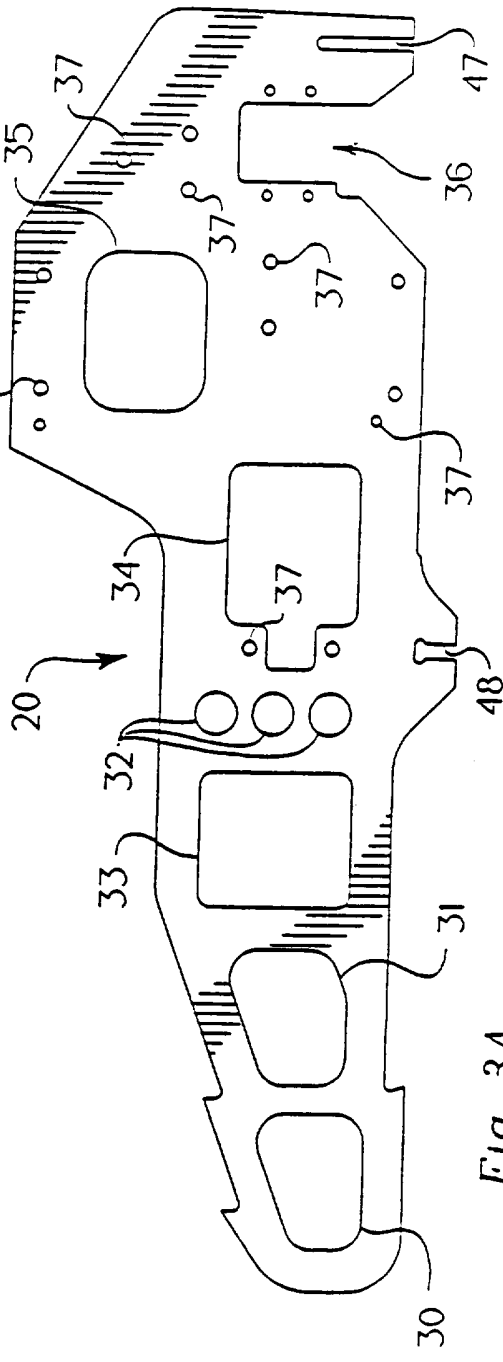


Fig. 3A

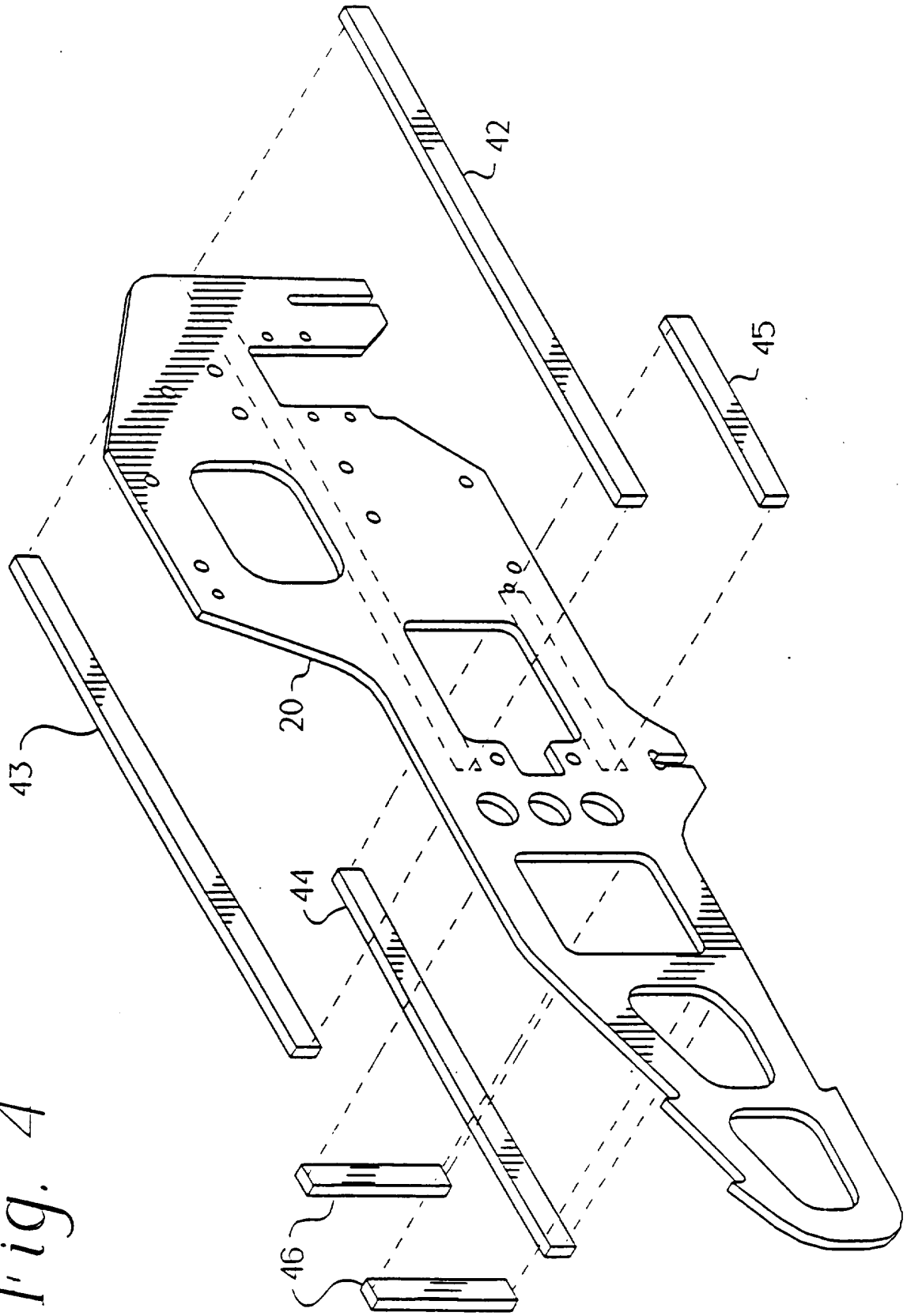


Fig. 4

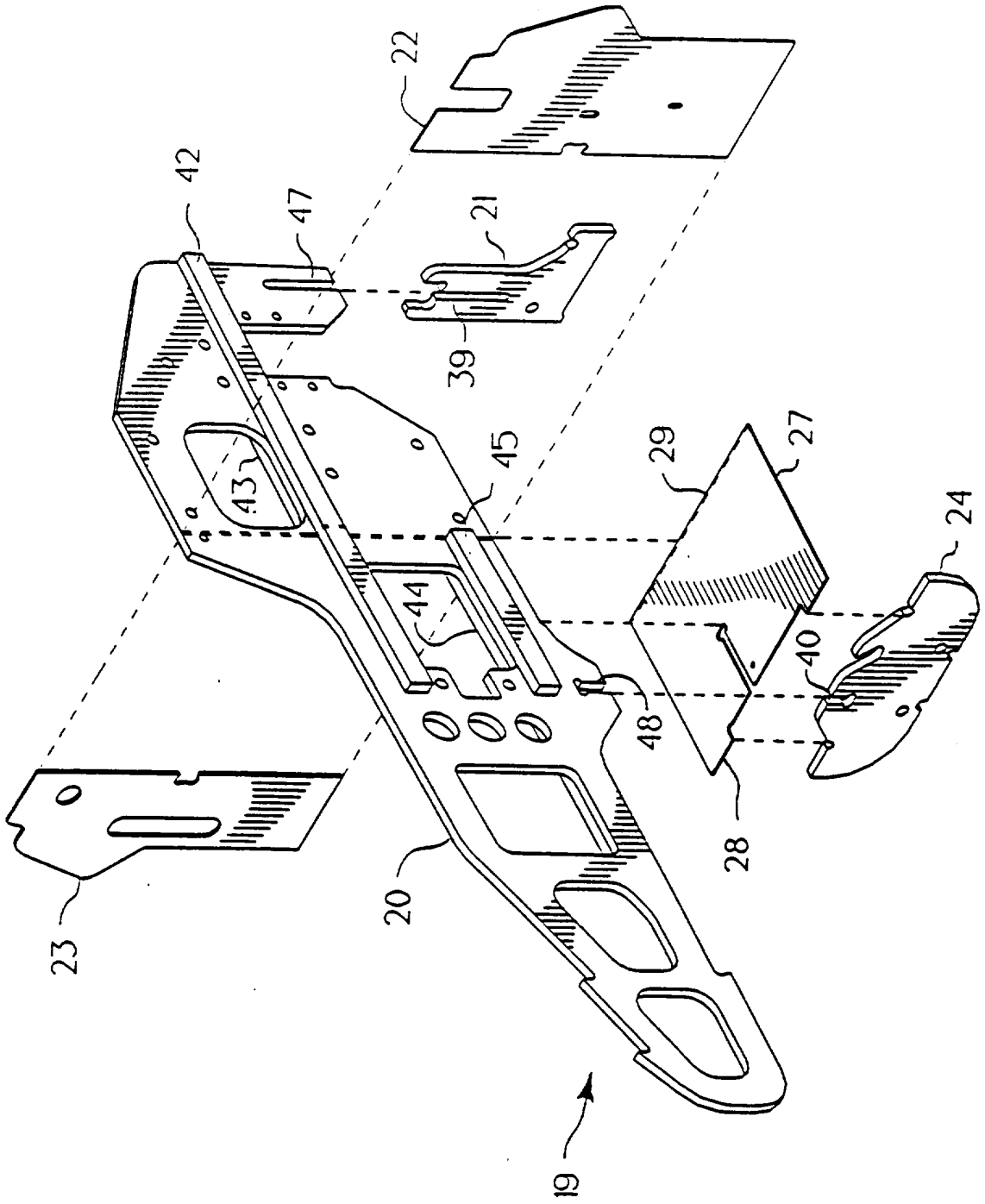
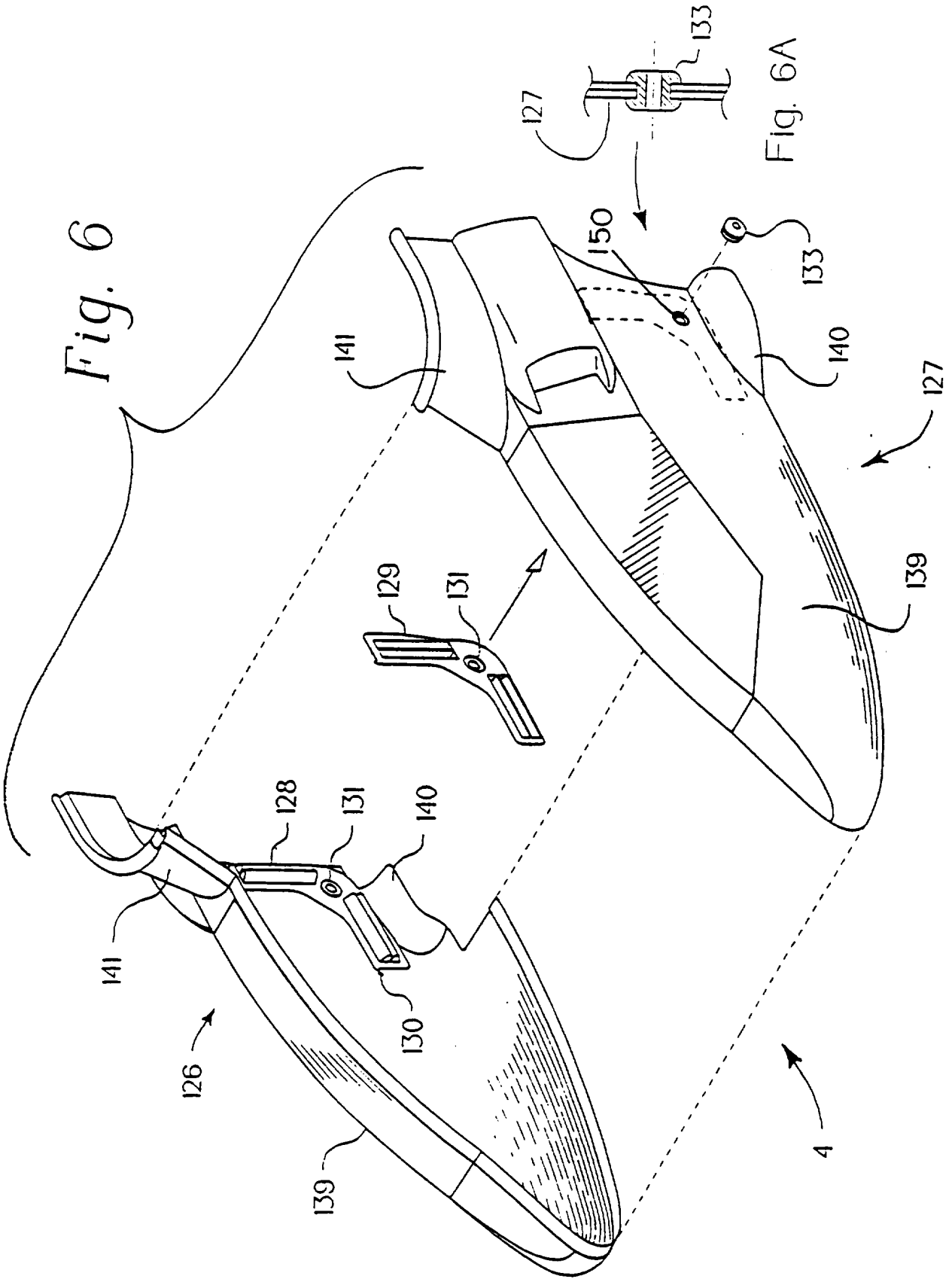


Fig. 5

Fig. 6


133
127
Fig. 6A
150
133
141
140
127
129
131
139
128
131
140
141
130
126
139
4

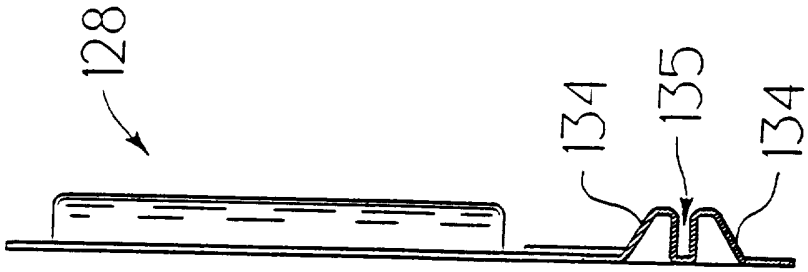


Fig. 7A

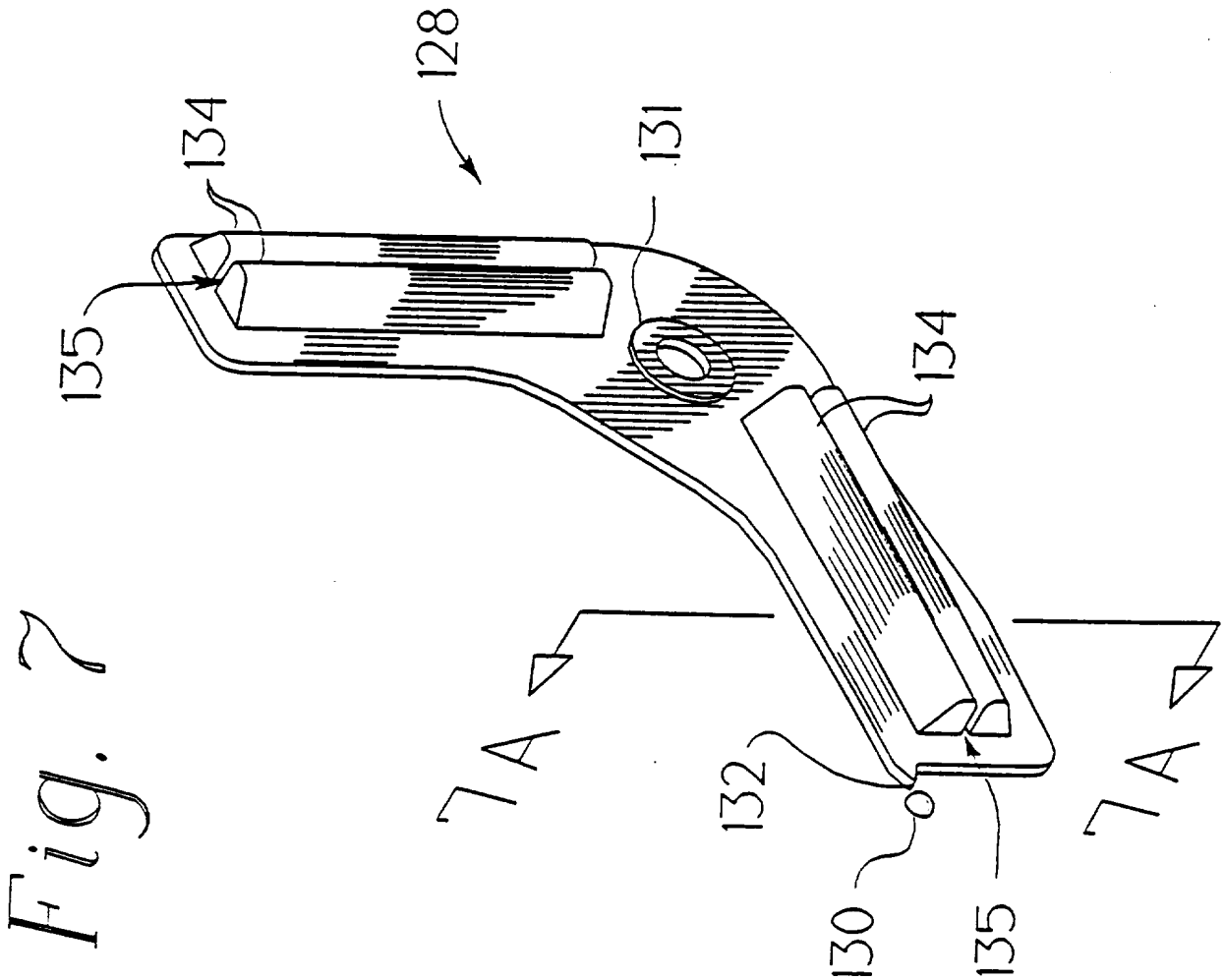


Fig. 7

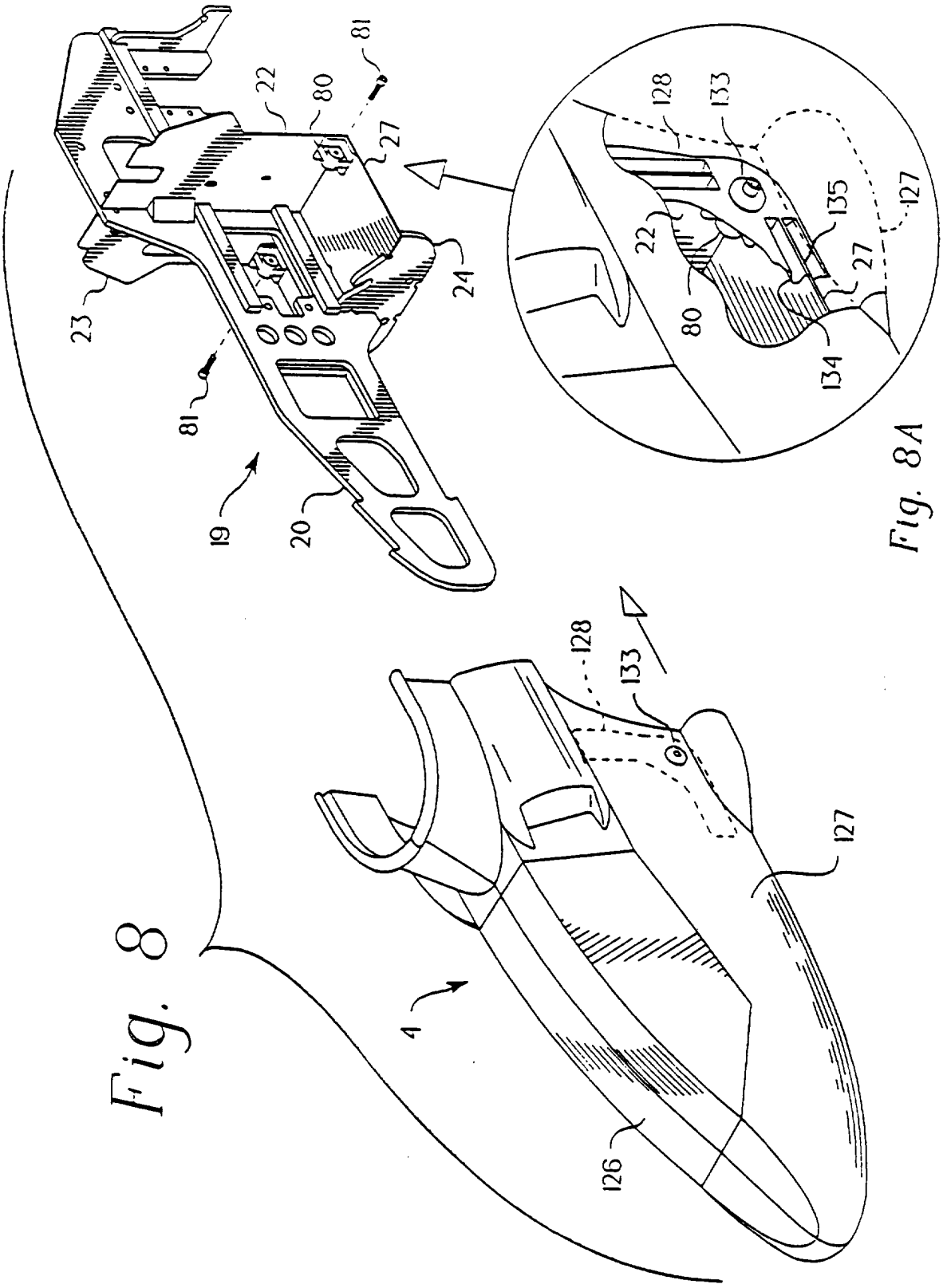

81
22
80
27
24
23
81
19
20
4
128
133
127
126
128
133
135
127
22
27
80
134

Fig. 8

Fig. 8A

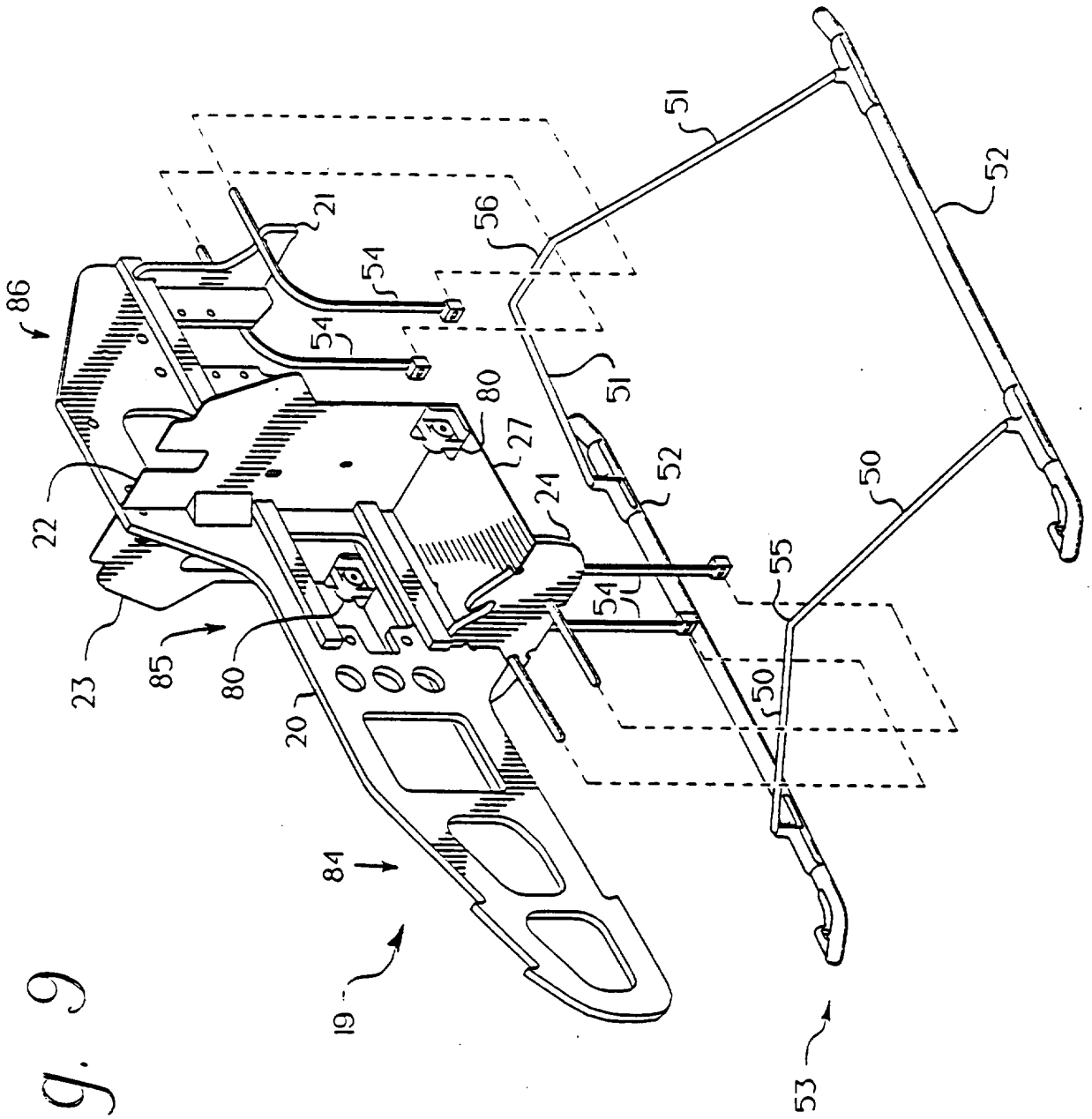


Fig. 9

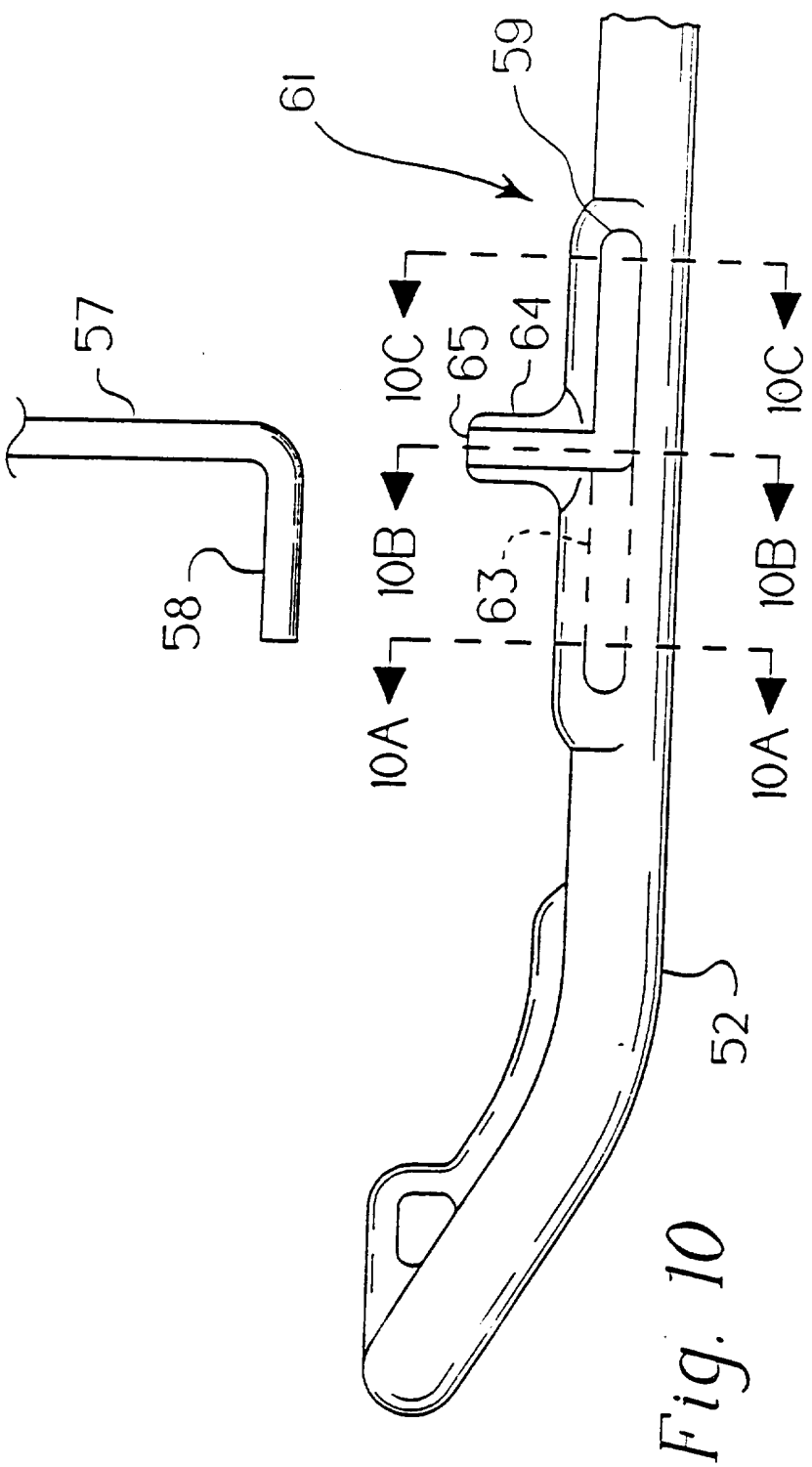


Fig. 10

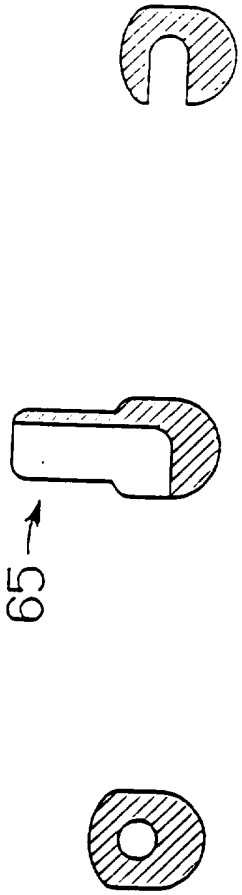


Fig. 10A Fig. 10B Fig. 10C

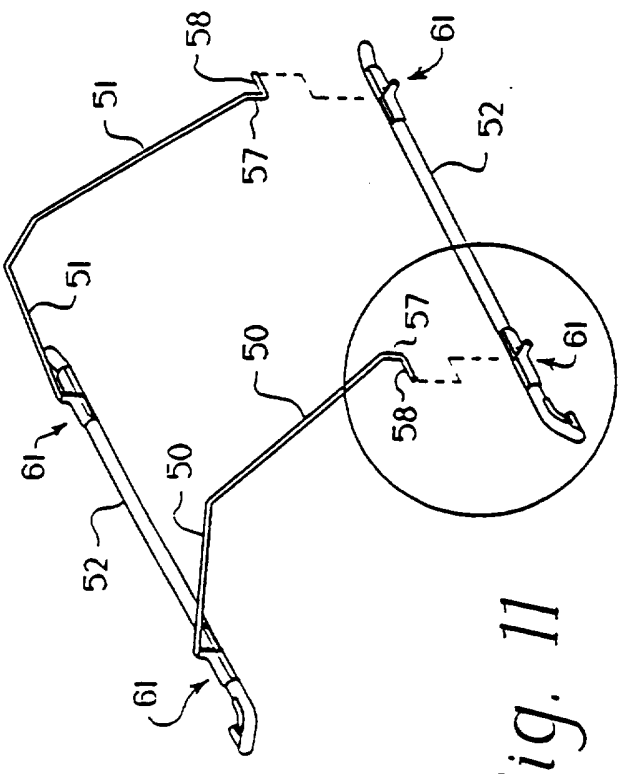


Fig. 11

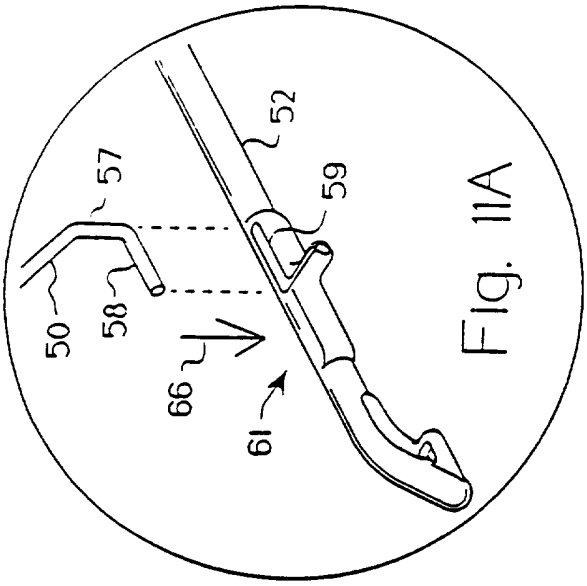


Fig. 11A

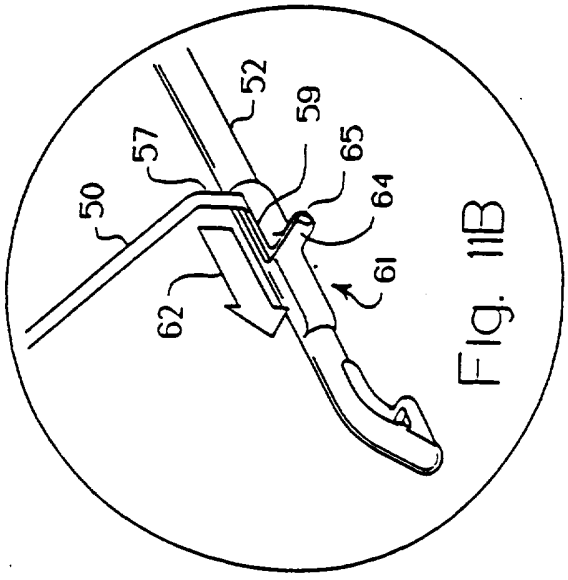


Fig. 11B

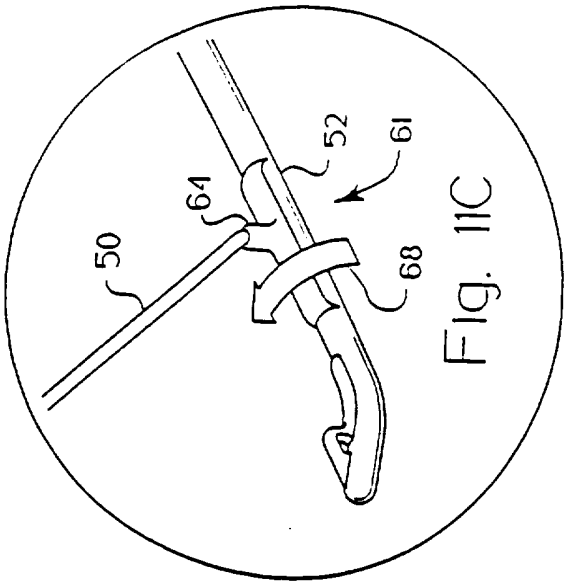


Fig. 11C

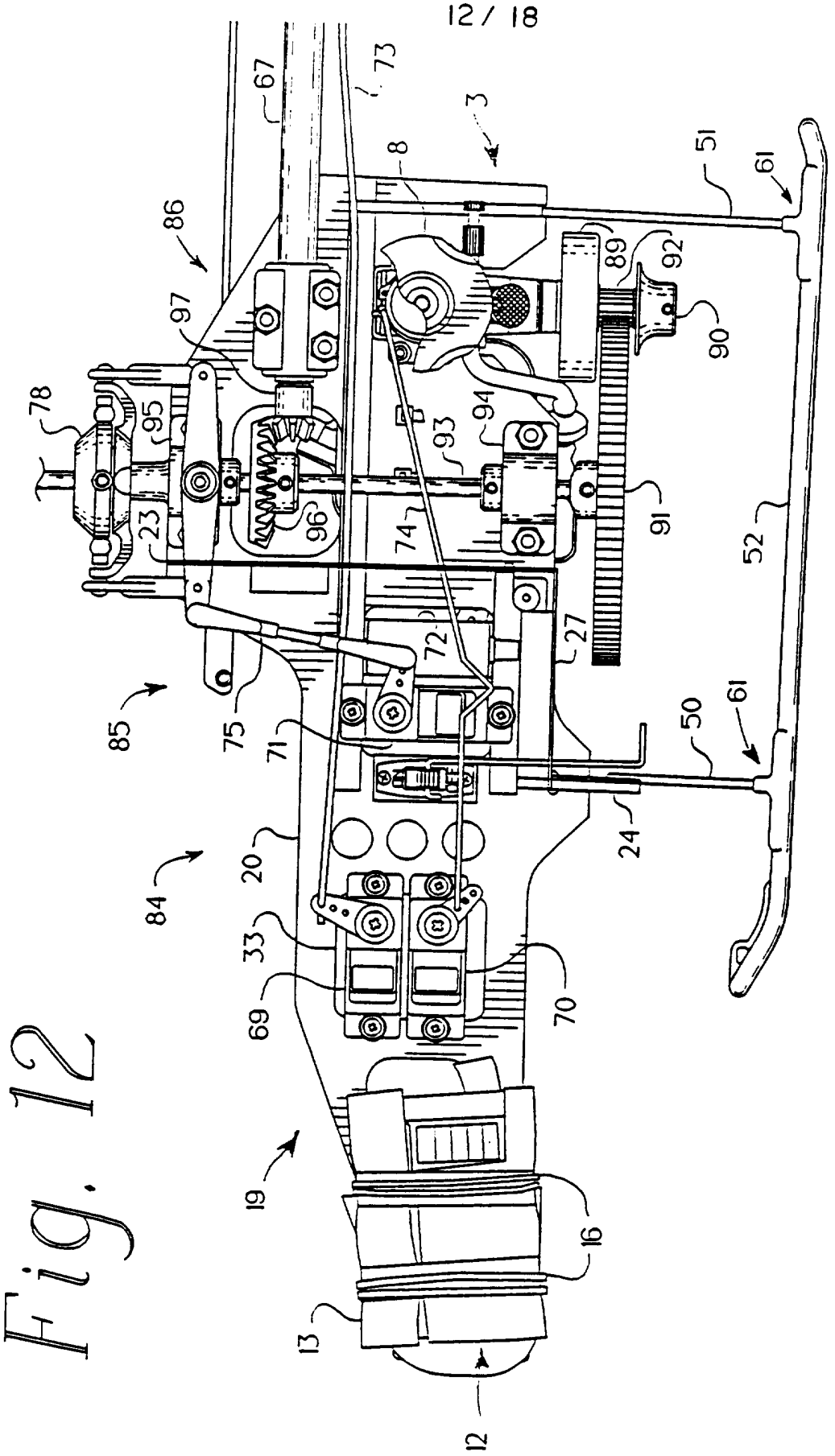
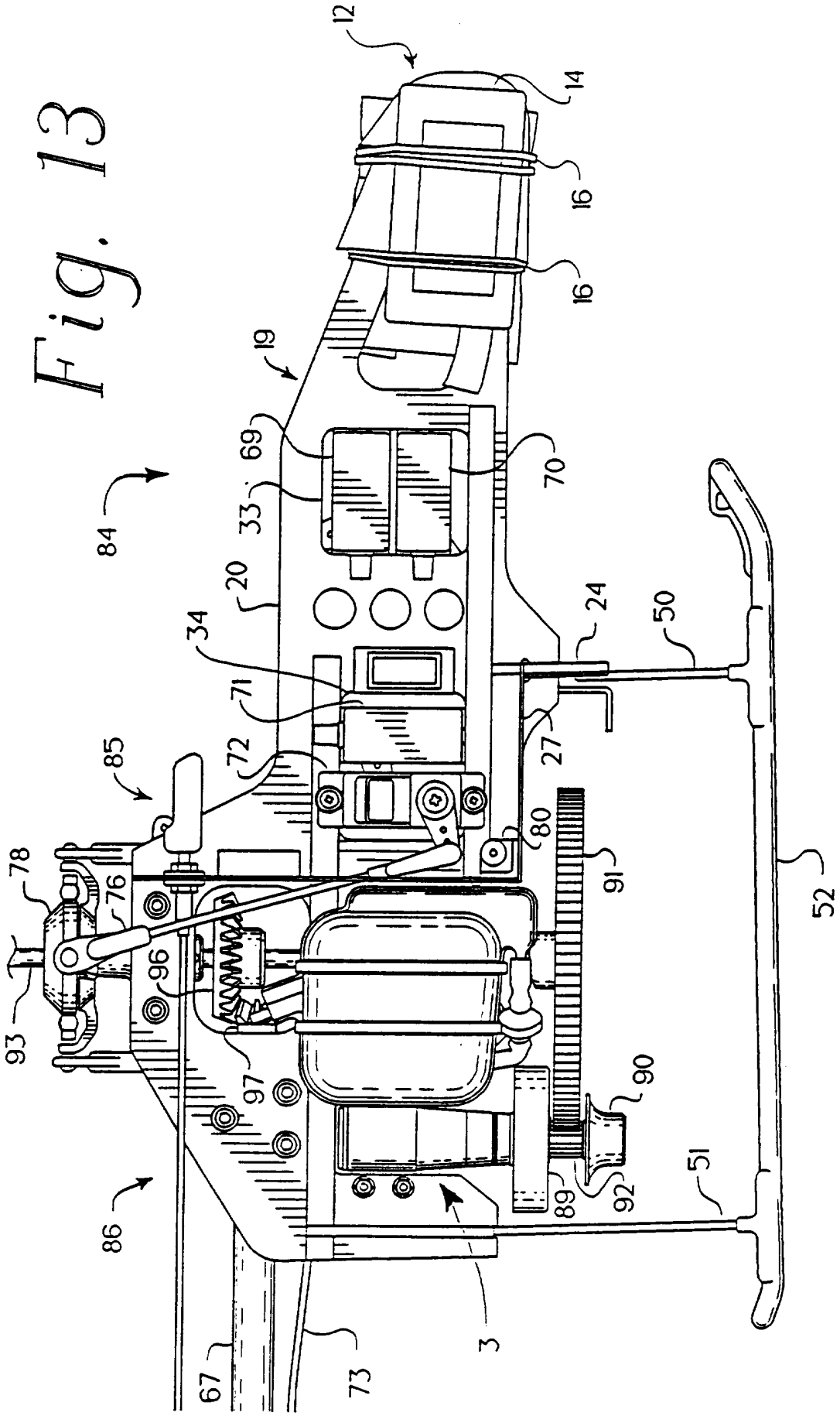

67
73
3
8
51
61
86
89
92
97
90
78
95
94
93
23
96
74
91
52
72
27
85
75
71
50
61
24
84
20
33
69
70
19
16
13
12

Fig. 12

Fig. 13


12
14
16
16
19
69
70
84
33
20
34
24
50
71
72
27
85
80
91
78
76
52
96
93
97
90
86
89
92
51
3
67
73

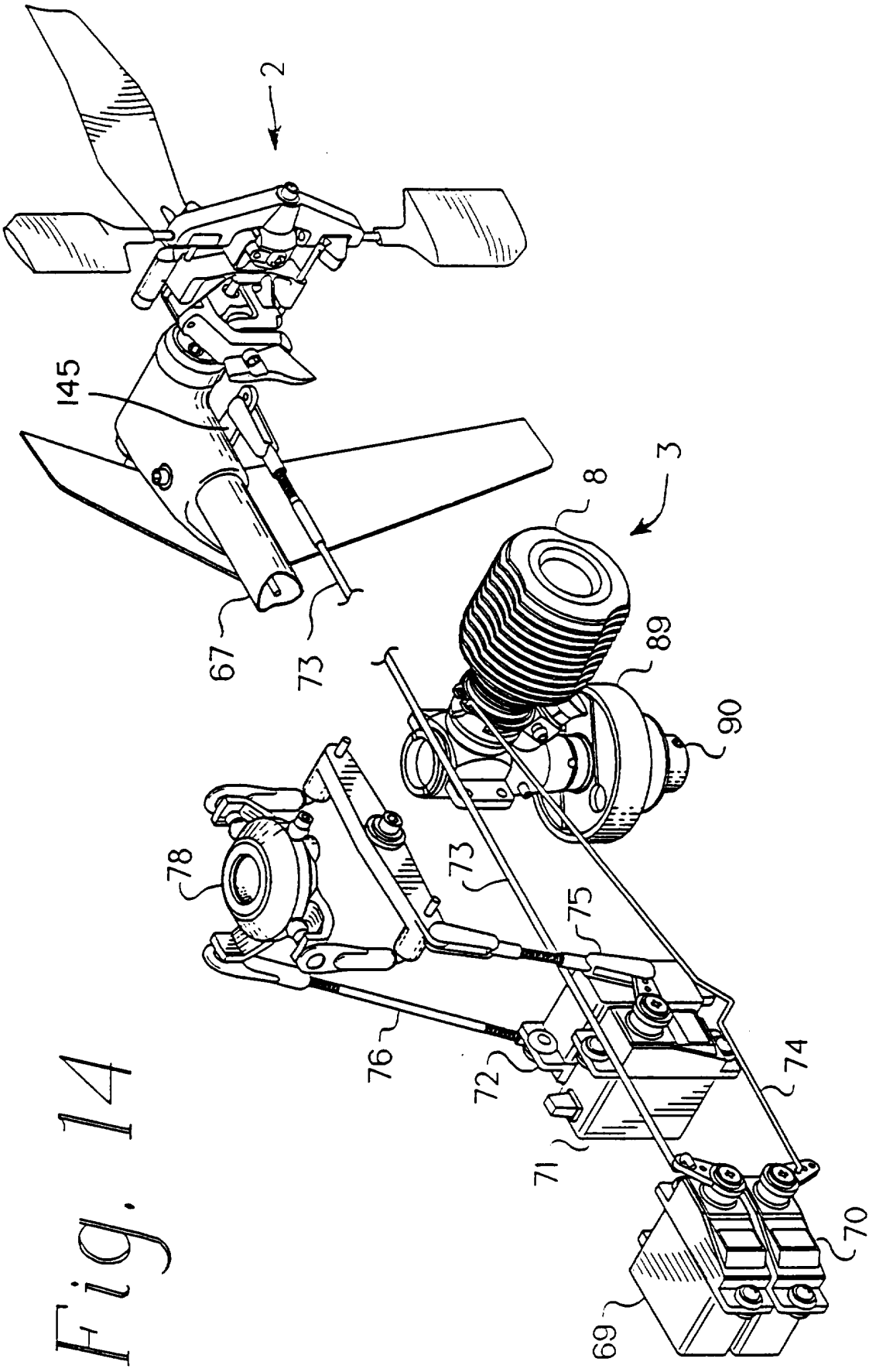


Fig. 14

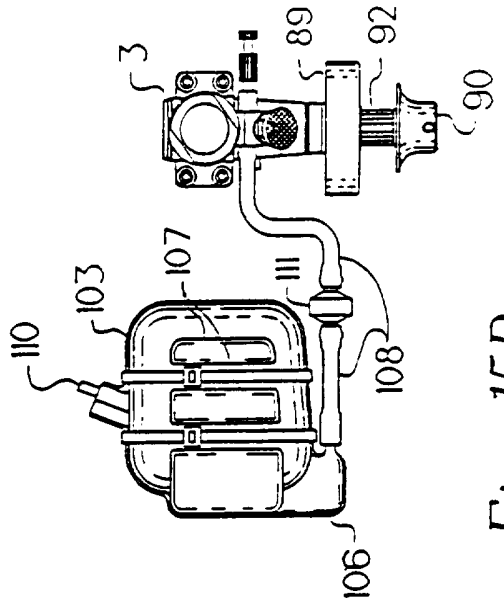
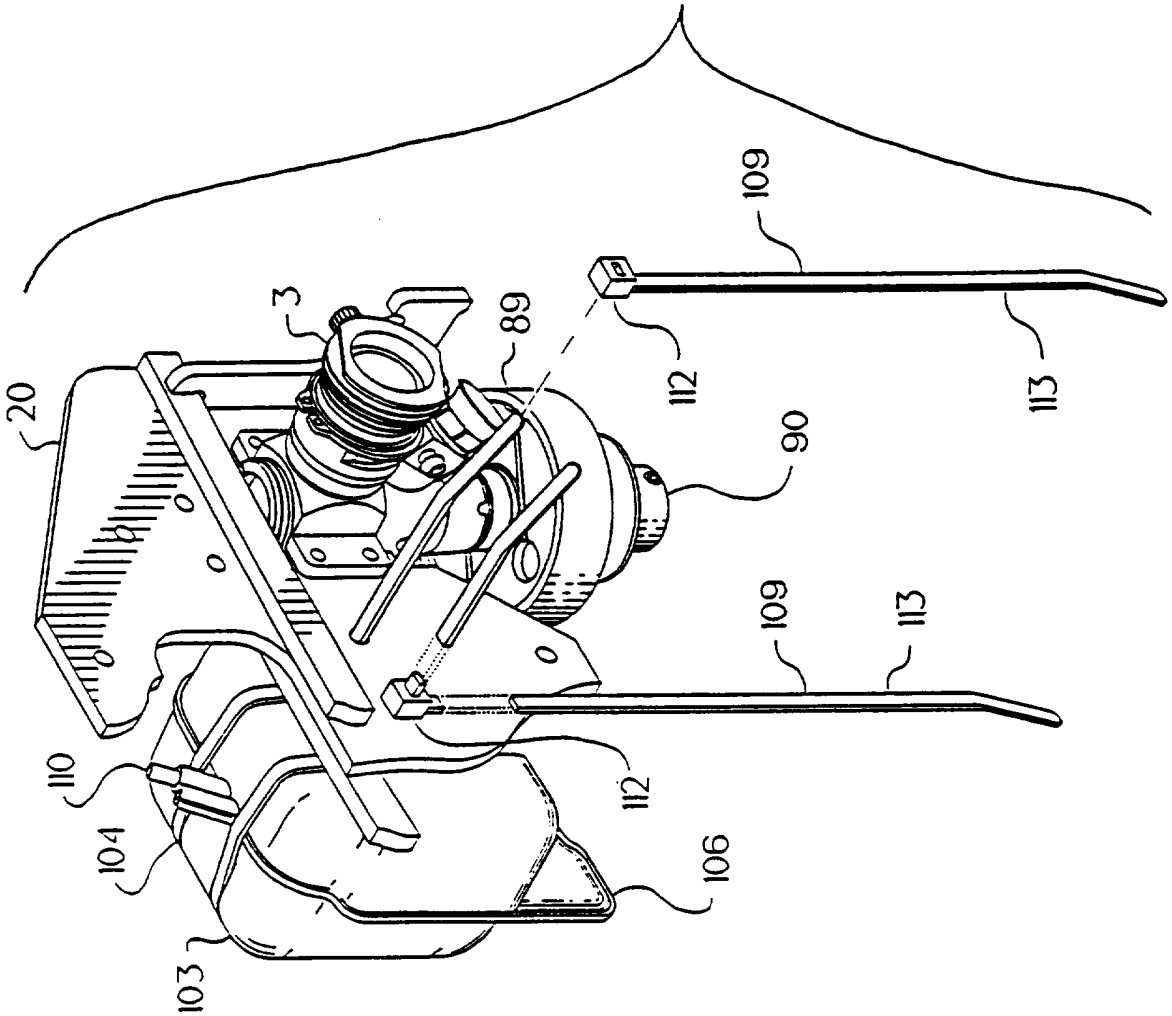


Fig. 15B

Fig. 15A



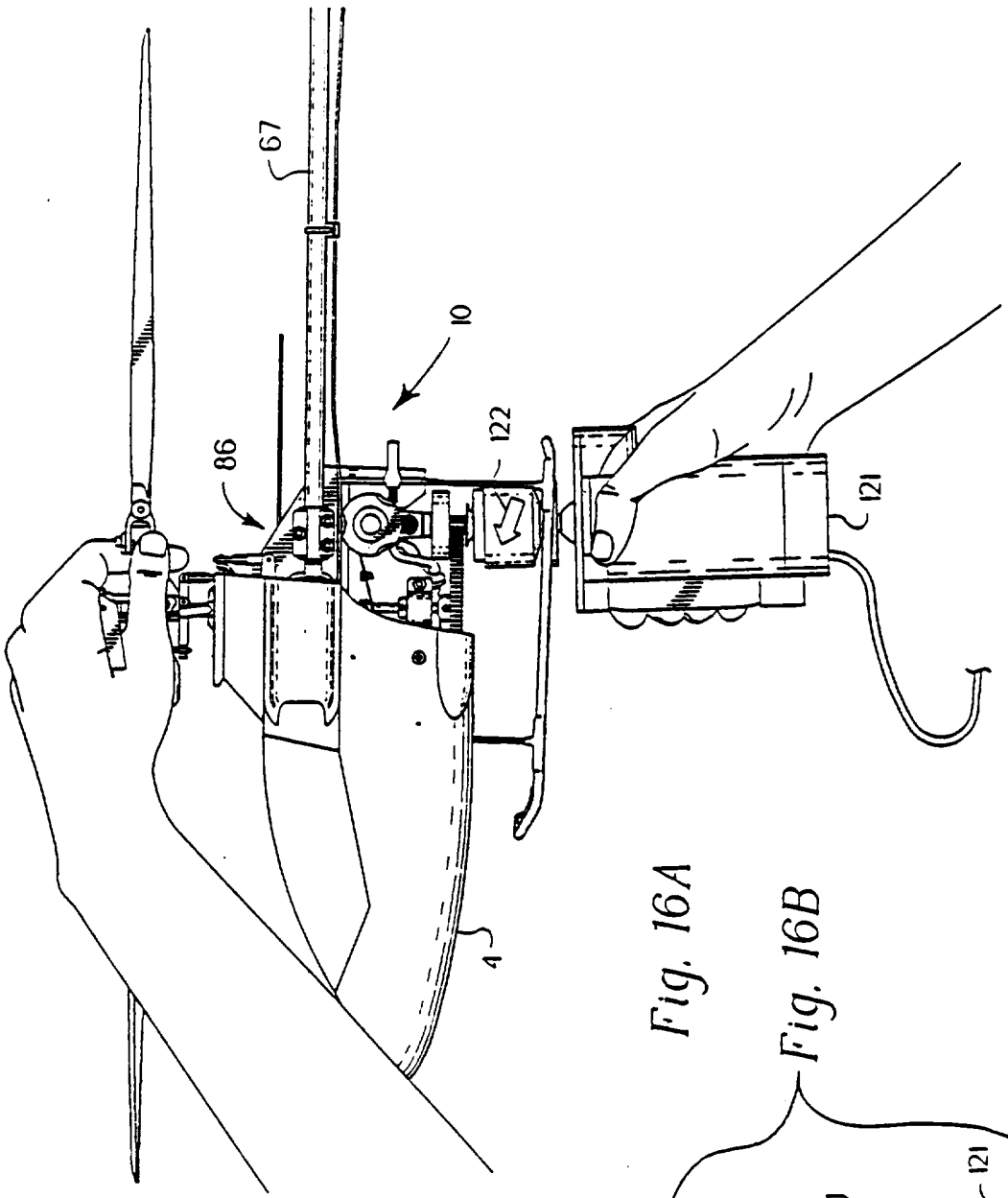


Fig. 16A

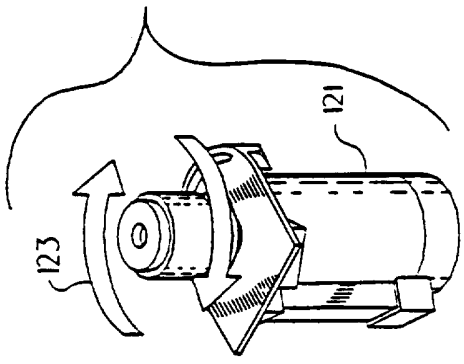


Fig. 16B

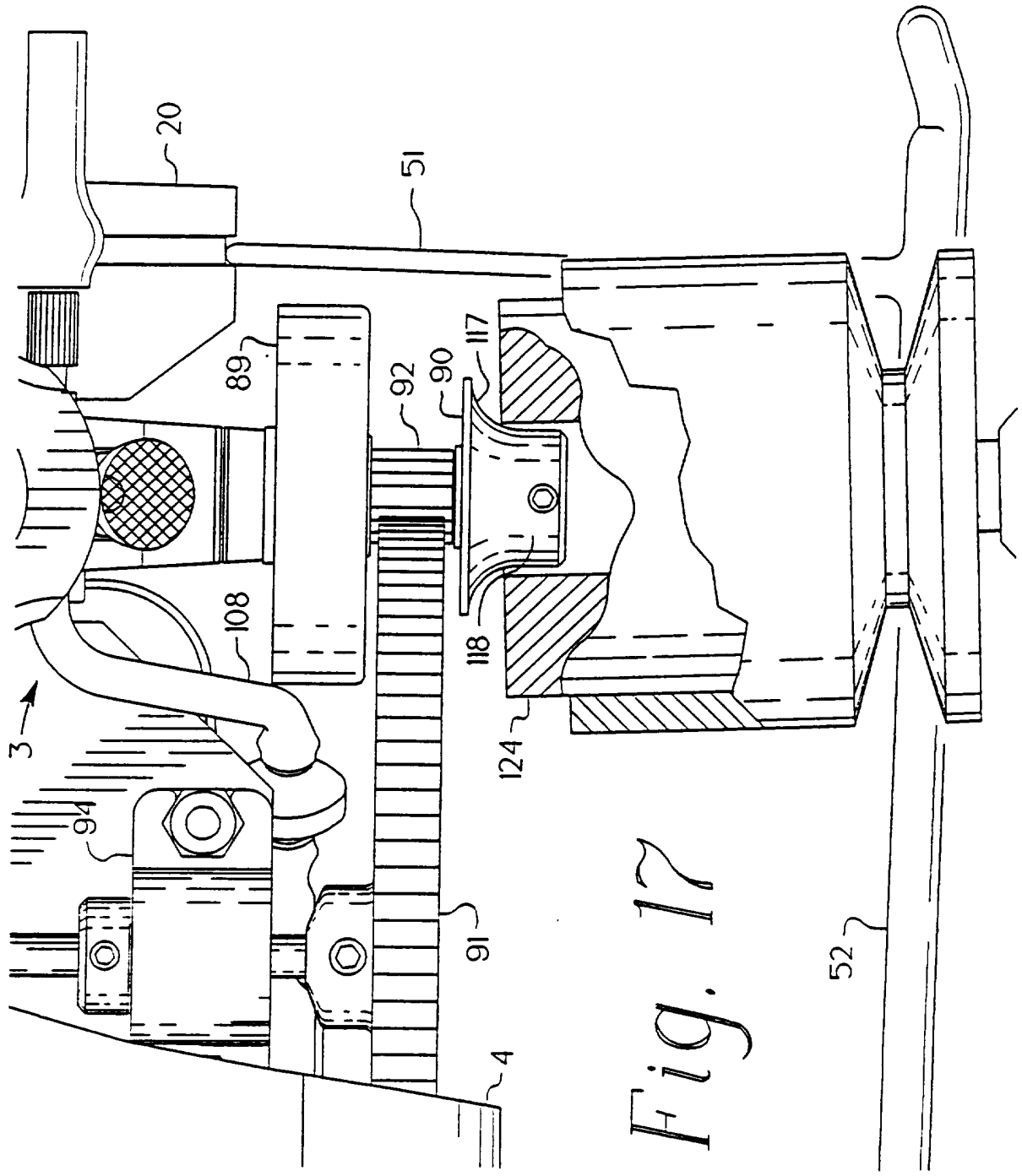


Fig. 17

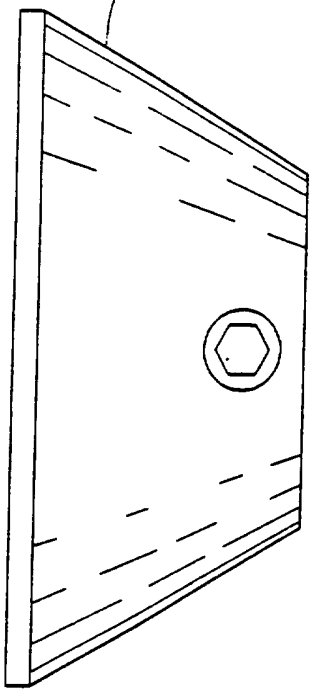


Fig. 18A

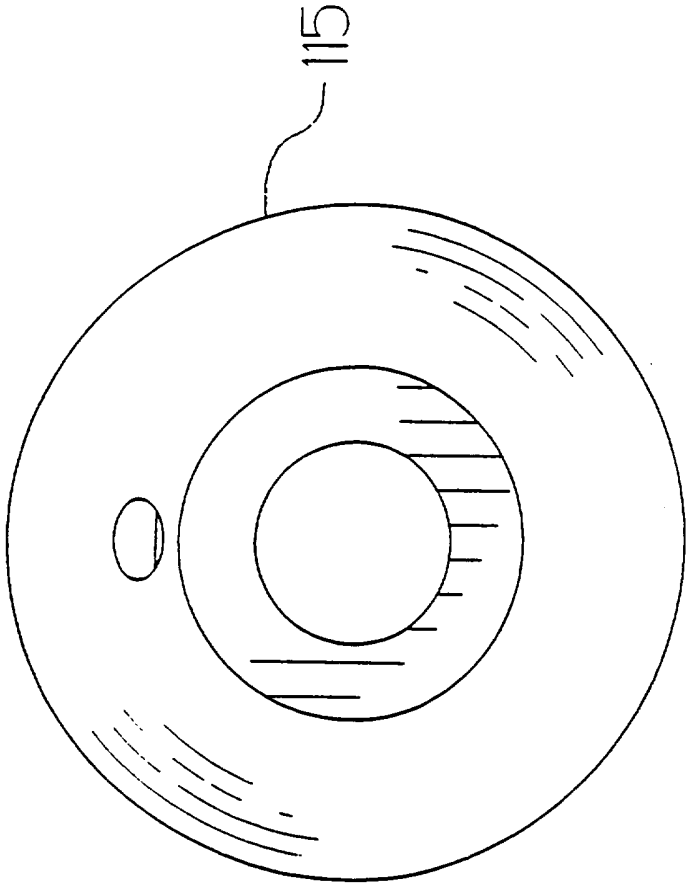


Fig. 18B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10489

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B64C 01/06, 01/12, 13/20, 25/52, 27/04

US CL :Please See Extra Sheet.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 244/17.11, 17.17, 17.19, 17.21, 108, 119, 120, 121, 131, 132, 133, 189; 446/ 36, 37

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 3,127,696 (PAGLIUSO) 07 APRIL 1964, see entire document.	1,14, 15, 18,24 --- 2-4, 7, 17, 25-28, 30
Y	US, A, 3,144,223 (NICHOLS) 11 AUGUST 1964, see figure 1.	25
A	US, A, 4,270,711 (CRESAP ET AL.) 02 JUNE 1981, see Figure 1.	NONE
A	US, A, 4,579,301 (BRAND) 01 APRIL 1986, see Figure 9.	NONE
Y	US, A, 4,706,907 (KOPYLOV) 17 NOVEMBER 1987, see entire document.	3,4,7

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

19 DECEMBER 1995

Date of mailing of the international search report

25 JAN 1996

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

VIRNA LISSI MOJICA

Telephone No. (703) 308-1113

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10489

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 5,037,041 (UNTERHITZENBERGER) 06 AUGUST 1991, see figure 2.	NONE
A	US, A, 5,301,900 (GROEN ET AL.) 12 APRIL 1994, see entire document.	NONE
A	US, A, 5,381, 988 (KATTAS) 17 JANUARY 1995, see Figure 1.	NONE
A	US, A, 5,358,201 (BROWN, SR.) 25 OCTOBER 1994, see Figure 6.	NONE
X	GB, A, 1,205,263 (WILSON) 16 SEPTEMBER 1970, see Figure 2.	8,9,11-13, 28
A	DT, A, 2,332,991 (HENZLER) 10 JANUARY 1974, see Figures 1-2.	NONE
Y	JP, A, 4-31197 (YOICHI ONISHI) 03 FEBRUARY 1992, see Figure 1.	26, 27

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10489

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
1-18 and 24-30

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10489

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

244/17.11, 17.17, 17.19, 108, 119, 120, 132, 133, 189; 446/ 36, 37

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s)1-7 and 24-30, drawn to a fuselage structure that includes a keel, a canopy and landing gear.
Group II, claim(s) 8-13, drawn to a landing gear assembly.
Group III, claim(s) 14-18, drawn to a helicopter canopy.
Group IV, claim(s)19-23, drawn to a starting device.
Group V, claim(s) 31, drawn to a fuselage structure which includes an engine and a starting device drawn to .
The inventions listed as Groups I - V do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: Groups I-V lack a showing of a single inventive concept since they are drawn to inventions which are known to be separate inventions to one of ordinary skill in the art, as well as by their separate classification status.