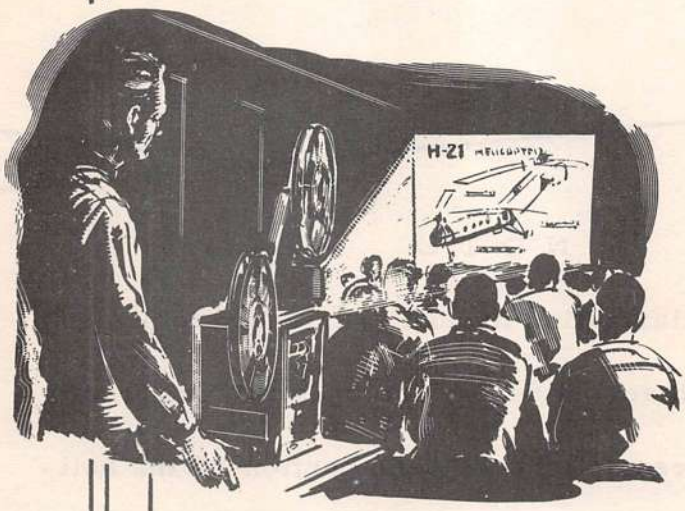
H-21

FAMILIARIZATION MANUAL

Piasecki helicopter corporation

MORTON, PENNSYLVANIA

FAMILIARIZATION MANUAL



NOTE:
This manual is published for familiarization purposes only & not to be used in lieu of the applicable technical order.

TECHNICAL SERVICE SCHOOL
SERVICE DEPARTMENT
August 1955

NOTE

This familiarization manual is intended to present basic H-21 series design features without greatly detailed descriptions of each portion of the helicopter. Small design differences between the YH-21, H-21A, H-21B, and H-21C have not been described, and the data has been presented so as to form a simplified composite picture of the four versions of H-21 series.

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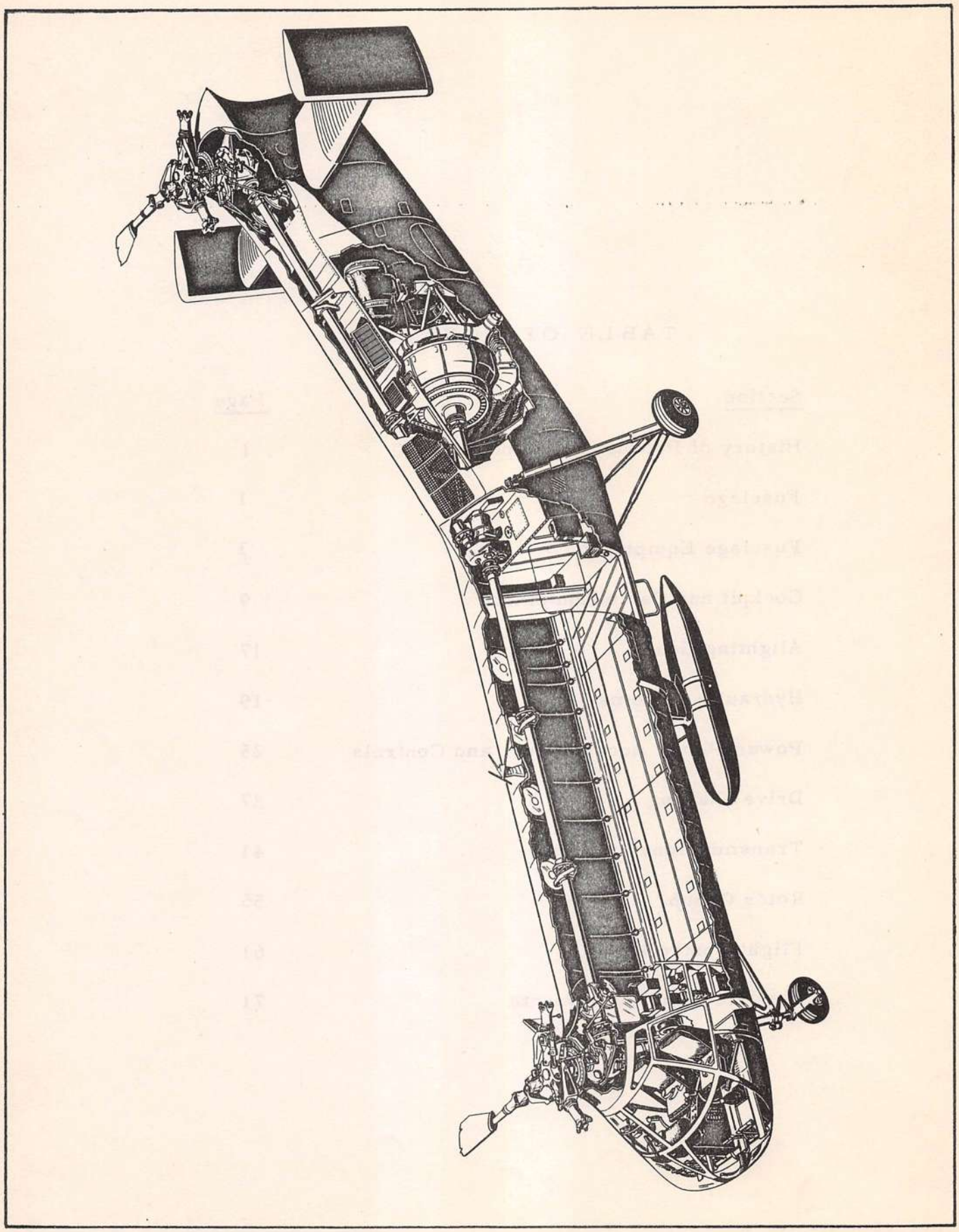


TYPICAL MODEL H-21 SERIES CUT-AWAY VIEW

HISTORY

OF PRODUCT DEVELOPMENT

PIASECKI HELICOPTER CORPORATION

The Piasecki Helicopter Corporation is the first company in the United States that was formed for and which has been devoted exclusively to the development and manufacture of helicopters.

Originated in 1940 by a group of young engineers who met for discussions and experiments in rotary wing design, the company was incorporated in 1943 as the P-V Engineering Forum. In 1946 the company was refinanced, expanded, and renamed Piasecki Helicopter Corporation.

The first helicopter was the single place, single rotored PV-2. Work was undertaken on this model with an original investment and working capital of $3,000. Operations were begun in an unused restaurant in downtown Philadelphia and were moved later into an empty garage in Roxborough.

The PV-2 was first flown in April, 1943. It was one of the first successful helicopters to be built and flown in the United States, and was the world's smallest helicopter.

Late in 1943, the U. S. Coast Guard requested the Navy to procure a large transport type helicopter to be used for rescue work. The characteristics required of this helicopter included ability to:

a. carry an 1800-pound payload;
b. land on the deck of a vessel in rough seas;
c. take aboard a shifting and unpredictable load in rescue work;
d. withstand large center of gravity displacement;
e. take aboard up to five men or their equivalent on a rescue ladder or hoist and still keep an even keel.

After investigating every conceivable configuration, it was finally decided that the tandem rotored design would best fulfill all of the above requirements. Advantages of the tandem design which influenced this decision included the following:

a. Large permissible displacement of the center of gravity, permitting wide latitude in the placement of payload within the passenger-cargo compartment.
b. Elimination of a power-consuming anti-torque device, making available more power to produce lift, especially during hovering and vertical climb when the power requirement is high.

c. Maximum space for accommodation of payload with minimum drag-producing frontal area with an airframe connecting two longitudinally disposed rotors.
d. Powerful longitudinal and directional control as a result of the rotors being a considerable distance from the center of gravity, thereby generating large force couples.
e. No hazard to personnel on the ground with both rotors mounted at the top of the structure.
f. Adequate clearance between the rotor blades and the ground or ground objects assuring less likelihood of damage to the helicopter in tail-low, quick-stop landings or other maneuvers.
g. Interchangeability of parts of the forward and rear rotor hubs, upper controls and rotor transmissions because the two rotors are of equal size.
h. Hovering in high side winds made possible by the powerful lateral thrust and yaw control of tandem rotors.
i. Efficient structure because the cabin, engine and fuel installation, and rotor supporting structure can all be combined within the fuselage and disposed between the rotors.

On February 1, 1944, Piasecki received its first contract from the Bureau of Aeronautics, Navy Department, for the design and construction of the PV-3—the design created to fulfill the Coast Guard requirement. This helicopter was designated XHRP by the Navy. The company completed contracts for three of these experimental tandem helicopters which were prototypes of the HRP-1. A total of 20 of the latter models were built for the Navy, Coast Guard, and Marines. The HRP-1 is an 8 to 10-place, single engine, passenger and cargo transport type helicopter. It is powered by a 600-horsepower Pratt and Whitney R-1340 radial air-cooled engine, which drives two 3-bladed, non-overlapping 41-foot diameter rotors. It carries approximately a ton of useful load. The basic structure of the fuselage is steel tube with fabric covering. The HRP-1 is equipped with a fixed tricycle landing gear. The basic mission of the HRP-1 is rescue, utility, personnel and cargo transport.

The Navy Bureau of Aeronautics wrote requirements in 1945 for a high performance, utility helicopter to operate from aircraft carriers, battleships, and cruisers. In 1946, Piasecki Helicopter Corporation won a design competition for this type, and the XHJP-1 was the result. Production models of the XHJP-1 are known as the HUP-1, -2, -2S, -3, and H-25A. It is a tandem rotored, 4 to 7-place, single engine, rescue and utility helicopter. The fuselage is of all-metal, semi-monocoque construction with a conventional fixed landing gear. It is powered by a Continental R-975-46 engine with a take-off rating of 550 horsepower. The overlapped tandem design provides a compact fuselage and rotor system, permitting the HUP to go down any aircraft carrier elevator without folding the blades and down a cruiser elevator with blades folded. The mission of the HUP is shipbased rescue, observation and utility, personnel and cargo transport. The HUP-2

is the first production helicopter to be equipped with an auto-pilot which permits automatic "hands off" flying. Piasecki Helicopter Corporation has delivered 339 HUP type helicopters to the U. S. Navy, U. S. Army, Royal Canadian Navy, and the French Navy.

In June, 1948, Piasecki received a limited production contract from the Navy Department for the all-metal HRP-2 helicopter, a substantially improved and modernized version of the HRP-1. The contract called for five of this streamlined version. Principal improvements of the HRP-2 over the HRP-1 are its semi-monocoque fuselage, side-by-side pilot seating, improved visibility under all flight conditions, and greater cabin capacity. Primary use of the HRP-2's was for Marine Corps amphibious assault evaluations and training.

In June, 1949, Piasecki received an invitation from the U. S. Air Force Air Materiel Command to submit proposals for a large, high-altitude Arctic rescue helicopter to be used by the Air Rescue Service of the Military Air Transport Service. Piasecki proposed a more powerful version of the HRP-2 in this competition. The award was made to Piasecki and the H-21 Work Horse was born.

The H-21 type helicopter is a tandem rotored design with two 44-foot diameter, 3-bladed rotors which are powered by a Wright R-1820-103 engine. The fuselage is of all-metal semi-monocoque construction with side-by-side seating for pilot and co-pilot in the transparent nose enclosure. The pilot's seat is on the right, and complete dual controls are included. All flight controls are hydraulically actuated, providing fingertip operation of the cyclic and collective pitch controls and minimum foot pressure on the directional pedals. Even with the hydraulic system inoperative, the direct mechanical system makes it possible for one pilot to fly the H-21 Work Horse for extended periods without undue fatigue. Winterization features permit operation of the helicopter at temperatures as low as minus 65°F. Inflatable floats can be fitted to the tricycle wheel landing gear, thereby enabling the helicopter to alight on any type of surface. The cabin can accommodate 12 litters plus two medical attendants or, alternatively, up to 20 troop seats. Items of equipment which are too bulky to fit into the cabin can be carried suspended below the fuselage on an external cargo sling. Personnel or cargo loads of up to 400 pounds can be loaded or unloaded by means of a hydraulic hoist while the helicopter is hovering.

Two basic versions of the H-21 type helicopter have been designed and manufactured. Since the Arctic rescue version (YH-21 and H-21A) was required to meet stringent altitude performance criteria, the rotor and drive systems and the basic structure of the aircraft were designed for the reduced power (1150 horsepower) available from the engine at high altitudes, thereby reducing helicopter weight and providing maximum performance at high altitudes. The cabins of the YH-21 and H-21A are equipped with 14 troop seats.

The other basic version of the H-21 type utilizes the full take-off rating (1425 horsepower) of the engine. It is being manufactured for the U. S. Air Force (model H-21B) as a tactical assault transport helicopter and for the U. S. Army (model H-21C) as a tactical and logistical support vehicle. Both of these models have bullet-sealing oil tanks and provisions for a bullet-sealing fuel cell. Either model can be equipped with armor kits to provide protection from small calibre projectiles for vital components such as gear boxes, oil coolers, and the crew compartment. Complete provisions for auxiliary external fuel tanks and inflatable floats are incorporated in both models. The cabin will accommodate 20 troop seats. The external cargo sling has a capacity of two and one-quarter tons (4500 pounds). An auto-pilot is installed in the H-21B, and provisions for the auto-pilot are incorporated in the H-21C.

A U. S. Air Force design competition for a large rescue helicopter, which was announced early in 1946 and won by the Piasecki Helicopter Corporation, resulted in the development of the H-16 type helicopter, the most advanced twin engined transport type helicopter flying today.

The USAF contract for the YH-16 and YH-16A involves the development of a large utility transport tandem helicopter for the USAF and U. S. Army for troop and cargo transport. The first unit (YH-16), a dynamic test article, made its initial flight at the Philadelphia International Airport on 23 October 1953. Since its first flight, the Transporter has made numerous test flights. It has reached speeds in excess of 130 miles per hour in early forward flight tests. Piasecki pilots report that the helicopter has very good flying qualities.

The second unit (YH-16A), powered with two shaft turbine engines, is scheduled to fly in the spring of 1955. The U. S. Army is actively programming quantity procurement of a higher-powered, 5 to 7-ton payload version of the H-16 type helicopter.

The present YH-16 is a 40-passenger, twin-engined transport helicopter designed and built for the U. S. Air Force. The helicopter's fuselage is nearly 78 feet long, about the size of a Convair Liner, the popular fixed-wing transport used by several airlines. With the rotors turning, the over-all length is 134 feet. The rotors are 82 feet in diameter.

The first helicopter in the H-16 series (YH-16) is powered by two Pratt & Whitney R-2180 reciprocating engines with take-off power ratings of 1650 horsepower each. The second aircraft in this series (YH-16A) will have two Allison T-38 type shaft turbines rated at 2222 shaft horsepower. The YH-16A is designed for speeds over 125 miles per hour (109 knots), a range of more than 200 statute miles, and a service ceiling of over 18,000 feet.

The configuration of the YH-16 is similar to that of the smaller Piasecki HUP. The fuselage is straight with a high tail section that rises 25 feet

off the ground.

There is an engine installed beneath each rotor. Each engine drives the rotor overhead through a transmission, and the two transmission assemblies are connected by a shaft that runs along the upper part of the fuselage. In the event one engine fails, the other unit will drive both rotors.

Performance remains classified except for the fact that the YH-16's design gross weight is over 30,000 pounds.

Because the turbine engines are lighter and more powerful than the piston engines, the proportion of payload in the second aircraft (YH-16A) will exceed that of the YH-16 by a generous margin.

In addition to its 40 passengers, the helicopter will carry a normal crew of three. The large cockpit has room for a pilot and co-pilot as well as a flight engineer or navigator.

There is a conventional loading door at the forward end of the large cabin, and a ramp at the rear of the cabin that can be lowered for fast loading and unloading of passengers, cargo, or litter patients. The cabin can be arranged to carry 32 men in litters instead of 40 seated passengers.

Outside the forward cabin door there is a cable hoist that can be operated by the pilot. This will permit loading or unloading of cargo or personnel over water or terrain where the helicopter cannot land.

Originally conceived as a rescue helicopter, the YH-16's enormous load-carrying capacity has led both the Air Force and the Army to expand their conception of how it can be used in military logistic operations.

Experience in Korea, especially, has opened up new applications for the 5 to 7-ton H-16 type helicopter. This aircraft will be able to transport over 40 fully-equipped soldiers to the battlefront and land them without need of prepared landing areas. Long, rough, and hot truck rides, road building and maintenance will be a thing of the past.

For moving supplies, including guns and ammunition, it is not necessary to load the H-16. A sling hung from the bottom of the fuselage can be used to carry equipment, and the pilot can unload his cargo with the flick of a switch.

Piasecki has other designs for the H-16, including one with a high landing gear that will permit the use of a cargo pod fastened on the belly of the aircraft. The pods can be loaded and unloaded or moved about on the ground independent of the helicopter, much like truck trailers.

PHC intends to continue to devote all its efforts to the development and production of helicopters. In order to secure the most rapid and efficient advances in performance and reliability at a minimum of cost, PHC has been operating under certain philosophies which call for:

a. developing successive models of a given type in order to secure the greatest possible value from service experience on components and the entire helicopter;
b. giving full consideration to both present and future functional requirements to make certain:

    1. the product will do the immediate job well;
    2. it will have growth possibilities for early future use.

Prime emphasis will be given to meeting or exceeding all aspects of Military Service Requirements including performance, reliability, and reduced cost.

For over a decade the company has been making noteworthy contributions to the advancement of technological progress in the field of rotary wing aeronautics. The Piasecki organization has:

a. developed and built the world's first successful tandem rotored helicopter;
b. designed and manufactured the first rotary wing aircraft (HUP) to be officially designated a "Fleet Helicopter" by the U. S. Navy;
c. delivered several hundred of these HUP models to the U. S. Navy, with additional units of this type delivered to the U. S. Army and the French Navy;
d. designed and built the H-21 (PH-42) helicopter which established helicopter records for speed (146.735 miles per hour) and altitude (22, 210 feet), which was the first helicopter to demonstrate satisfactory characteristics for operations at temperatures down to minus 65°F, and which is being procured in quantity for the U. S. Air Force, the U. S. Army, and the Royal Canadian Air Force;
e. developed, manufactured, and flown the first production prototype helicopter in the United States of over 40-place capacity — the twin engined YH-16, which made its initial flight on 23 October 1953;
f. pioneered the application of automatic pilot devices to helicopters, which resulted in the first successful cross-country flight of a helicopter under the control of an auto-pilot from take-off to landing and through which the Piasecki HUP-2 became the first production helicopter to incorporate an auto-pilot as standard equipment;
g. advanced rotary wing designs and helicopter applications which are of a military classified nature.

The Piasecki Helicopter Corporation has a total of almost 4,000 personnel, which includes a staff of nearly 400 rotary engineering specialists and a manufacturing force of over 2,000. Total plant area is 830,000

square feet. The Piasecki production organization employs the most modern machinery and techniques for the economical production of quality transport helicopters.

Most of the company's facilities are located in the suburban Philadelphia area: main offices and principal plant at Morton, subassembly manufacturing at Ardmore; flight testing at the Philadelphia International Airport; and warehouses at Chester, Pa. and Wilmington, Del.

Piasecki Helicopter Company of Canada, Ltd. (a wholly-owned subsidiary of the Piasecki Helicopter Corporation) occupies a 42,000-square foot hangar at Arnprior, Ontario for the overhaul and repair of Piasecki Helicopters purchased by the Canadian government. In addition, certain tools, fixtures, and helicopter parts will be manufactured at Arnprior.

Quality control and component testing are of vital importance to product reliability. Exhaustive testing of all components of the H-21 type helicopter has been accomplished to insure the highest possible degree of reliability under rigorous operating conditions.

The following text containing a semi-technical review of one of our current helicopter types is presented in order to delineate the various basic features of this aircraft for your information.

FUSELAGE

The fuselage of the H-21 is a semi-monocoque structure. The fuselage shell is reinforced by frames, vertical stiffeners, bulkheads, longitudinal intercostals, beams, longerons, and a keel with a removable section in the engine compartment.

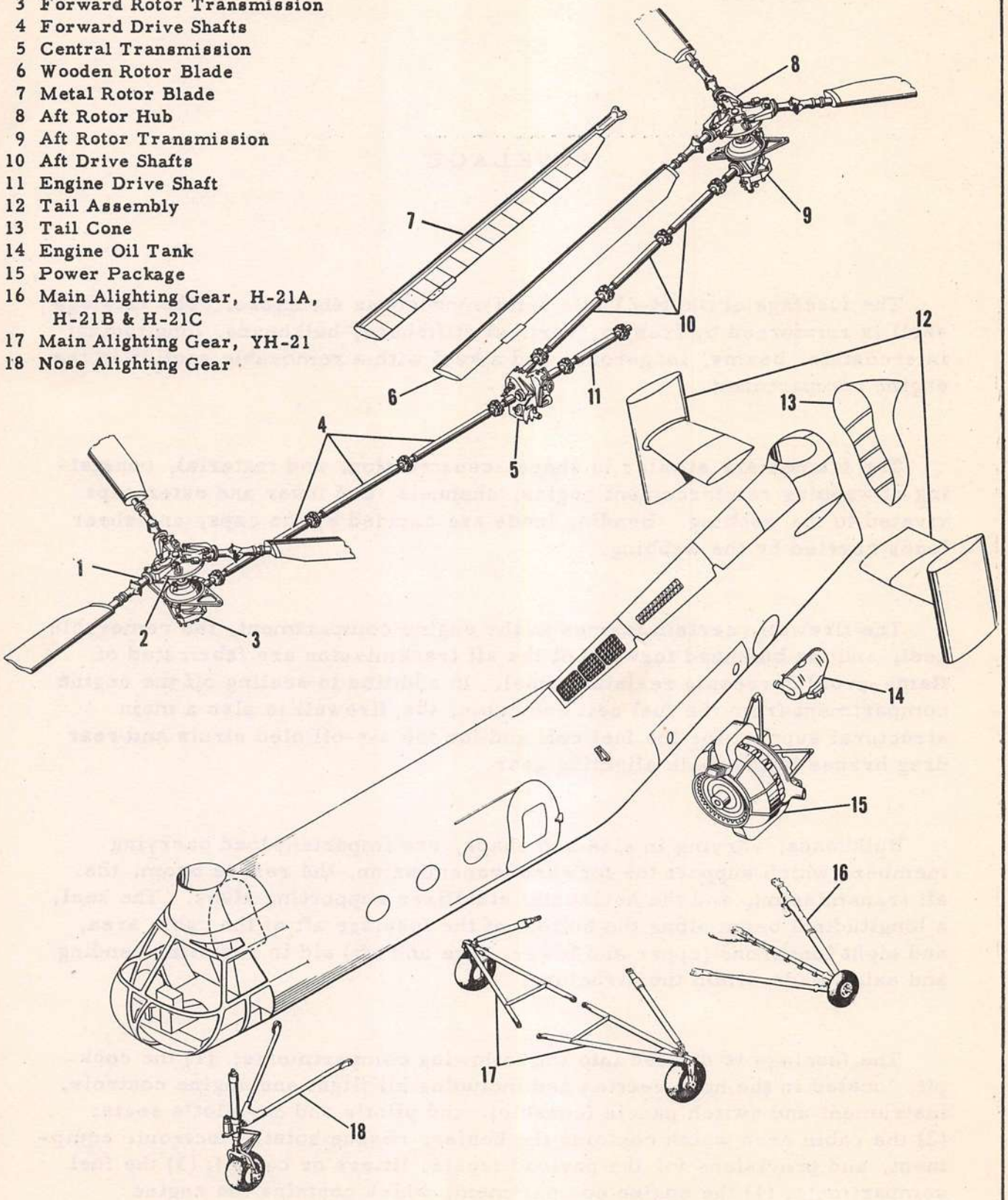
The frames are similar in shape, construction, and material, consisting of webbing reinforcement angles, channels, and inner and outer caps riveted to the webbing. Bending loads are carried by the caps, and shear loads carried by the webbing.

The firewall, certain frames in the engine compartment, the removable keel, and the bulkhead forward of the aft transmission are fabricated of flame-proof corrosion resistant steel. In addition to sealing off the engine compartment from the fuel cell and cabin, the firewall is also a main structural support for the fuel cell and for the air-oil oleo struts and rear drag braces of the main alighting gear.

Bulkheads, varying in size and shape, are important load carrying members which support the forward transmission, the rescue boom, the aft transmission, and the horizontal stabilizer supporting stubs. The keel, a longitudinal beam along the bottom of the fuselage aft of the cabin area, and eight longerons (upper and lower, fore and aft) aid in resisting bending and axial loads within the structure.

The fuselage is divided into the following compartments: (1) the cockpit, located in the nose section and including all flight and engine controls, instrument and switch panels (console), and pilot's and co-pilot's seats; (2) the cabin area which contains the heater, rescue hoist, electronic equipment, and provisions for the payload (seats, litters or cargo); (3) the fuel compartment; (4) the engine compartment, which contains the engine package, oil cooling systems, and the inverters; and (5) the tail section, which contains the aft transmission and horizontal stub supports for the stabilizers and the fibre-glass tail cone fairing.

1 Forward Rotor Hub
2 Rainshield
3 Forward Rotor Transmission
4 Forward Drive Shafts
5 Central Transmission
6 Wooden Rotor Blade
7 Metal Rotor Blade
8 Aft Rotor Hub
9 Aft Rotor Transmission
10 Aft Drive Shafts
11 Engine Drive Shaft
12 Tail Assembly
13 Tail Cone
14 Engine Oil Tank
15 Power Package
16 Main Alighting Gear, H-21A, H-21B & H-21C
17 Main Alighting Gear, YH-21
18 Nose Alighting Gear



MAJOR COMPONENTS

FUSELAGE EQUIPMENT

A. NOSE ENCLOSURE

The nose enclosure is comprised of twelve transparent plastic panels and one laminated glass panel with the necessary framework to support them. The laminated glass panel is located on the right side in front of the pilot to provide clearer vision and a scratch-proof surface for a windshield wiper.

B. COCKPIT SLIDING WINDOWS

Windows on either side of the cockpit are retained at the top and bottom by tracks on the outside of the fuselage. The windows are normally opened by depressing a trigger located in the forward lower corner and pulling the window aft. For emergency exit, the windows may be jettisoned by pulling the emergency release handle and allowing the windows to fall free.

C. CABIN AND RESCUE DOORS

The main cabin door is located in the middle of the left side of the fuselage. The rescue door is located just aft of the cockpit on the right side. The doors are suspended from slotted tubular tracks bolted to the outside of the fuselage. Roller assemblies attached to the tops and bottoms of the door allow them to slide open or closed position. Transparent plastic knock-out panels are contained in each door for emergency escape.

D. CABIN WINDOWS

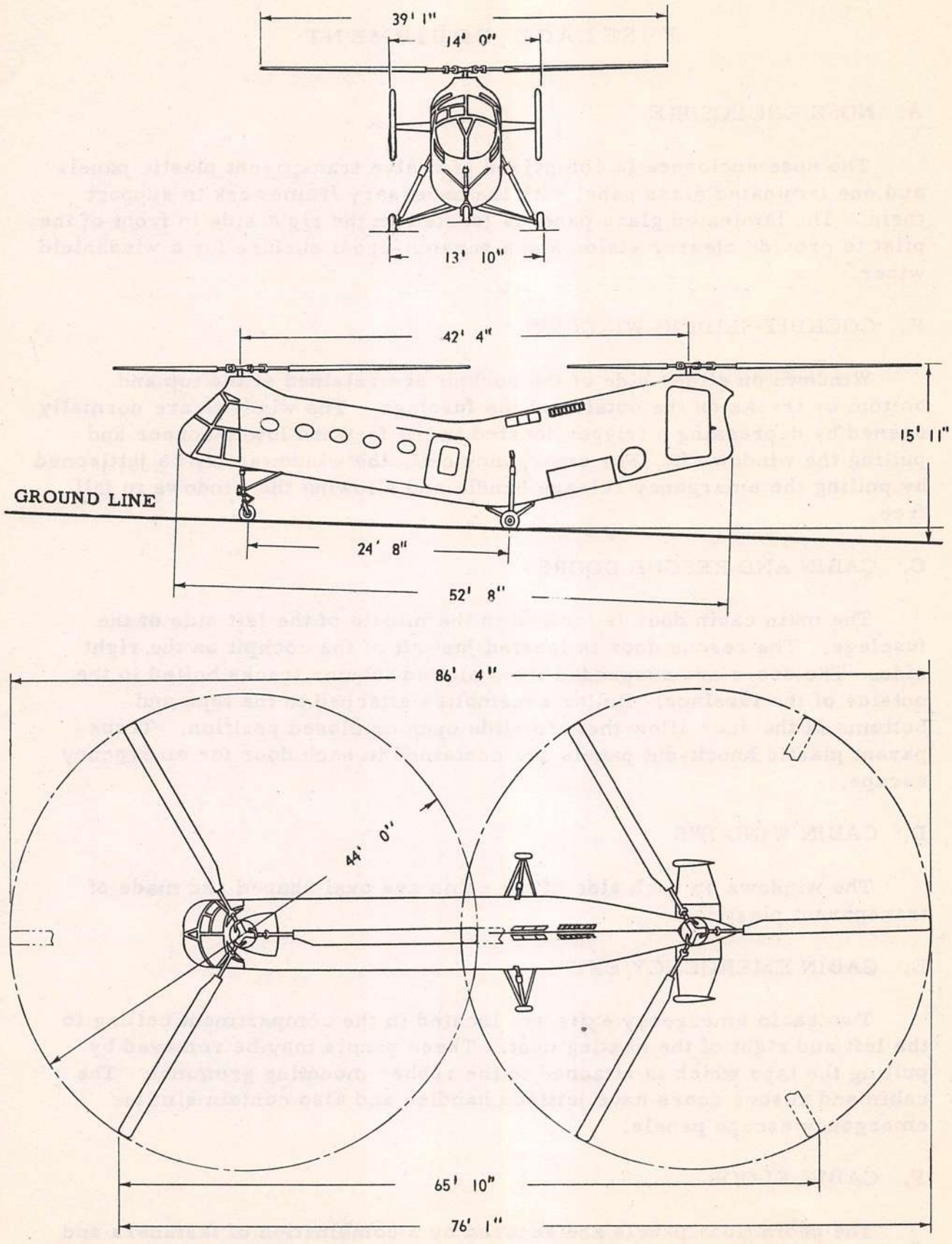
The windows on each side of the cabin are oval shaped and made of transparent plastic.

E. CABIN EMERGENCY EXITS

Two cabin emergency exits are located in the compartment ceiling to the left and right of the heating duct. These panels may be removed by pulling the tape which is attached to the rubber mounting grommet. The cabin and rescue doors have jettison handles and also contain similar emergency escape panels.

F. CABIN FLOOR

The cabin floor panels are secured by a combination of fasteners and screws. Fittings are located throughout the floor surface to facilitate installation and anchorage for cargo, troop seats, and/or litters.



TYPICAL OVERALL DIMENSIONS—H-21C SHOWN

G. ENGINE HATCH DOORS

Two engine hatch doors, one on either side of the fuselage, are attached to the fuselage by six clamps. The doors have circular cut-outs for engine exhaust stack clearance. The doors may be quickly removed for engine removal and installation. These doors are vital structural members and must be in place prior to engine run-up.

H. AIR EXIT PORTS

Two air exit ports are located on the lower sides of the fuselage just aft of the engine mount bulkhead. The ports permit air to escape from the engine compartment.

I. ENGINE HATCH KEEL

The engine hatch keel is located beneath the engine and is removable to permit engine changes. The keel is constructed of corrosion-resistant steel and aluminum alloy, and, although removable, it is a structural member and considered a part of the lower keel of the helicopter.

J. DORSAL COWLING

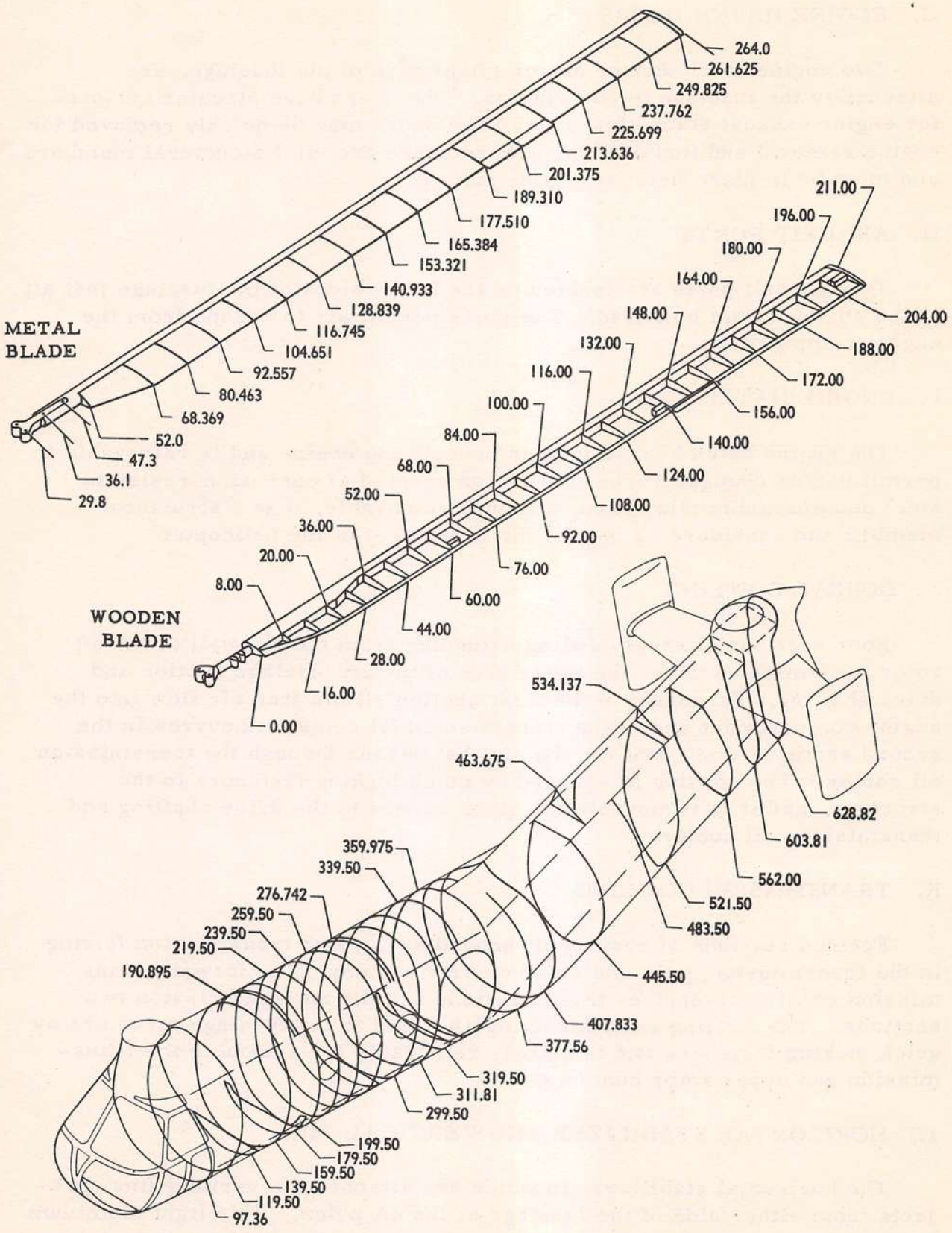
Four sections of sheet cowling extending from the firewall to the aft rotor transmission cover the upper side of the aft fuselage section and drive shafting. Screening in the first section allows free air flow into the engine compartment and to the transmission oil cooler. Louvres in the second section permit exit for the air that passes through the transmission oil cooler. The cowling is secured by quick locking fasteners to the structure, and it is removable for quick access to the drive shafting and transmission oil cooler.

K. TRANSMISSION COWLING

Formed sections of cowling fit around each rotor transmission fairing in the transmission, oil, and rotor control system. The forward transmission cowling comprises three sections and the aft transmission two sections. The cowling is fastened together and to the fuselage structure by quick locking fasteners and is quickly removable for access to the transmission and upper rotor controls.

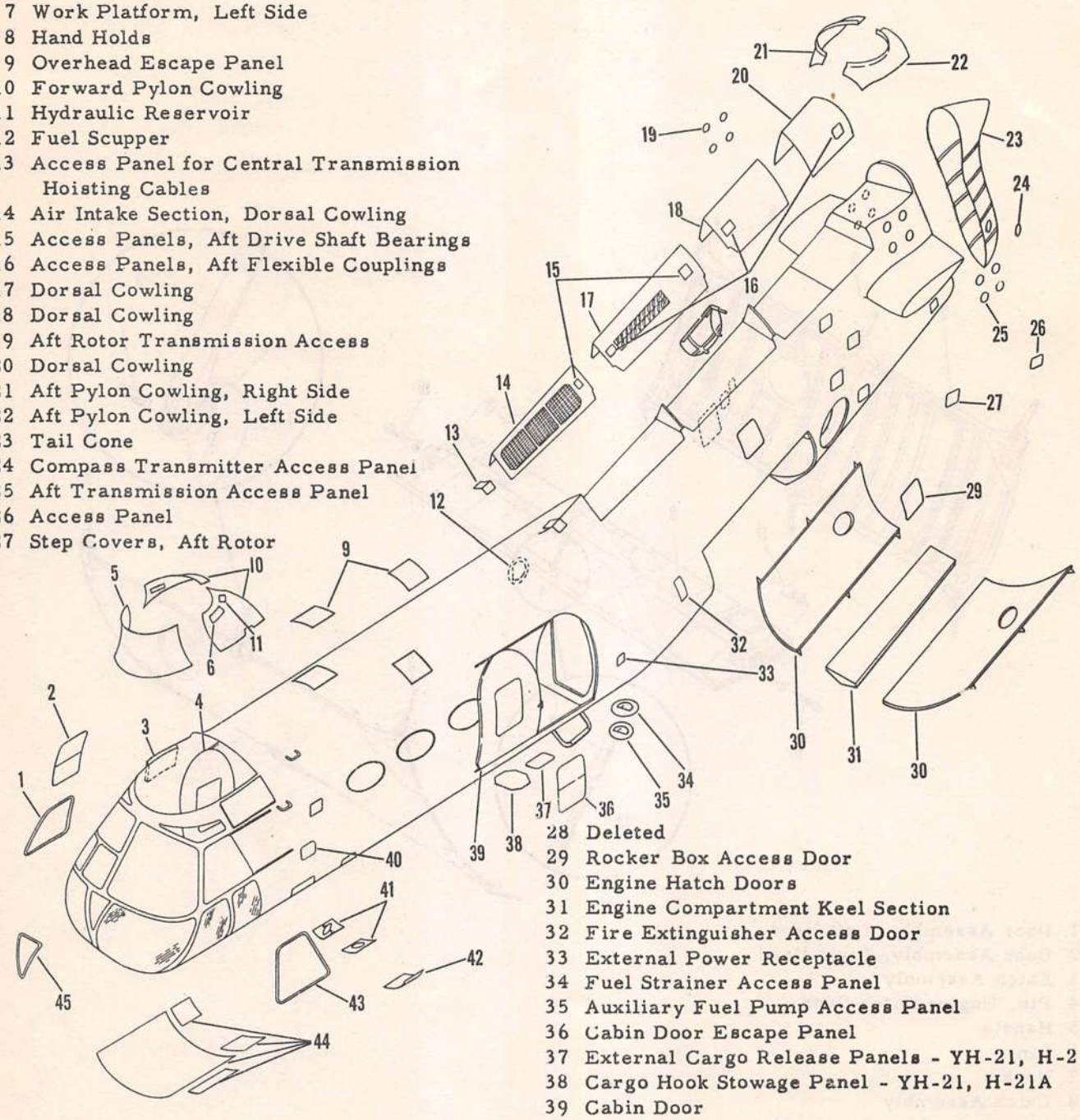
L. HORIZONTAL STABILIZER AND VERTICAL FINS

The horizontal stabilizer, to which are attached the vertical fins, projects from either side of the fuselage at the aft pylon. This light aluminum alloy assembly provides additional stability for forward flight. The inboard portion of the stabilizer (stub) is coated with a rough surface compound and provides a work platform for the rear transmission.



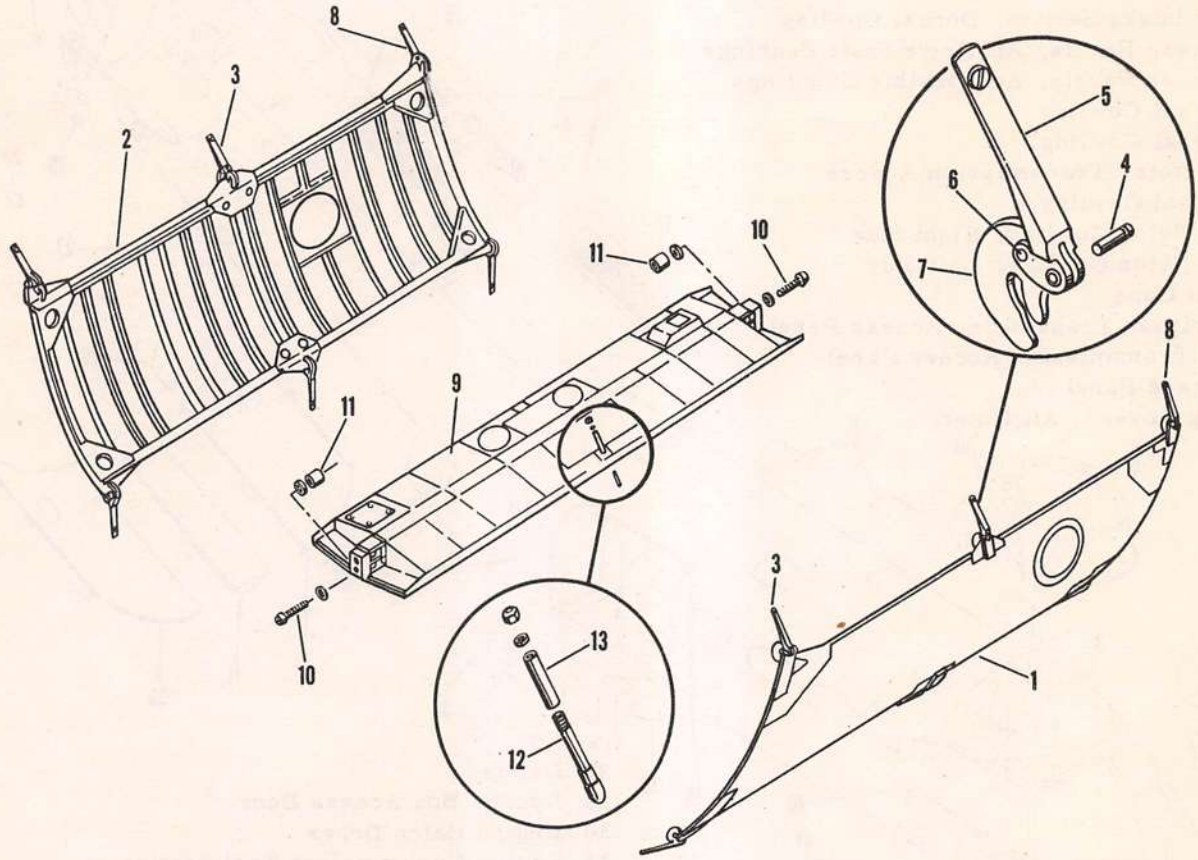
BLADE AND FUSELAGE STATION DIAGRAM

1 Pilot's Escape Window
2 Rescue Door Escape Panel
3 Work Platform, Right Side
4 Rescue Door
5 Forward Pylon Cowling
6 Access Panel for Rotor Transmission Servicing
7 Work Platform, Left Side
8 Hand Holds
9 Overhead Escape Panel
10 Forward Pylon Cowling
11 Hydraulic Reservoir
12 Fuel Scupper
13 Access Panel for Central Transmission Hoisting Cables
14 Air Intake Section, Dorsal Cowling
15 Access Panels, Aft Drive Shaft Bearings
16 Access Panels, Aft Flexible Couplings
17 Dorsal Cowling
18 Dorsal Cowling
19 Aft Rotor Transmission Access
20 Dorsal Cowling
21 Aft Pylon Cowling, Right Side
22 Aft Pylon Cowling, Left Side
23 Tail Cone
24 Compass Transmitter Access Panel
25 Aft Transmission Access Panel
26 Access Panel
27 Step Covers, Aft Rotor



28 Deleted
29 Rocker Box Access Door
30 Engine Hatch Doors
31 Engine Compartment Keel Section
32 Fire Extinguisher Access Door
33 External Power Receptacle
34 Fuel Strainer Access Panel
35 Auxiliary Fuel Pump Access Panel
36 Cabin Door Escape Panel
37 External Cargo Release Panels - YH-21, H-21A
38 Cargo Hook Stowage Panel - YH-21, H-21A
39 Cabin Door
40 Steps, Forward Rotor
41 Nose Alighting Gear Access Panel
42 Hydraulic Test Outlets Access Panels
43 Co-pilot's Escape Panel
44 Lower Controls Access Panel
45 Instrument Console Access Panel

ACCESS DOORS AND PANELS



1 Door Assembly, Left Hand
2 Door Assembly, Right Hand
3 Latch Assembly
4 Pin, Engine Hatch Door
5 Handle
6 Pin
7 Hook
8 Latch Assembly
9 Keel Assembly, Removable
10 Bolt
11 Nut
12 Pin, Engine Hatch Door
13 Spacer

ENGINE ACCESS DOORS

COCKPIT AND CABIN EQUIPMENT

A. PILOT AND CO-PILOT'S SEATS

The shock-mounted pilot and co-pilot seats, situated side by side in the cockpit, are bucket shaped to accommodate a parachute, cushion, or individual-type life raft. These seats have a five-inch range of travel, vertically only, and may be secured in any one of several positions by an adjustment lever which is attached to the right aft side of each seat.

B. CUSHIONS

The pilot and co-pilot seats are equipped with seat and back cushions, internally constructed of a sponge rubber facing and kapok filler. The entire outer cover of each cushion, with the exception of one side, is made of olive drab artificial leather. The side touching the seat or the back is made of cotton webbing, specially treated so as to be resistant to mildew or moisture.

C. PILOT AND CO-PILOT SAFETY BELTS

The pilot and co-pilot seats are equipped with safety belts and shoulder harnesses for protection of pilot personnel. The safety belt is adjusted by lengthening or shortening the adjustable section of the belt. The shoulder harness is adjusted by pulling up on the webbing to shorten the straps and lengthened by weaving the webbing back through the buckle. An inertia reel is provided to permit the pilot or co-pilot to lean forward when the reel is unlocked. The inertia reel lock/release mechanism is located at the left forward corner of each seat.

D. RELIEF TUBES

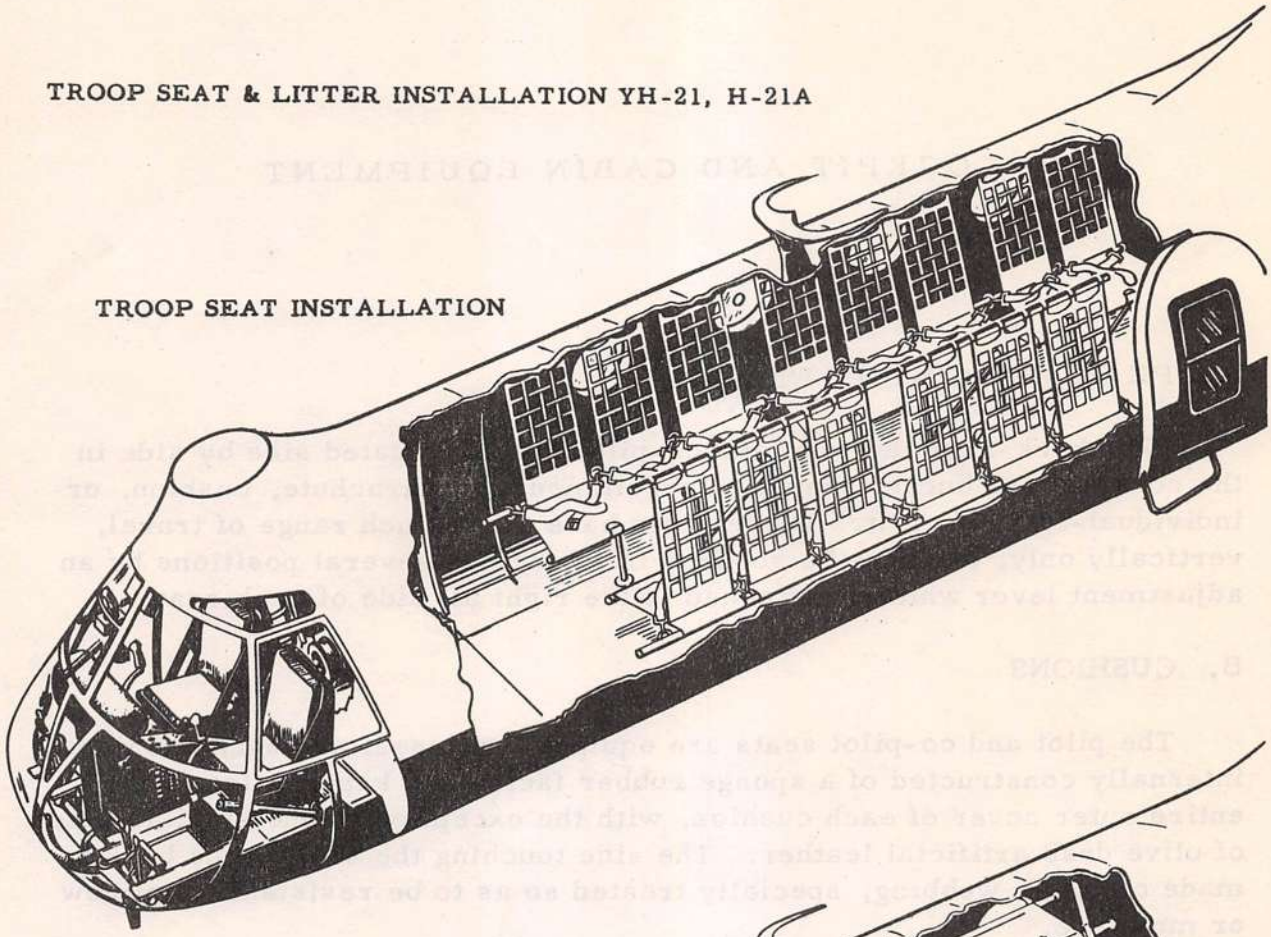
Two relief tubes, installed in the cockpit, are available for use by either the pilots or the passengers. One relief tube is located under the pilot's seat, the other is aft of the co-pilot's seat.

E. TROOP SEATS AND LITTERS

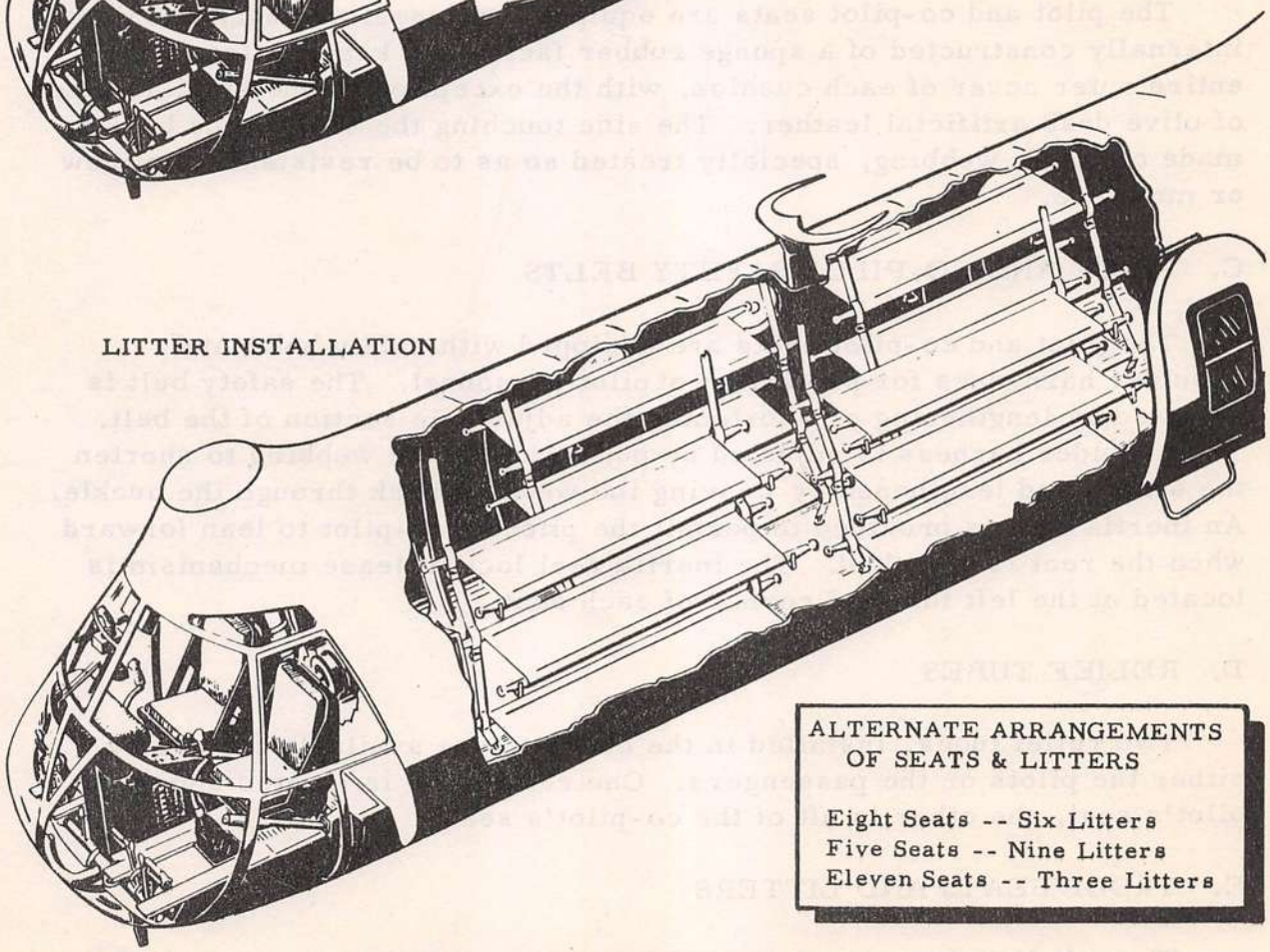
These helicopters can accommodate fully equipped troops and/or litter patients in combinations thereof as shown in the accompanying table:

TROOP SEAT & LITTER INSTALLATION YH-21, H-21A

TROOP SEAT INSTALLATION



LITTER INSTALLATION



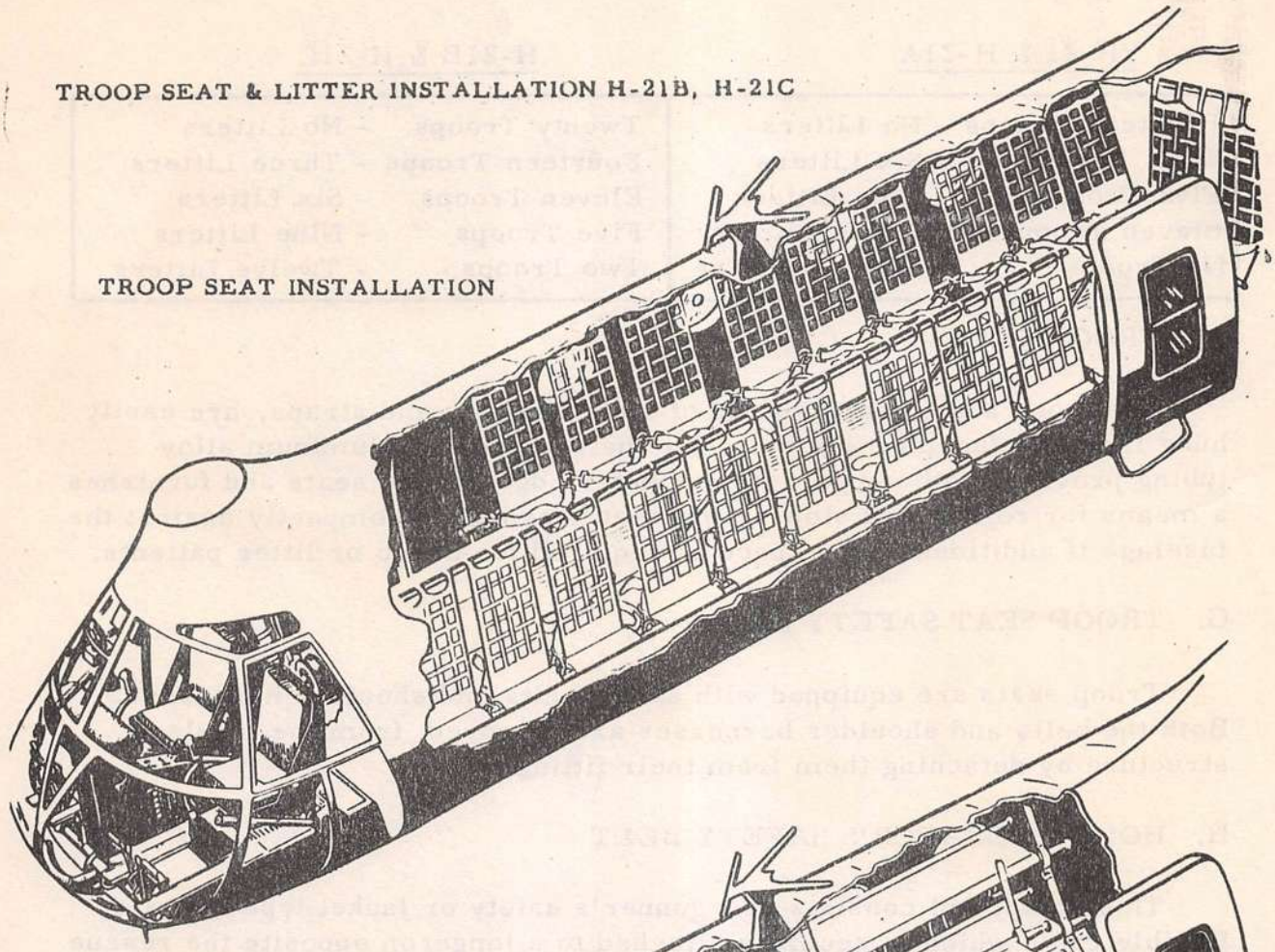
ALTERNATE ARRANGEMENTS OF SEATS & LITTERS

Eight Seats -- Six Litters
Five Seats -- Nine Litters
Eleven Seats -- Three Litters

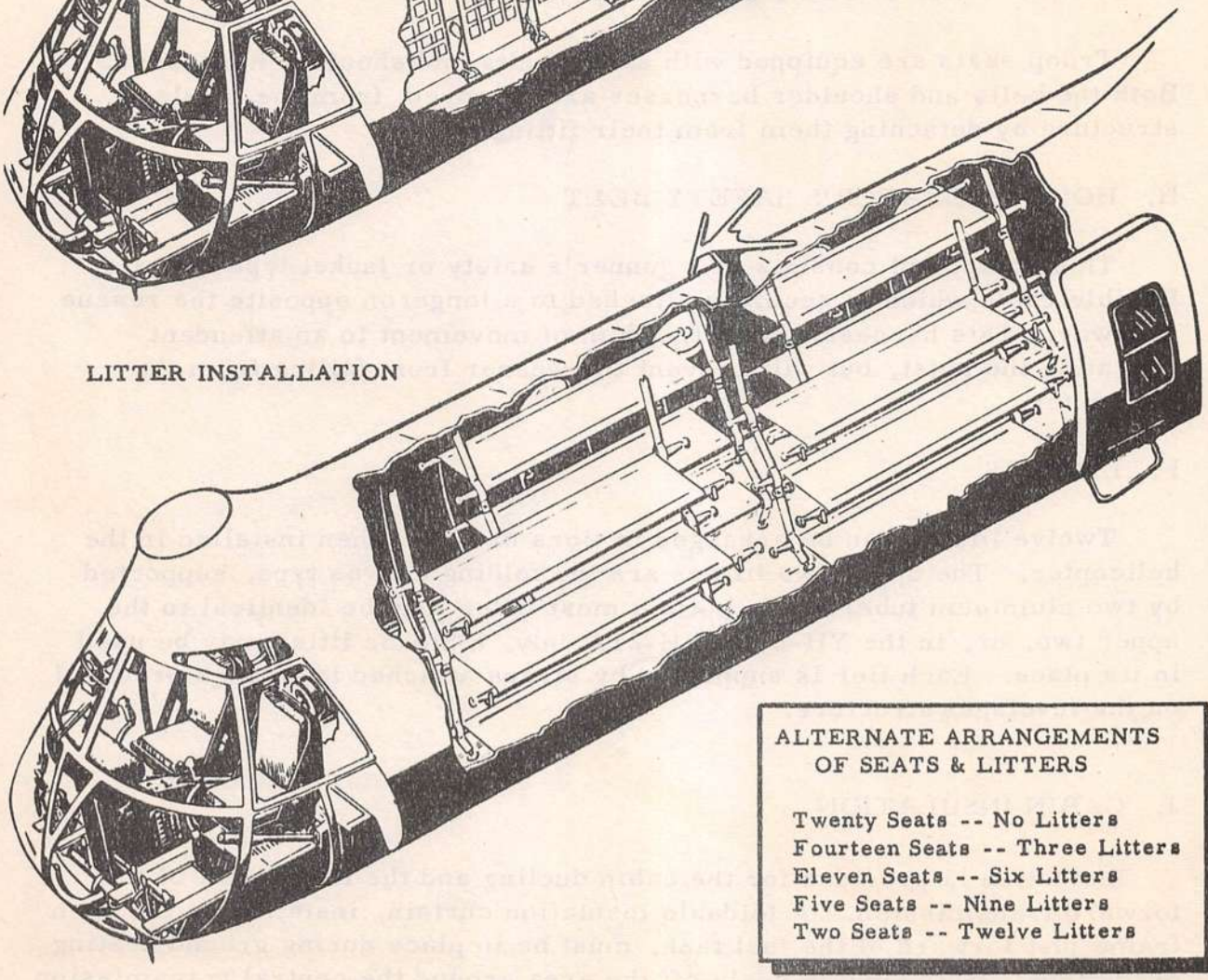
LITTERS AND CABIN SEATS—YH-21 & H-21A

TROOP SEAT & LITTER INSTALLATION H-21B, H-21C

TROOP SEAT INSTALLATION



LITTER INSTALLATION



ALTERNATE ARRANGEMENTS OF SEATS & LITTERS

Twenty Seats -- No Litters
Fourteen Seats -- Three Litters
Eleven Seats -- Six Litters
Five Seats -- Nine Litters
Two Seats -- Twelve Litters

LITTERS AND CABIN SEATS—H-21B & H-21C

YH-21 & H-21A		H-21B & H-21C	
Fourteen Troops	- No Litters	Twenty Troops	- No Litters
Eight Troops	- Six Litters	Fourteen Troops	- Three Litters
Five Troops	- Nine Litters	Eleven Troops	- Six Litters
Eleven Troops	- Three Litters	Five Troops	- Nine Litters
No Troops	- Twelve Litters	Two Troops	- Twelve Litters

F. TROOP SEATS

The troop seats, constructed of cloth webbing and straps, are easily hung from the fuselage structure for their support. Aluminum alloy tubing provides both support for the outer edges of the seats and furnishes a means for rolling and stowing the seat assemblies compactly against the fuselage if additional floor space is required for cargo or litter patients.

G. TROOP SEAT SAFETY BELTS

Troop seats are equipped with safety belts and shoulder harnesses. Both the belts and shoulder harnesses are removed from the fuselage structure by detaching them from their fittings.

H. HOIST OPERATOR'S SAFETY BELT

This equipment consists of a gunner's safety or jacket type belt and flexible cable which is securely attached to a longeron opposite the rescue doorway. This harness allows freedom of movement to an attendant operating the hoist, but will prevent the wearer from falling from the helicopter.

I. LITTERS

Twelve litters can be arranged in tiers of three when installed in the helicopter. The upper two litters are the folding canvas type, supported by two aluminum tubes. The bottom most litter may be identical to the upper two, or, in the YH-21 and H-21A only, a Stokes litter may be used in its place. Each tier is supported by straps attached to fittings provided on the fuselages structure.

J. CABIN INSULATION

Insulation is provided for the cabin ducting and the lower part of the forward transmission. A foldable insulation curtain, installed on the open frame just forward of the fuel tank, must be in place during ground heating operations. This curtain seals off the area around the central transmission and retains the heat in that section. Cabin insulation is completed by panels which are easily snap fastened to the fuselage.

K. BLACKOUT CURTAINS

Curtains made of a steel spring wire frame and a cloth cover are provided to blackout the cabin doors and windows.

L. FIRE EXTINGUISHERS

Two fire extinguishers are strategically installed in the helicopter. One is located on the forward side of the canted bulkhead behind the pilot's seat. The other is located on the forward side of the bulkhead of the fuel cell. The agent with which these extinguishers are filled is suitable for combating electrical fires as well as open flames.

M. FIRST AID KITS

First aid kits are easily accessible. One is mounted on the cockpit bulkhead behind and to the left of the co-pilot. The remaining kits (two for the YH-21 and H-21A, three for the H-21B and H-21C) are located each side of the heating duct, approximately mid-way of the cabin.

N. LIFE RAFT

There are space and structural provisions in the YH-21 and H-21A helicopters for stowage of a six man life raft opposite the rescue door. If litters are installed, the life raft may be stowed laterally just forward of the bulkhead at the aft end of the cabin. The preferred location under the troop seat utilizes one tie-down pad and two special fittings which are provided for securing the raft. The alternate position utilizes two tie-down pads and one special fitting for securing the raft. The pilot's, co-pilot's and troop seats in the H-21B and H-21C helicopters are designed to accommodate individual type life rafts.

O. CABIN-COCKPIT HEATING SYSTEM

The helicopter recirculating air heating and ventilating system has a gasoline heater with a rated output of 200,000 BTU/hour. The heater is mounted vertically in the cabin forward of the rescue door and is operated electrically by two switches on the overhead switch panel. The heater receives fuel from the engine fuel supply. A blower and motor mounted directly beneath the heater blows cabin air through the heater. The heated air is then transmitted by ducting under the cockpit floor to the foot warmers and windshield defrosters. Ducting leading rearward from the heater along the top of the cabin, provides heat supply for this area. Controllable air outlets mounted within this overhead duct allow the heated air to flow into the cabin area. Controls within the ducting also allow ground heating of the overhead shaft bearings, transmissions, and engine compartment, using either an auxiliary heating unit or the helicopter's heating system.

HELICOPTER HEATING SYSTEM
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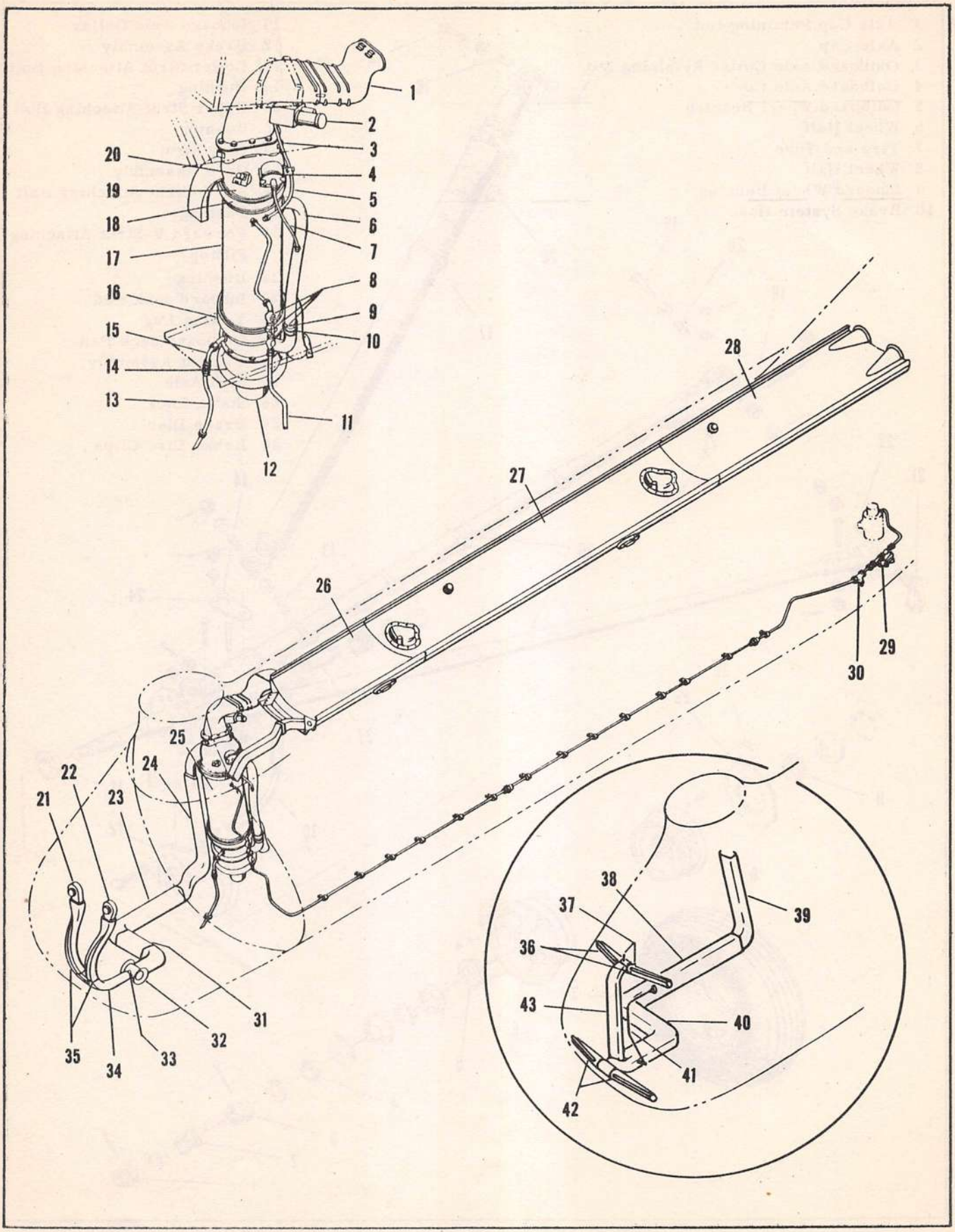
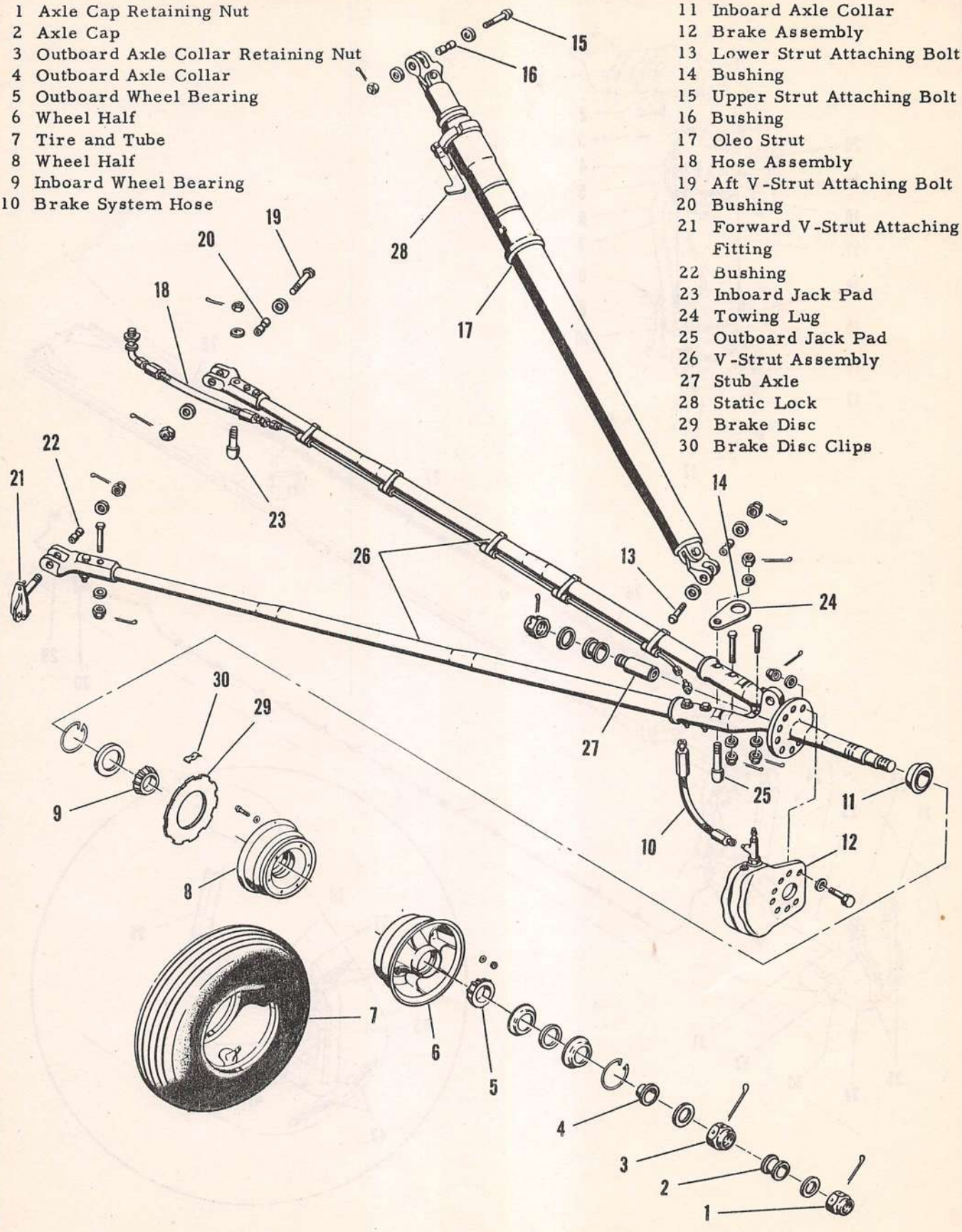


HELICOPTER HEATING SYSTEM

1 Axle Cap Retaining Nut
2 Axle Cap
3 Outboard Axle Collar Retaining Nut
4 Outboard Axle Collar
5 Outboard Wheel Bearing
6 Wheel Half
7 Tire and Tube
8 Wheel Half
9 Inboard Wheel Bearing
10 Brake System Hose
11 Inboard Axle Collar
12 Brake Assembly
13 Lower Strut Attaching Bolt
14 Bushing
15 Upper Strut Attaching Bolt
16 Bushing
17 Oleo Strut
18 Hose Assembly
19 Aft V-Strut Attaching Bolt
20 Bushing
21 Forward V-Strut Attaching Fitting
22 Bushing
23 Inboard Jack Pad
24 Towing Lug
25 Outboard Jack Pad
26 V-Strut Assembly
27 Stub Axle
28 Static Lock
29 Brake Disc
30 Brake Disc Clips



MAIN ALIGHTING GEAR

ALIGHTING GEAR

A. GENERAL DESCRIPTION

The alighting gear on the H-21 is a tricycle type gear. Wheels and tires are installed on delivered models, but provisions have been incorporated on YH-21 and H-21A helicopters to enable quick installation of flotation gear if and when the helicopter is used under conditions which makes the use of such gear feasible.

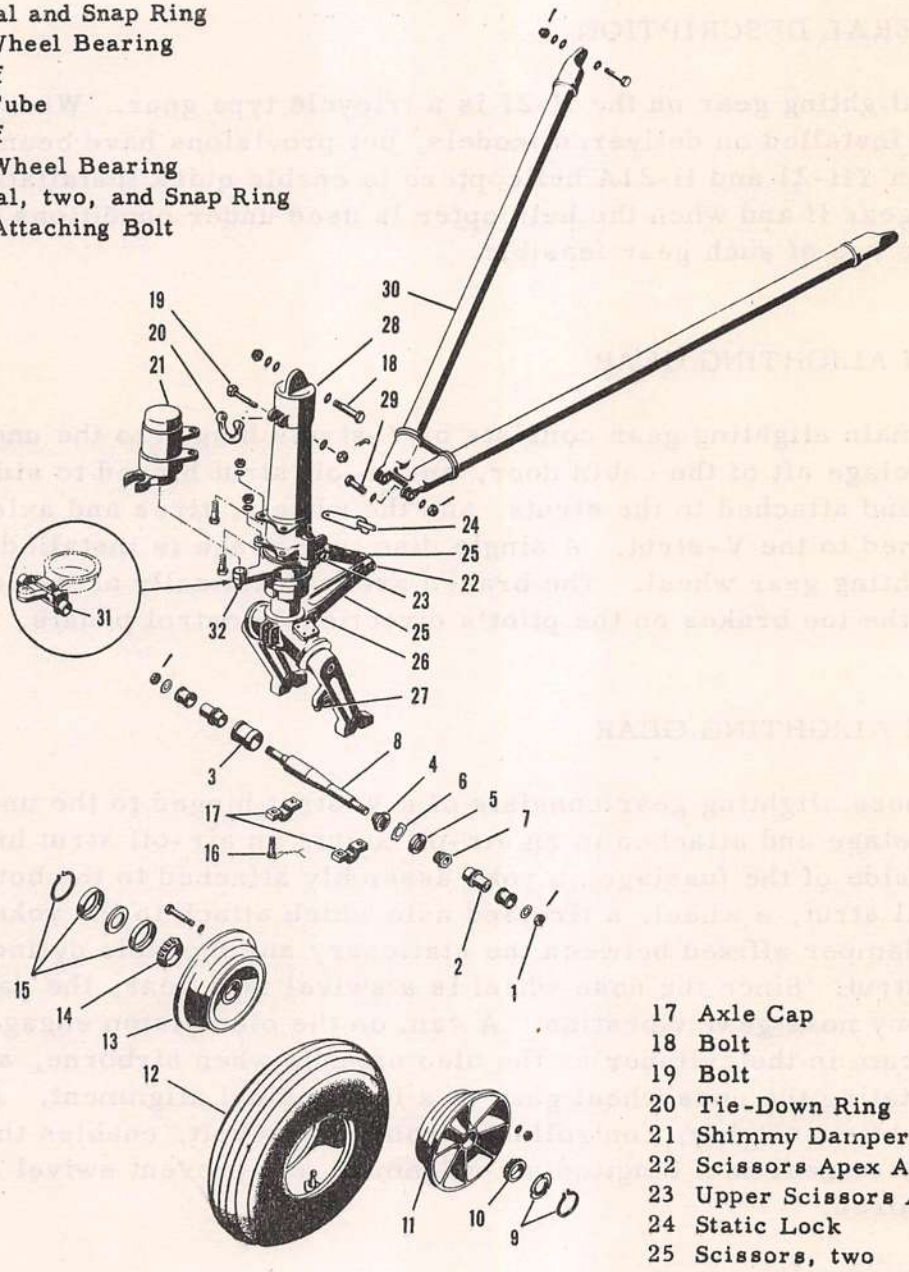
B. MAIN ALIGHTING GEAR

The main alighting gear consists of V-struts hinged to the underside of the fuselage aft of the cabin door, an air-oil strut hinged to sides of the fuselage and attached to the struts, and the wheels, tires and axles which are attached to the V-strut. A single disc type brake is installed in each main alighting gear wheel. The brakes are hydraulically actuated by depressing the toe brakes on the pilot's directional control pedals.

C. NOSE ALIGHTING GEAR

The nose alighting gear consists of a V-strut hinged to the underside of the fuselage and attached to an air-oil strut, an air-oil strut hinged to the underside of the fuselage, a yoke assembly attached to the bottom of the air-oil strut, a wheel, a tire and axle which attach to the yoke, and a shimmy damper affixed between the stationary and movable cylinders of the oleo strut. Since the nose wheel is a swivel type gear, the damper absorbs any nose gear vibration. A cam on the oleo piston engages a follower cam in the cylinder as the oleo extends when airborne, automatically rotating the nose wheel gear to a longitudinal alignment. A locking pin and cable assembly, controllable from the cockpit, enables the pilot to lock the nose gear in a longitudinal alignment and prevent swivel action when required.

1 Axle Nut, two
2 Axle Float Sleeve
3 Axle Collar
4 Adjustable Collar Bushing
5 Collar Lock Nut
6 Lock Washer
7 Adjustable Collar
8 Axle
9 Grease Seal and Snap Ring
10 Small ID Wheel Bearing
11 Wheel Half
12 Tire and Tube
13 Wheel Half
14 Large ID Wheel Bearing
15 Grease Seal, two, and Snap Ring
16 Axle Cap Attaching Bolt



17 Axle Cap
18 Bolt
19 Bolt
20 Tie-Down Ring
21 Shimmy Damper
22 Scissors Apex Attaching Bolt
23 Upper Scissors Attaching Bolt
24 Static Lock
25 Scissors, two
26 Lower Scissors Attaching Bolt
27 Jack Point
28 Shock Strut Assembly
29 V-Strut Attaching Bolts
30 V-Strut Assembly
31 Towing Provision, H-21A
32 Shimmy Damper Centering Bolt

NOSE ALIGHTING GEAR

HYDRAULIC SYSTEMS

A. BRAKE SYSTEM

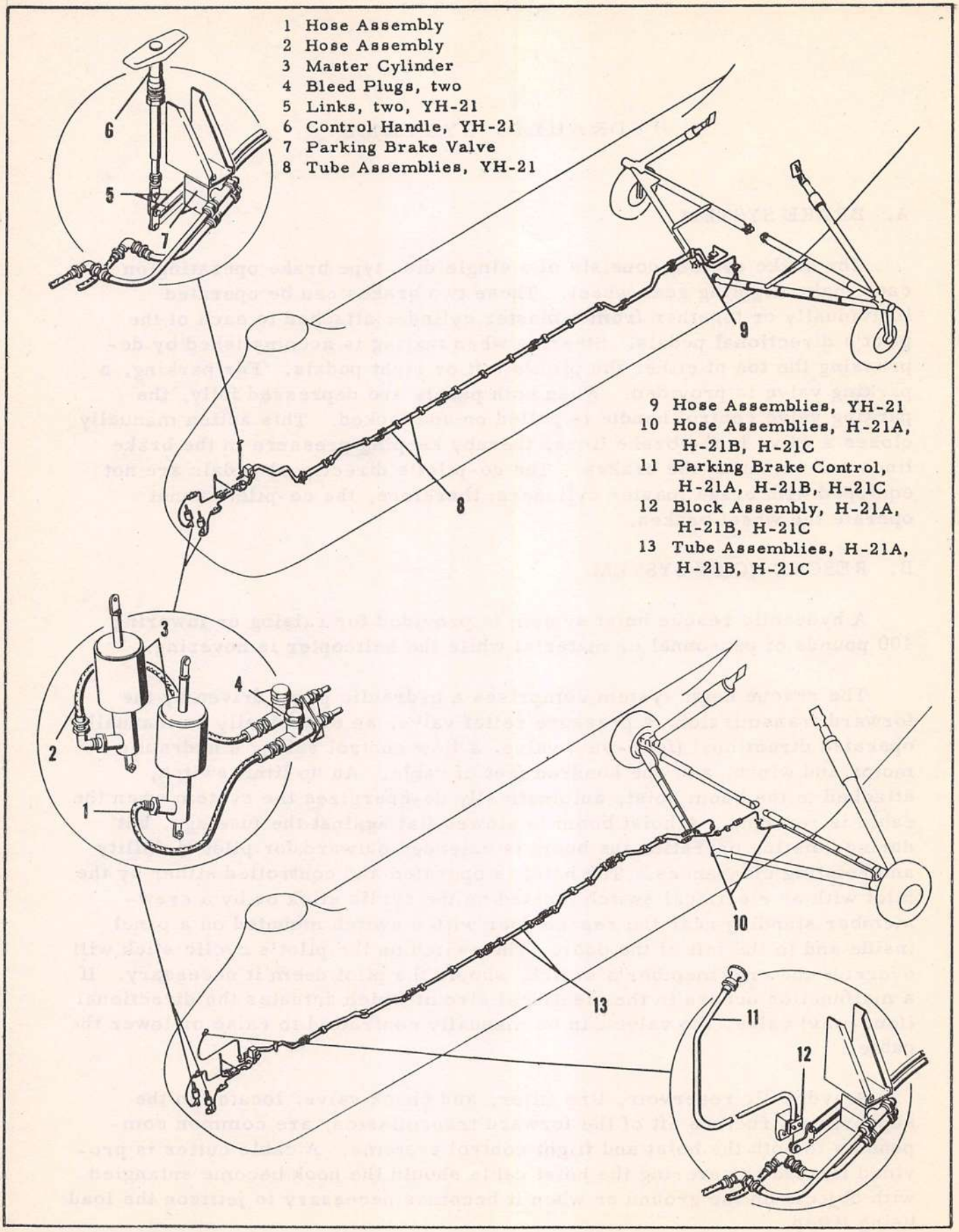
The brake system consists of a single disc type brake operating on each main alighting gear wheel. These two brakes can be operated individually or together from a master cylinder attached to each of the pilot's directional pedals. Steering when taxiing is accomplished by depressing the toe of either the pilot's left or right pedals. For parking, a parking valve is provided. When both pedals are depressed fully, the parking valve control handle is pulled on and locked. This action manually closes a valve in the brake lines, thereby keeping pressure in the brake lines and actuating the brakes. The co-pilot's directional pedals are not equipped with brake master cylinders; therefore, the co-pilot cannot operate the wheel brakes.

B. RESCUE HOIST SYSTEM

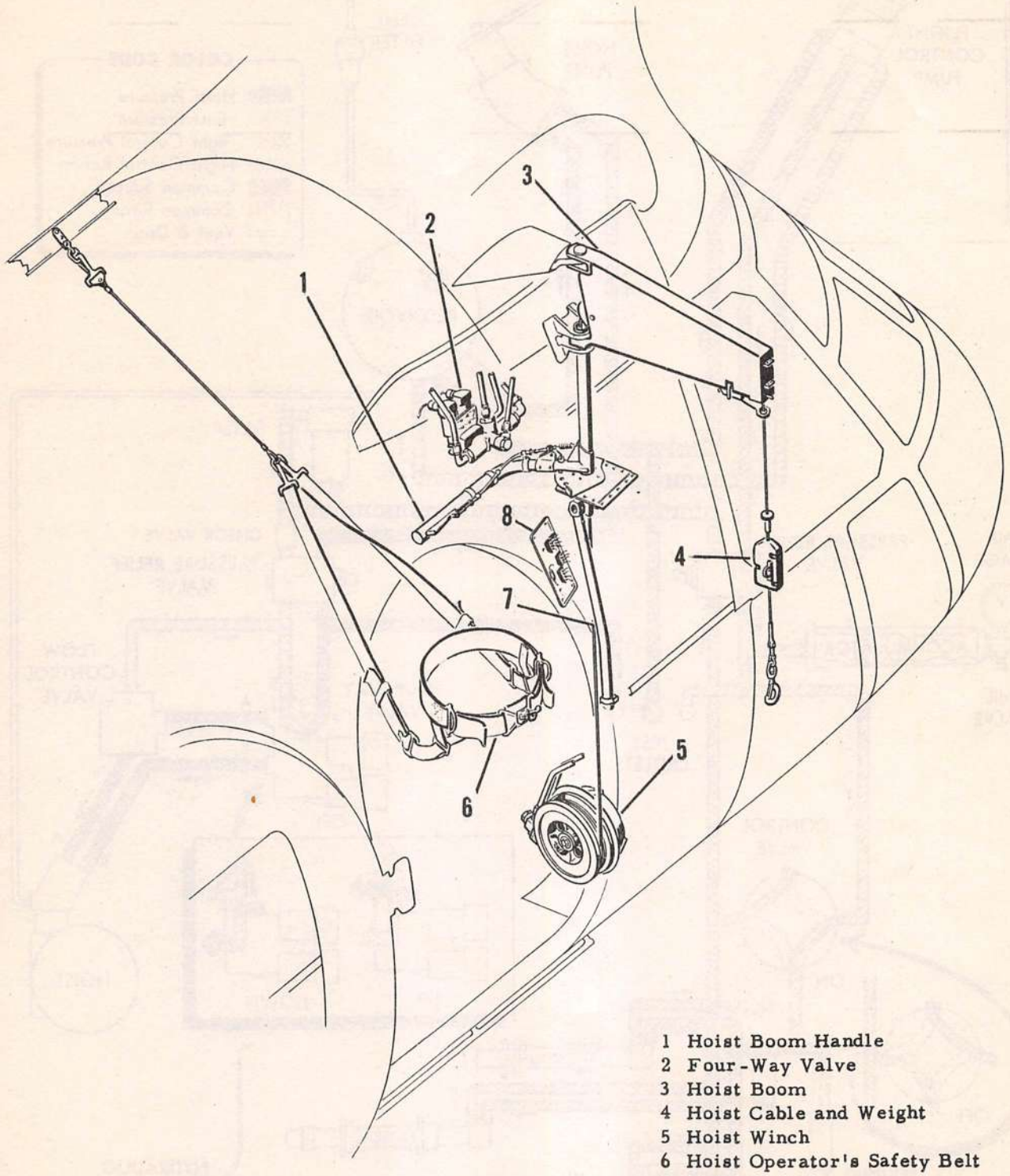
A hydraulic rescue hoist system is provided for raising or lowering 400 pounds of personnel or material while the helicopter is hovering.

The rescue hoist system comprises a hydraulic pump driven by the forward transmission, a pressure relief valve, an electrically or manually operated directional (four-way) valve, a flow control valve, a hydraulic motor and winch, and one hundred feet of cable. An up limit switch, attached to the boom hoist, automatically de-energizes the system when the cable is rewound. A hoist boom is stowed flat against the fuselage, but during hoisting operation the boom is extended outward for pilot visibility and hoisting clearances. The hoist is operated and controlled either by the pilot with an electrical switch located on the cyclic stick or by a crewmember standing near the rescue door with a switch mounted on a panel inside and to the left of the door. The switch on the pilot's cyclic stick will override the crewmember's switch, should the pilot deem it necessary. If a malfunction occurs in the electrical circuit which actuates the directional (four-way) valve, the valve can be manually controlled to raise or lower the cable.

A hydraulic reservoir, line filter, and check valve, located in the supporting structure aft of the forward transmission, are common components to both the hoist and flight control systems. A cable cutter is provided for use in severing the hoist cable should the hook become entangled with objects on the ground or when it becomes necessary to jettison the load being lifted.

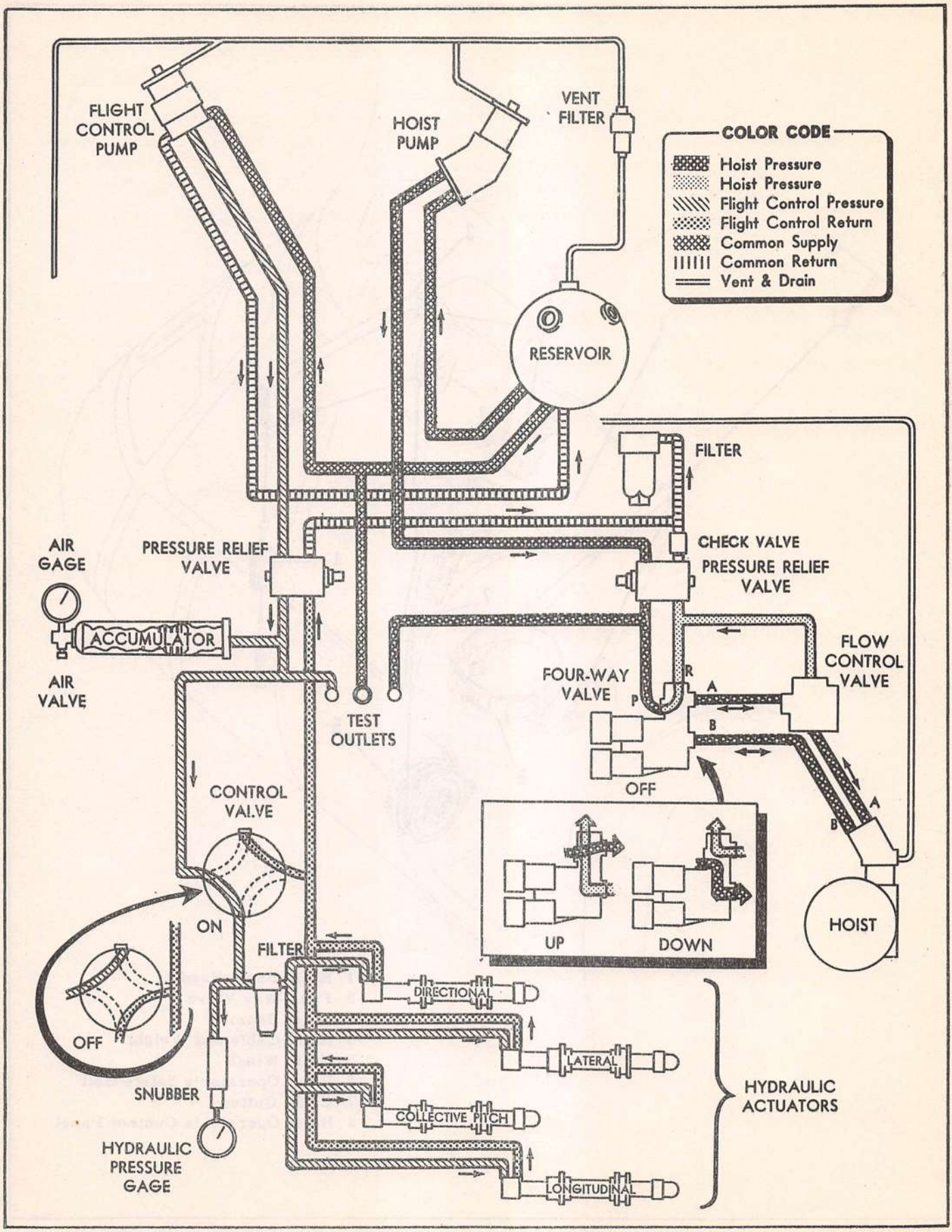


HYDRAULIC BRAKE SYSTEM



1 Hoist Boom Handle
2 Four-Way Valve
3 Hoist Boom
4 Hoist Cable and Weight
5 Hoist Winch
6 Hoist Operator's Safety Belt
7 Cable Cutter
8 Hoist Operator's Control Panel

RESCUE HOIST EQUIPMENT



HYDRAULIC SYSTEM SCHEMATIC

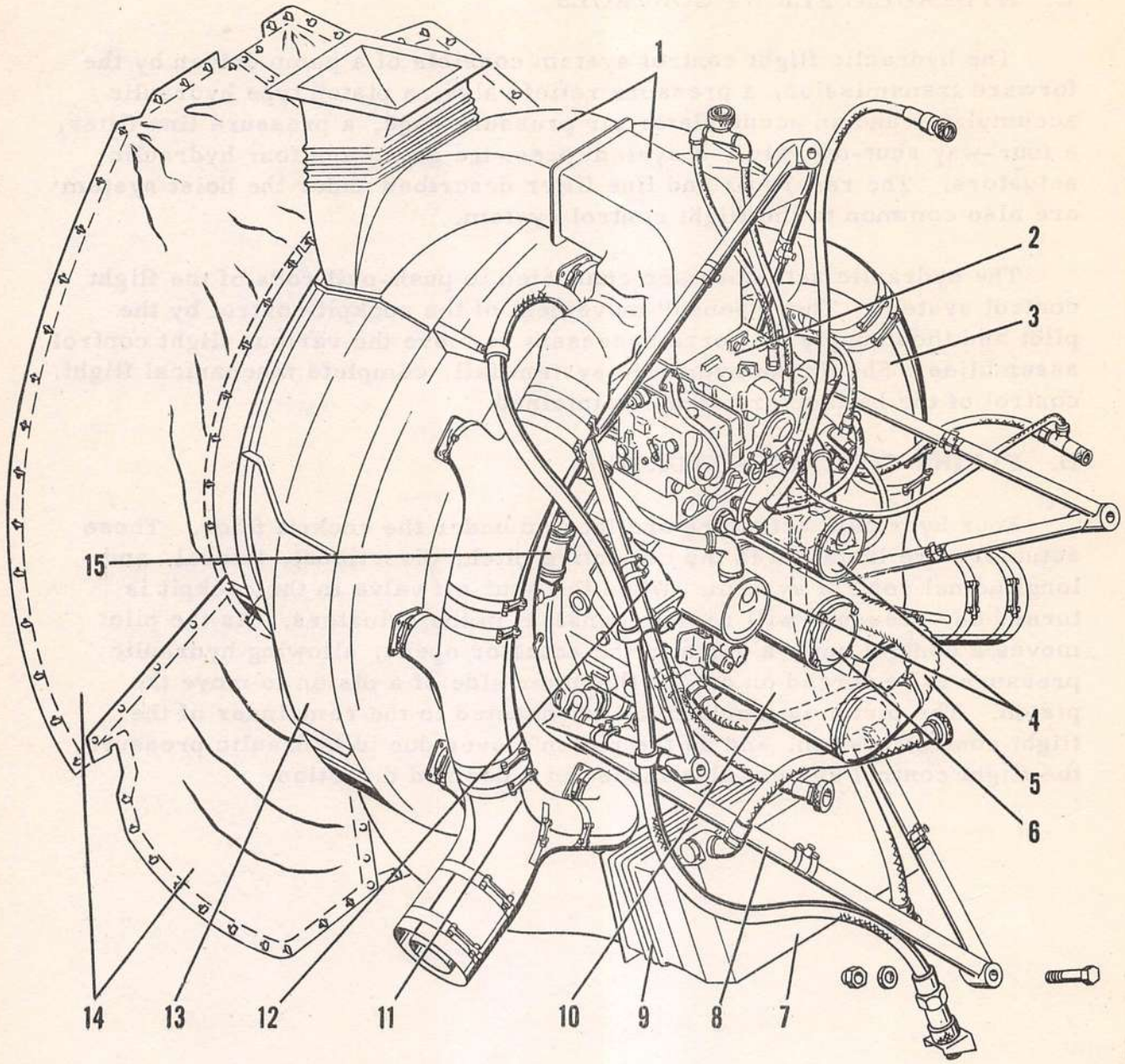
C. HYDRAULIC FLIGHT CONTROLS

The hydraulic flight control system consists of a pump driven by the forward transmission, a pressure relief valve, a piston type hydraulic accumulator and an accumulator air pressure gage, a pressure line filter, a four-way shut-off valve, a system pressure gage, and four hydraulic actuators. The reservoir and line filter described under the hoist system are also common to the flight control system.

The hydraulic actuators are connected to push-pull rods of the flight control system. They "sense" movement of the cockpit control by the pilot and then supply the force necessary to move the various flight control assemblies. Should the hydraulic system fail, complete mechanical flight control of the helicopter can be maintained.

D. FLIGHT CONTROL ACTUATORS

Four hydraulic actuators are located under the cockpit floor. These actuators are installed in the collective pitch, directional, lateral, and longitudinal control system. When the shut-off valve in the cockpit is turned on, pressure will remain constant in the actuators. As the pilot moves a control unit, a valve in the actuator opens, allowing hydraulic pressure to be forced on one or the other side of a piston to move the piston. The piston is mechanically connected to the remainder of the flight control system, and as the piston moves due to hydraulic pressure, the flight control system also moves in a desired direction.



1 Carburetor Air Ducting
2 Carburetor
3 Exhaust Collector Shroud
4 Magnetos
5 Generator Blast Tube
6 Starter
7 Oil Cooler
8 Engine Mount
9 Oil Cooler Air Ducting
10 Generator
11 Exhaust Collector
12 Manifold Pressure Limiter, YH-21, H-21A
13 Engine Cowling
14 Engine Curtain
15 Dynafocal Mount

POWER PLANT, ACCESSORIES, AND CONTROLS

A. POWER PLANT PACKAGE

The engine, a Wright R-1820-103, having nine air-cooled cylinders and a take-off rating of 1150 horsepower at 2500 rpm for YH-21 and H-21A helicopters and 1425 horsepower at 2700 rpm for H-21B and H-21C helicopters is housed in a separate compartment aft of the fuel cell and isolated from the rest of the fuselage compartments by flame proof firewalls. It is installed in the normal operating attitude with the drive end of the crank shaft facing forward. Direction of rotation when viewed from the rear is clockwise. A flame proof curtain is attached between the stator ring of the engine cowling and fuselage frames and will confine engine fires to the area aft of the engine. Access to the power plant and accessories section is gained through two large, removable doors on the underside of the fuselage. A removable keel section is provided so that the power plant may be lowered from or raised into the helicopter for removal and installation.

B. FUEL SYSTEM

The fuel system consists of a fuel cell, engine driven fuel pump, auxiliary fuel pump, shut-off valve, fuel strainer, pressure transmitter, and an oil dilution system.

The fuel cell is in a separate compartment aft of the cabin area and has a capacity of approximately 300 US gallons. The cell is of rubber impregnated nylon fabric construction and is supported on all sides with Waldes fasteners which attach to the compartment structure.

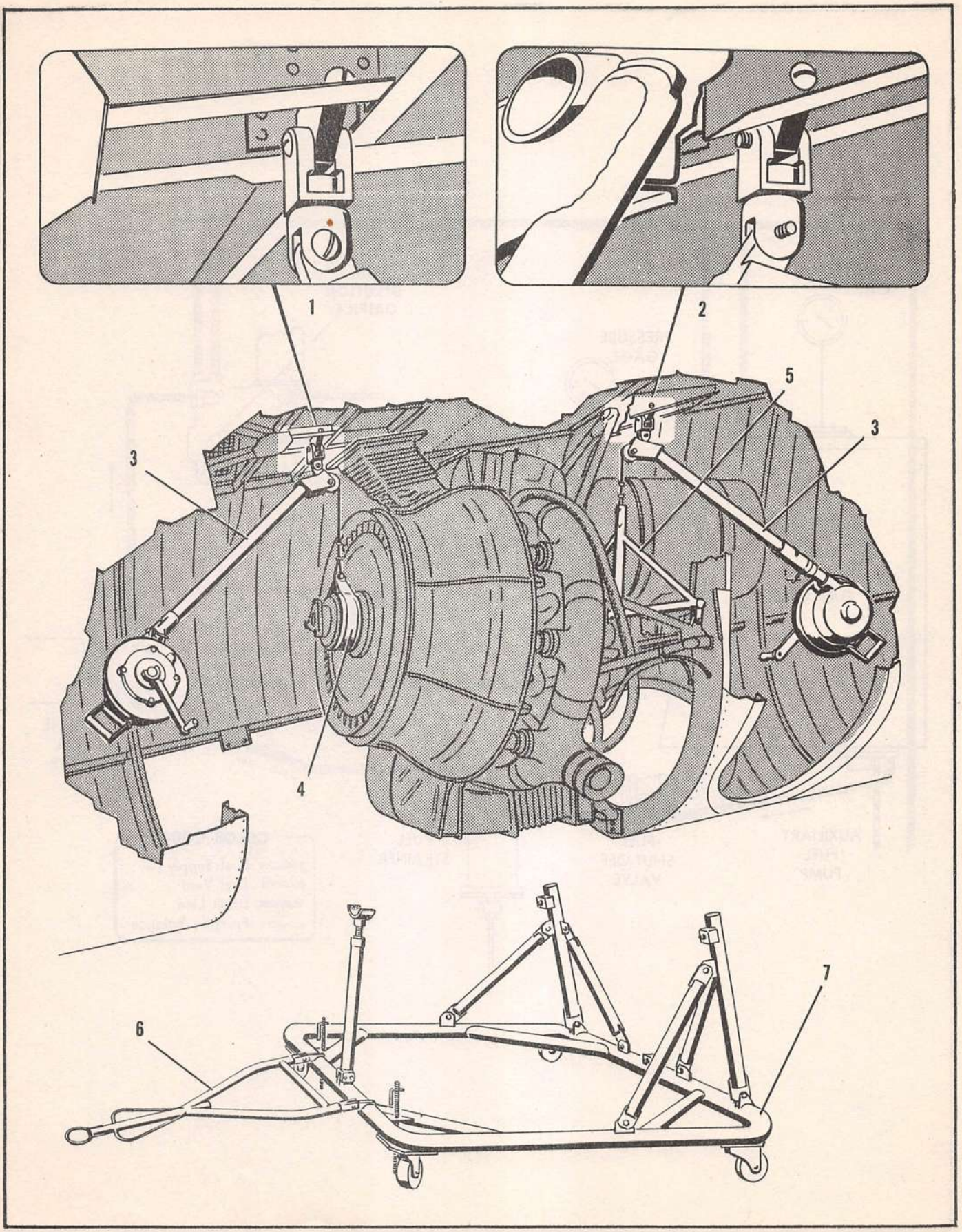
C. ENGINE OIL SYSTEM

The engine lubrication system consists of an oil tank of approximately 21-1/2 US gallons mounted in the fuselage aft of the engine, an oil pump contained within the engine, and an oil pressure relief valve. Oil temperature is controlled by an oil cooler located beneath the engine accessory section and attached to the engine mount.

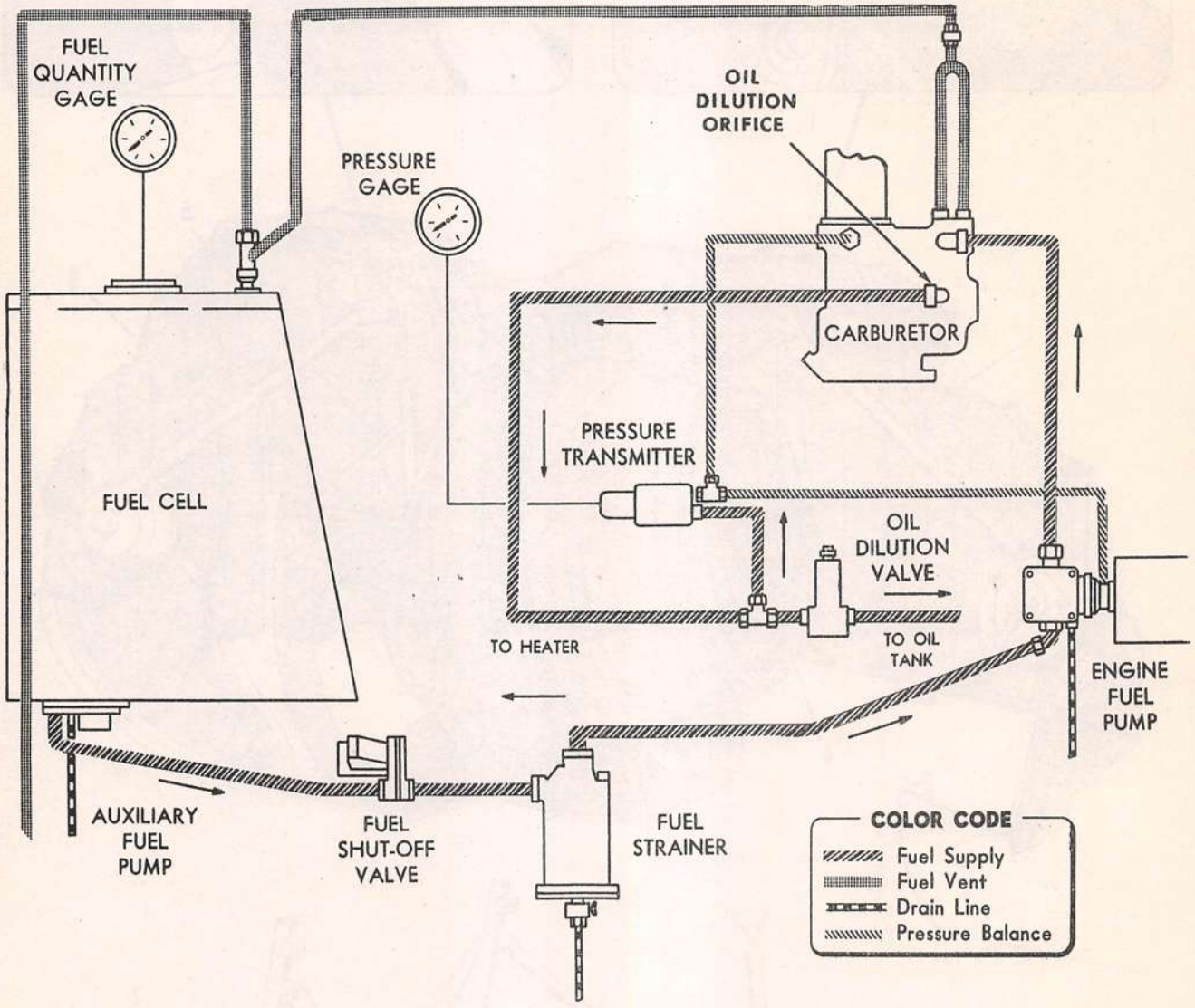
A diverter-segregator valve selects the section of the tank from which oil is taken. When the engine is started in cold weather, the segregator valve is open to the hopper, which is within the oil tank, and the oil is taken from it by the pump. The engine uses this oil from the hopper tank until the remaining oil reaches the correct operating temperature. The hopper circulates a small quantity of oil thus heating it faster. When proper oil temperature is reached the diverter valve opens the pump intake line to the tank proper.

ENGINE REMOVAL
INDEX

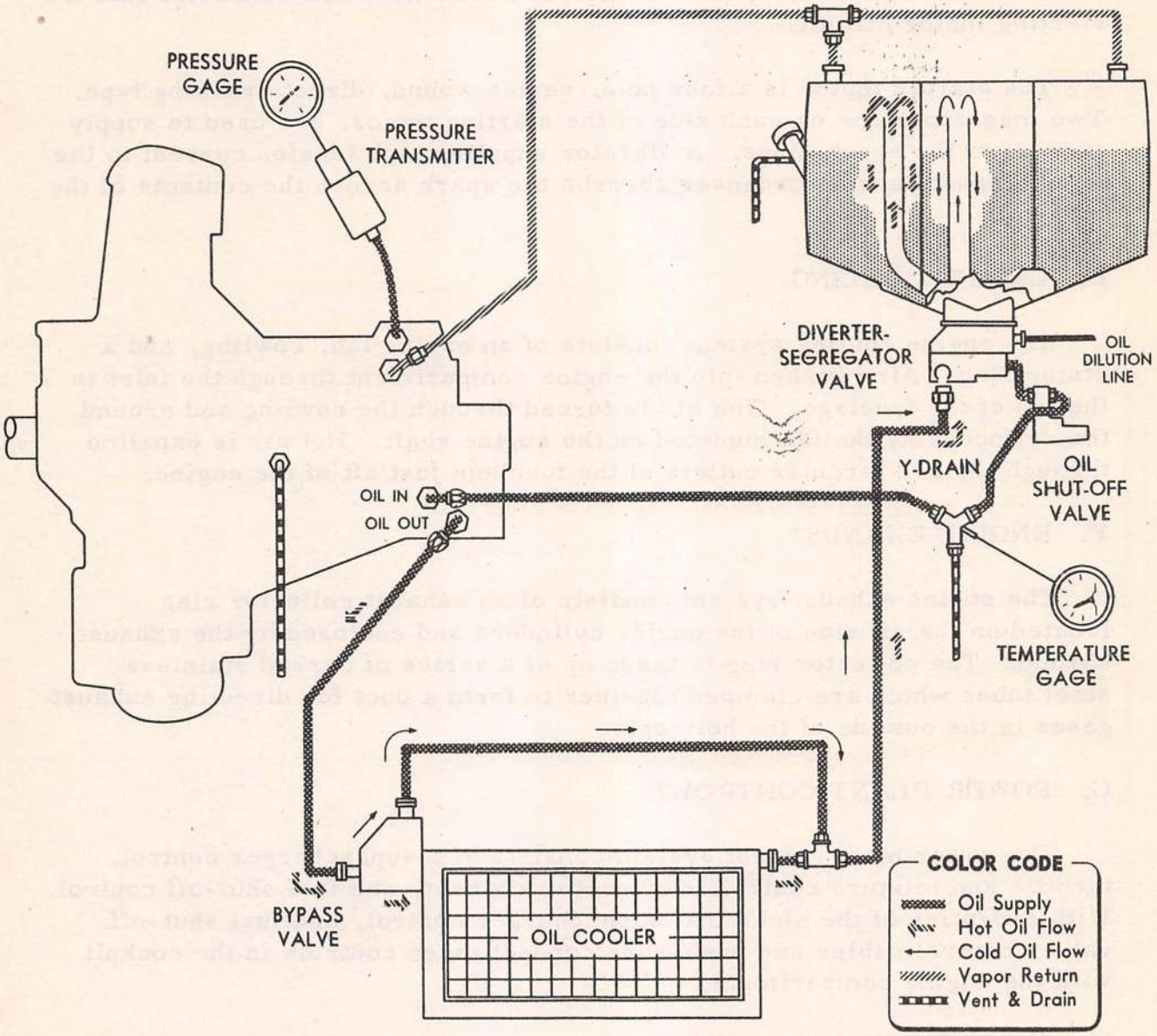
1 Forward Hoist Fitting
2 Aft Hoist Fitting
3 Portable Bomb Hoist
4 Forward Sling
5 Aft Sling
6 Engine Dolly Towing Handle
7 Engine Dolly



ENGINE REMOVAL



FUEL SYSTEM SCHEMATIC



POWER PLANT LUBRICATION SYSTEM SCHEMATIC

D. IGNITION AND STARTING SYSTEM

The ignition and starting system is used to turn the engine over and to furnish the necessary electrical power to fire the spark plugs. The starter switch on the pilot's collective pitch lever closes the contacts of the starter relay supply in the output from the battery or external power source to the starting motor. An induction vibrator and condenser are connected into the starting motor circuit.

The starter motor is a four pole, series wound, direct cranking type. Two magnetos, one on each side of the starting motor, are used to supply current to the spark plugs. A vibrator supplies high tension current to the right magneto and a condenser absorbs the spark across the contacts of the vibrator.

E. ENGINE COOLING

The engine cooling system consists of an engine fan, cowling, and a stator ring. Air is taken into the engine compartment through the inlet in the top of the fuselage. The air is forced through the cowling and around the cylinders by the fan mounted on the engine shaft. Hot air is expelled through the two circular outlets of the fuselage just aft of the engine.

F. ENGINE EXHAUST

The engine exhaust system consists of an exhaust collector ring located on the aft side of the engine cylinders and enclosed by the exhaust shroud. The collector ring is made up of a series of curved stainless steel tubes which are clamped together to form a duct for directing exhaust gases to the outside of the helicopter.

G. POWER PLANT CONTROLS

The power plant control system consists of a supercharger control, throttle and mixture control, carburetor air heat, and fuel shut-off control. With exception of the electrical supercharger control, and fuel shut-off valve, control cables and push-rods connect these controls in the cockpit with the engine compartment.

H. SUPERCHARGER CONTROL

The Wright R-1820-103 engine is equipped with a two speed, gear driven blower. Speed control of the blower is accomplished through the positioning of the supercharger clutch control shaft by a clutch actuator mounted on the engine accessory case. A switch on the console controls the actuator, which in turn uses engine oil hydraulically shifting the blower from low to high.

I. THROTTLE CONTROL

Throttle collective pitch synchronization is incorporated in the throttle control system. It aids in maintaining a constant rpm by increasing the engine power settings as collective pitch is applied to the rotors. Additional throttle control settings are obtained by rotation of a motorcycle type throttle grip on the collective pitch lever.

J. MIXTURE CONTROL

The mixture control consists of a control lever mounted on the console and connected to the mixture control lever on the carburetor by cables, push-rods, and bellcranks.

K. CARBURETOR AIR HEAT CONTROL

The carburetor air heat control consists of a control lever on the console, cables, quadrants under the cockpit floor and in the engine compartment, a push-rod and an air control door in the exhaust shroud around the collector ring. When the carburetor air lever is in the cold position, the engine fan forces air into the carburetor intake duct. When the carburetor air lever is in the hot position, the door cuts off the direct blast and air is drawn from around the exhaust manifold shroud.

L. FUEL SHUT-OFF VALVE CONTROL

The fuel shut-off valve, located between the auxiliary pump and the fuel strainer, is electrically operated from the cockpit.

ENGINE COWLING
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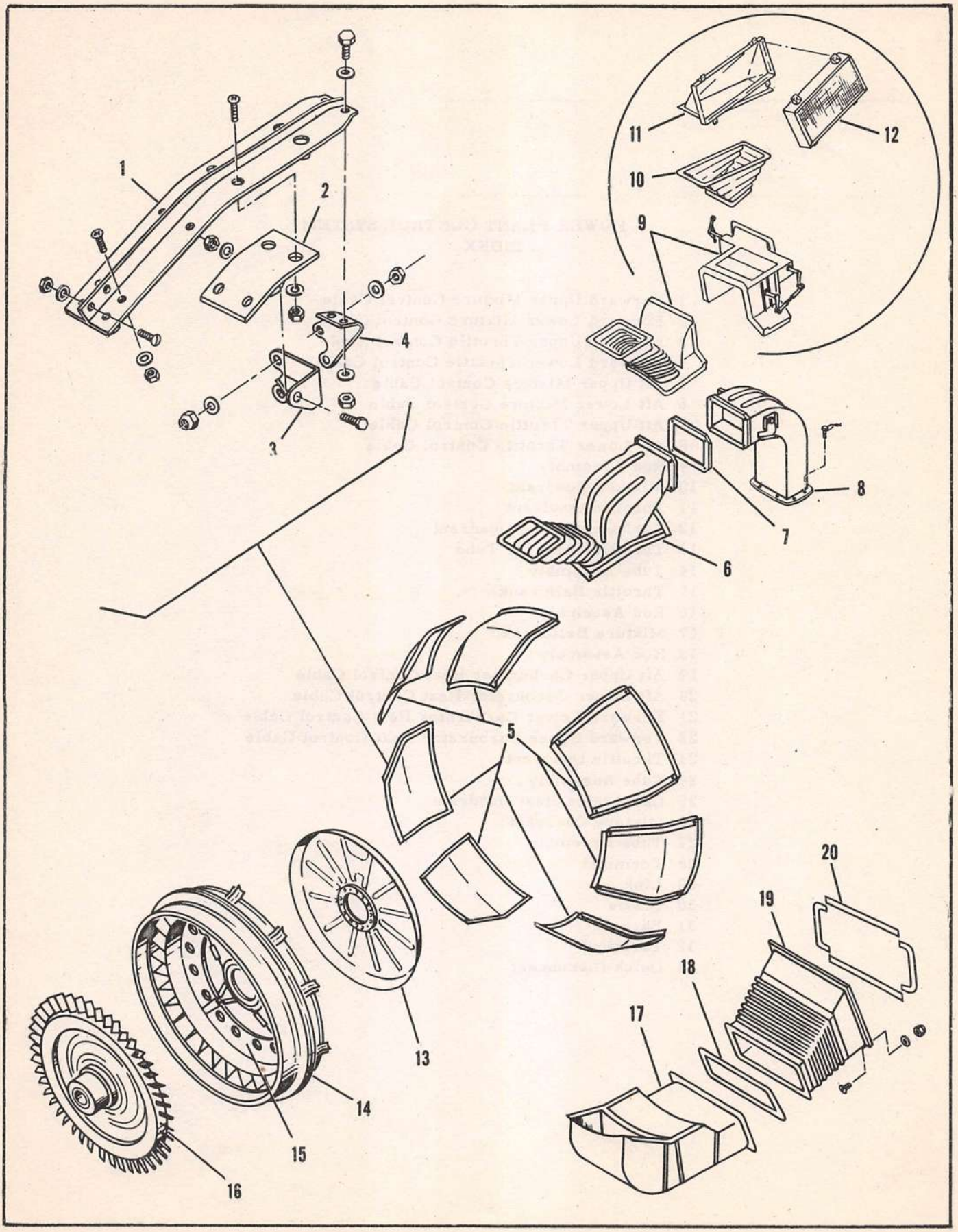
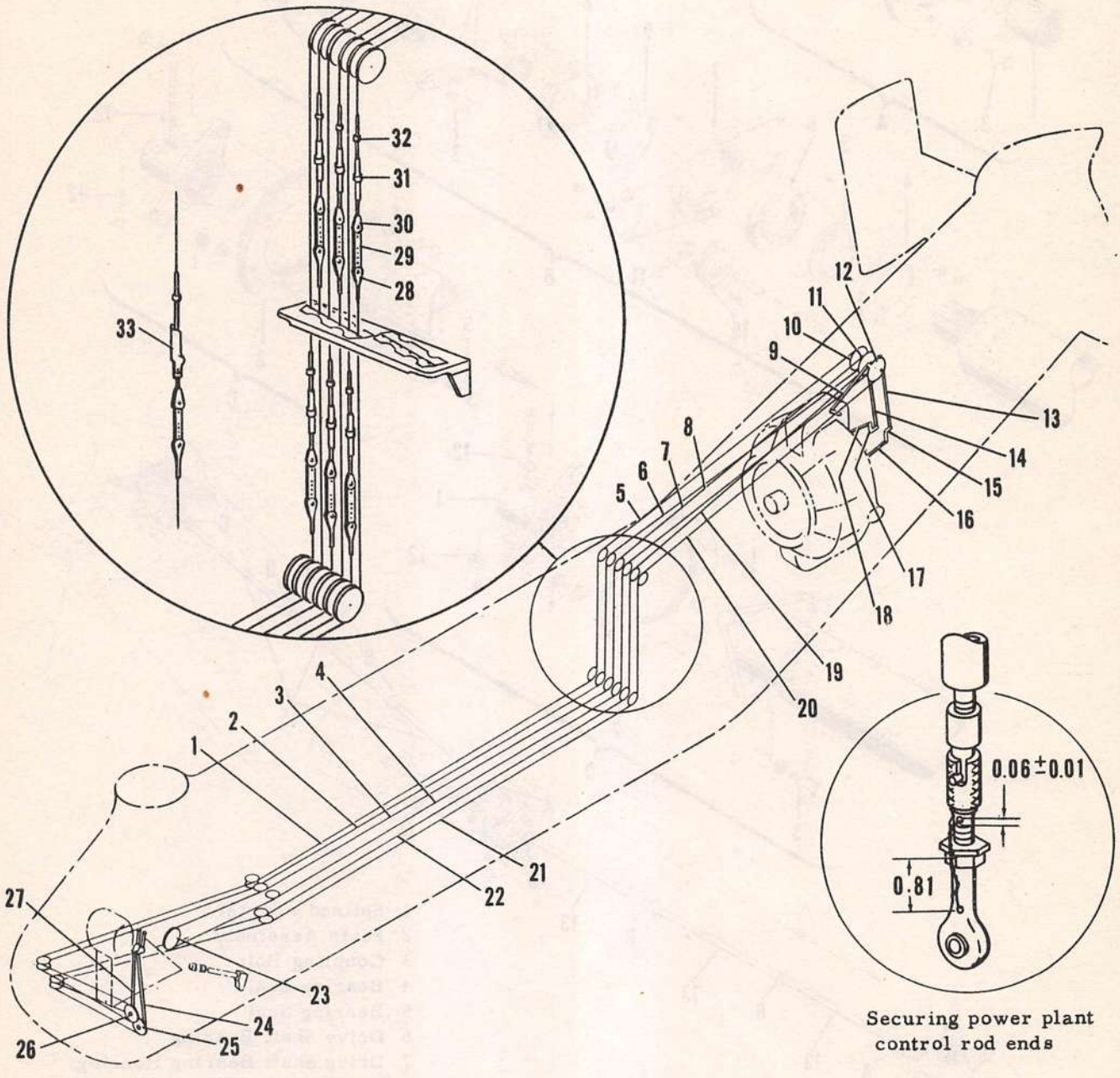


ENGINE COWLING

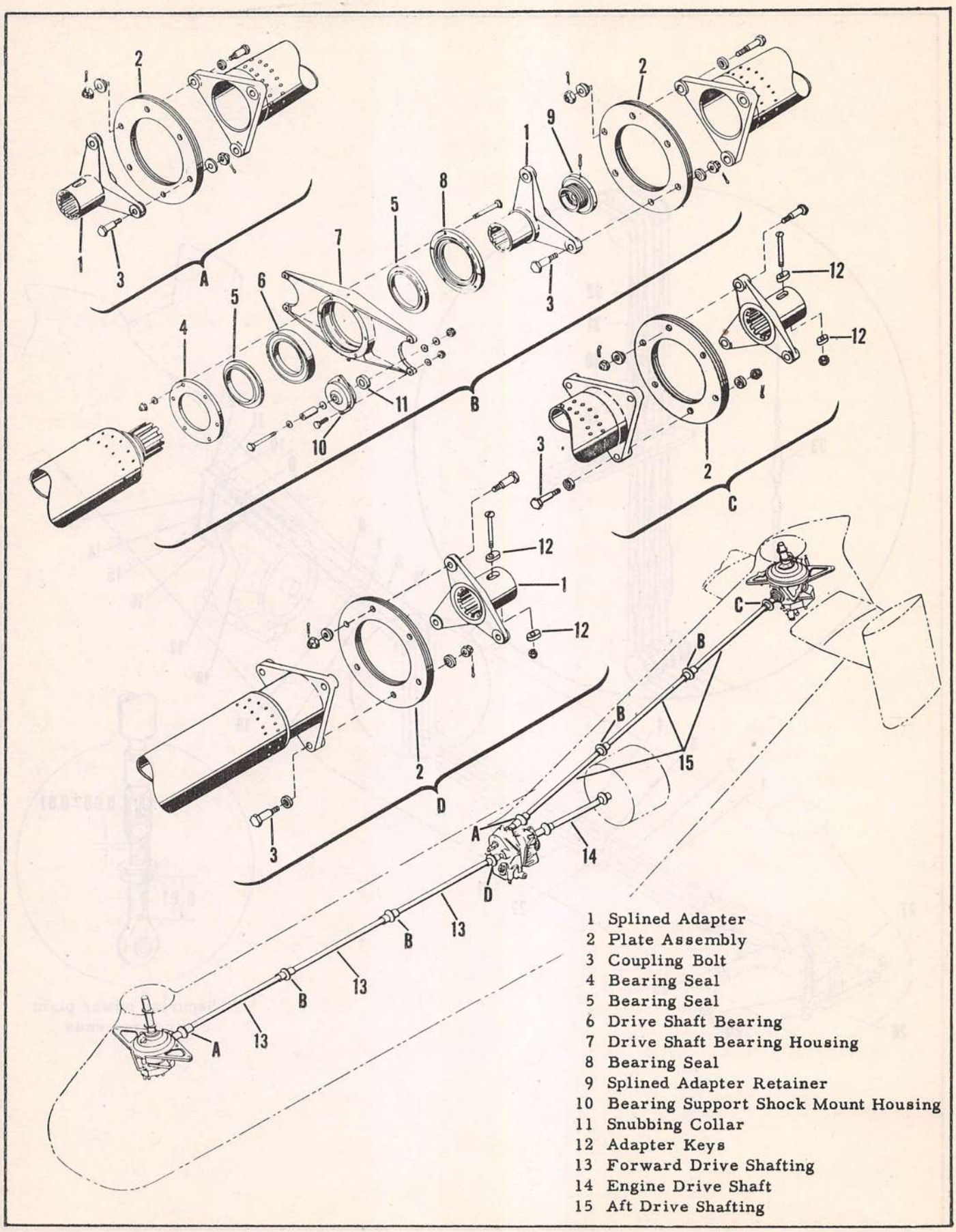
POWER PLANT CONTROL SYSTEM
INDEX

1 Forward Upper Mixture Control Cable
2 Forward Lower Mixture Control Cable
3 Forward Upper Throttle Control Cable
4 Forward Lower Throttle Control Cable
5 Aft Upper Mixture Control Cable
6 Aft Lower Mixture Control Cable
7 Aft Upper Throttle Control Cable
8 Aft Lower Throttle Control Cable
9 Rod Assembly
10 Mixture Quadrant
11 Throttle Quadrant
12 Carburetor Heat Quadrant
13 Throttle Override Tube
14 Tube Assembly
15 Throttle Bellcrank
16 Rod Assembly
17 Mixture Bellcrank
18 Rod Assembly
19 Aft Upper Carburetor Heat Control Cable
20 Aft Lower Carburetor Heat Control Cable
21 Forward Lower Carburetor Heat Control Cable
22 Forward Upper Carburetor Heat Control Cable
23 Throttle Quadrant
24 Tube Assembly
25 Carburetor Heat Quadrant
26 Mixture Quadrant
27 Tube Assembly
28 Terminal
29 Link
30 Clevis
31 Barrel
32 Terminal
33 Quick Disconnect



Securing power plant control rod ends

POWER PLANT CONTROL SYSTEM



1 Splined Adapter
2 Plate Assembly
3 Coupling Bolt
4 Bearing Seal
5 Bearing Seal
6 Drive Shaft Bearing
7 Drive Shaft Bearing Housing
8 Bearing Seal
9 Splined Adapter Retainer
10 Bearing Support Shock Mount Housing
11 Snubbing Collar
12 Adapter Keys
13 Forward Drive Shafting
14 Engine Drive Shaft
15 Aft Drive Shafting

DRIVE SHAFTING

DRIVE SHAFTING

A. SHAFTING ARRANGEMENT

The drive shaft system consists of seven sections of dural shafting which transmit engine torque to the central transmission-main clutch assembly and thence to the forward and aft rotor transmissions. A short shaft connects the engine crankshaft with the central transmission-main clutch assembly. Three sections of shafting connect the central transmission with the forward rotor transmission, and three sections of shafting connect the central transmission with the aft rotor transmission. Adapter couplings riveted to each end of the shaft sections are bolted to laminated stainless steel, flexible couplings, thereby interconnecting the shafting. The flexible couplings act as universal joints. Internally splined adapter couplings on the externally splined input and output transmission shafts are bolted to the flexible couplings located at the ends of the shafts. The adapter couplings on the output shaft of the central transmission for the forward rotor shaft and the input shaft of the aft rotor transmission are bolted to these splined shafts to prevent excessive longitudinal movement on the splines and hammering effect of the shafting against the transmission. Slotted holes in the adapter couplings and adapter keys, which fit into these slotted holes and are drilled to align with the existing bolt holes in the splined shaft, allow for longitudinal centering of the shafting between the transmissions. The transmission drive shafting is supported at four points to the overhead structure of the fuselage by bearings within housings bolted to rubber shock mounts, which in turn are bolted to hanger brackets extending from the structure. Due to allowable longitudinal movement of the shafting, the bearing housings are also allowed a limited fore and aft movement between the hangers.

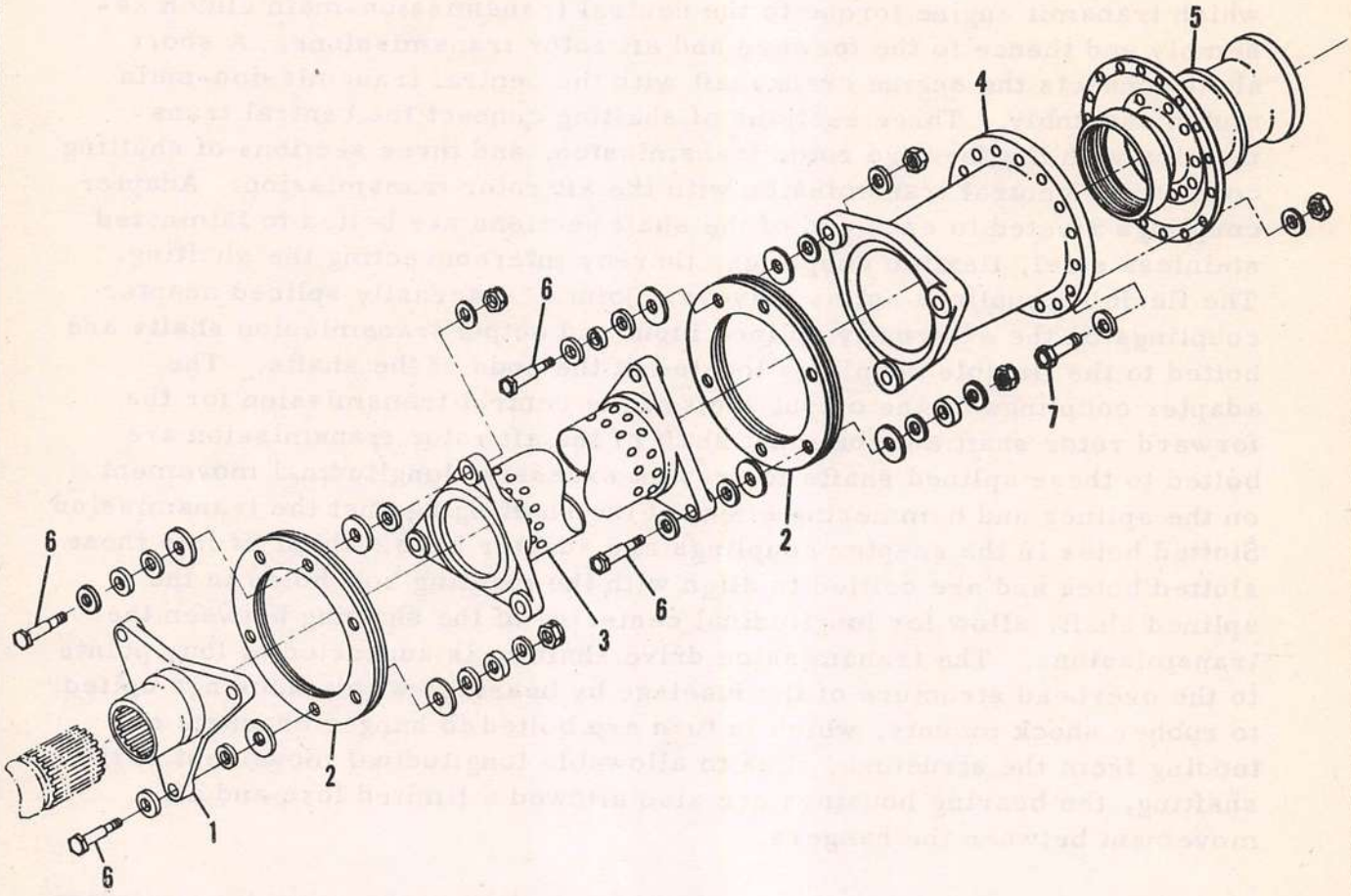
The engine drive shaft (short shaft) is similar to the rotor transmission shafting except at the connecting point on the engine. The aft flexible coupling of the engine drive shaft is bolted to an adapter which is an integral part of the cooling fan hub. The cooling fan hub is splined, seated, and secured to the engine crankshaft by two cones and a retaining torque nut.

B. FLEXIBLE COUPLINGS

The flexible couplings are flexible steel plates installed as a pack between shaft sections and the shafts and transmissions. The flexible couplings act as universal joints and allow for longitudinal deflection of the shafting.

The two flexible couplings attached to either end of the engine drive shaft consist of thirty plates each, 15 plates with flats ground perpen-

1 Splined Adapter
2 Flexible Plate Assembly
3 Shaft Assembly
4 Fan Hub Adapter
5 Fan Hub
6 Coupling Bolt
7 Fan Hub Adapter Bolt

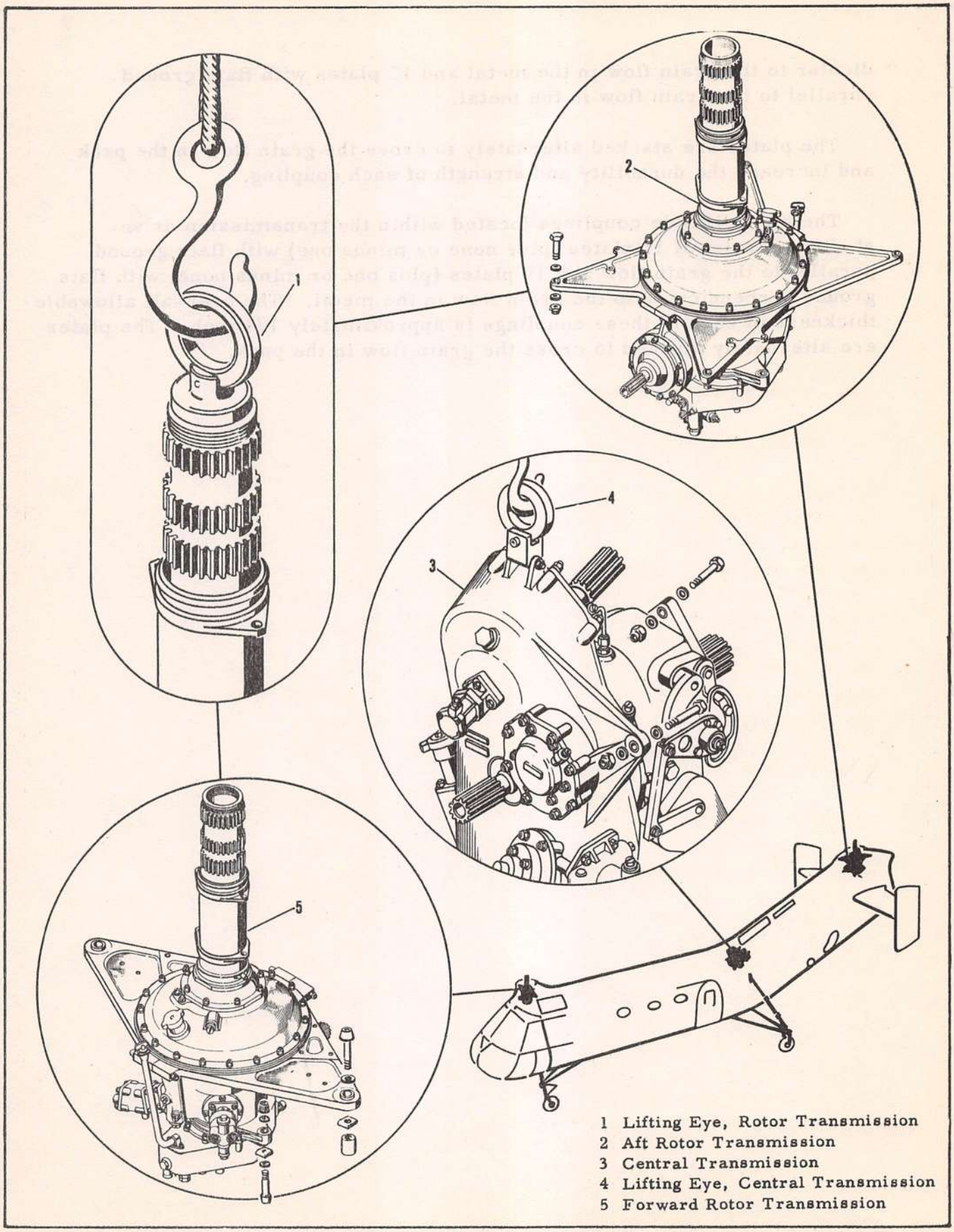


ENGINE DRIVE SHAFT

dicular to the grain flow in the metal and 15 plates with flats ground parallel to the grain flow in the metal.

The plates are stacked alternately to cross the grain flow in the pack and increase the durability and strength of each coupling.

The eight flexible couplings located within the transmission drive shafting consist of 11 plates (plus none or minus one) with flats ground parallel to the grain flow and 10 plates (plus one or minus none) with flats ground perpendicular to the grain flow in the metal. The over-all allowable thickness of each of these couplings is approximately 1/4 inch. The plates are alternately stacked to cross the grain flow in the pack.



1 Lifting Eye, Rotor Transmission
2 Aft Rotor Transmission
3 Central Transmission
4 Lifting Eye, Central Transmission
5 Forward Rotor Transmission

TRANSMISSION REMOVAL

TRANSMISSIONS

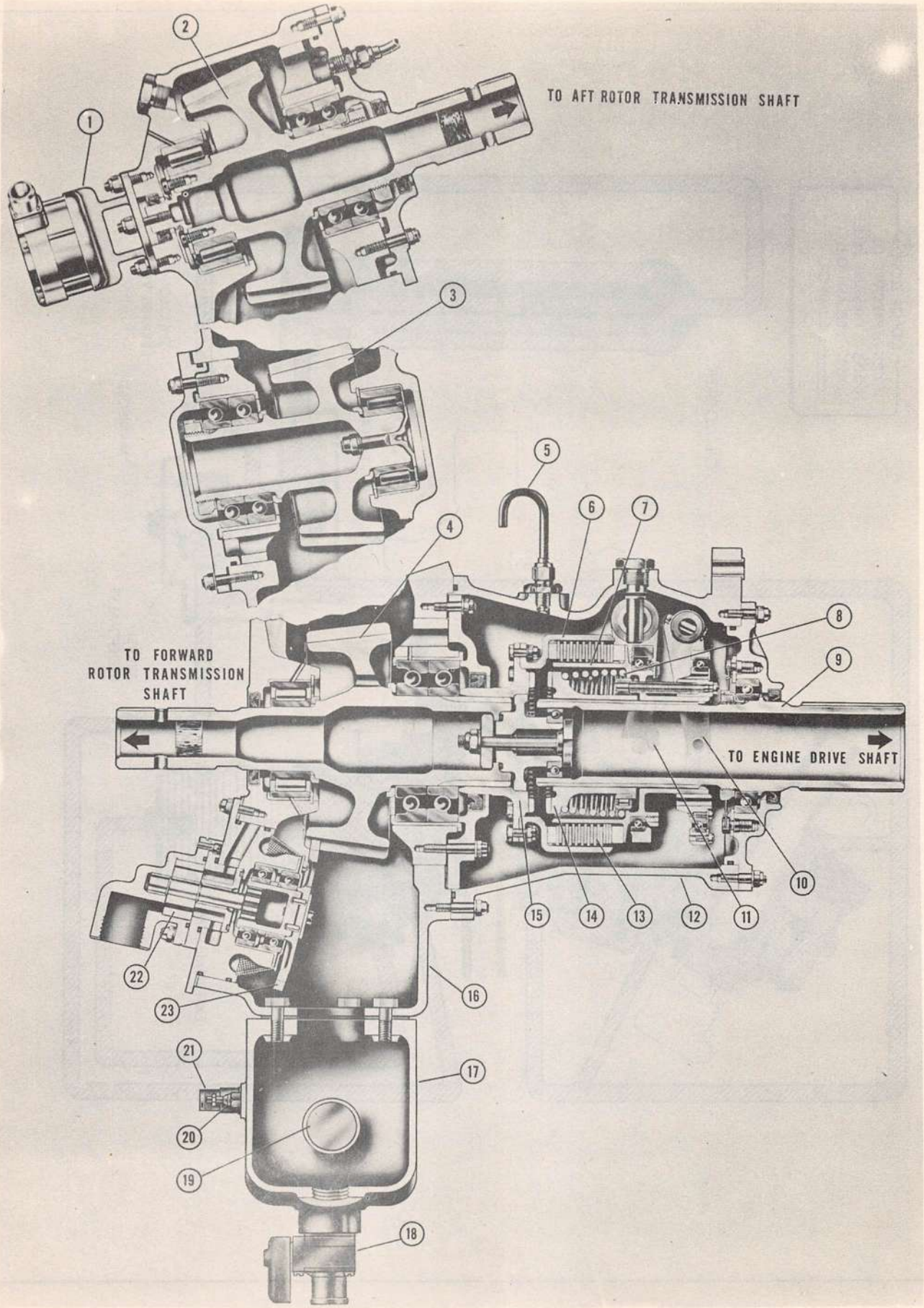
A. GENERAL

The transmission system is composed of a central transmission and main clutch assembly, a forward rotor transmission assembly and an aft rotor transmission assembly. The central transmission and clutch assembly is coupled to the engine with a short drive shaft and provides the means of transmitting engine torque to the rotor transmission drive shafting. Each of the rotor transmission assemblies are coupled to the central transmission assembly with three sections of drive shafting and provide the means of transmitting drive shaft torque to the rotor hub assemblies.

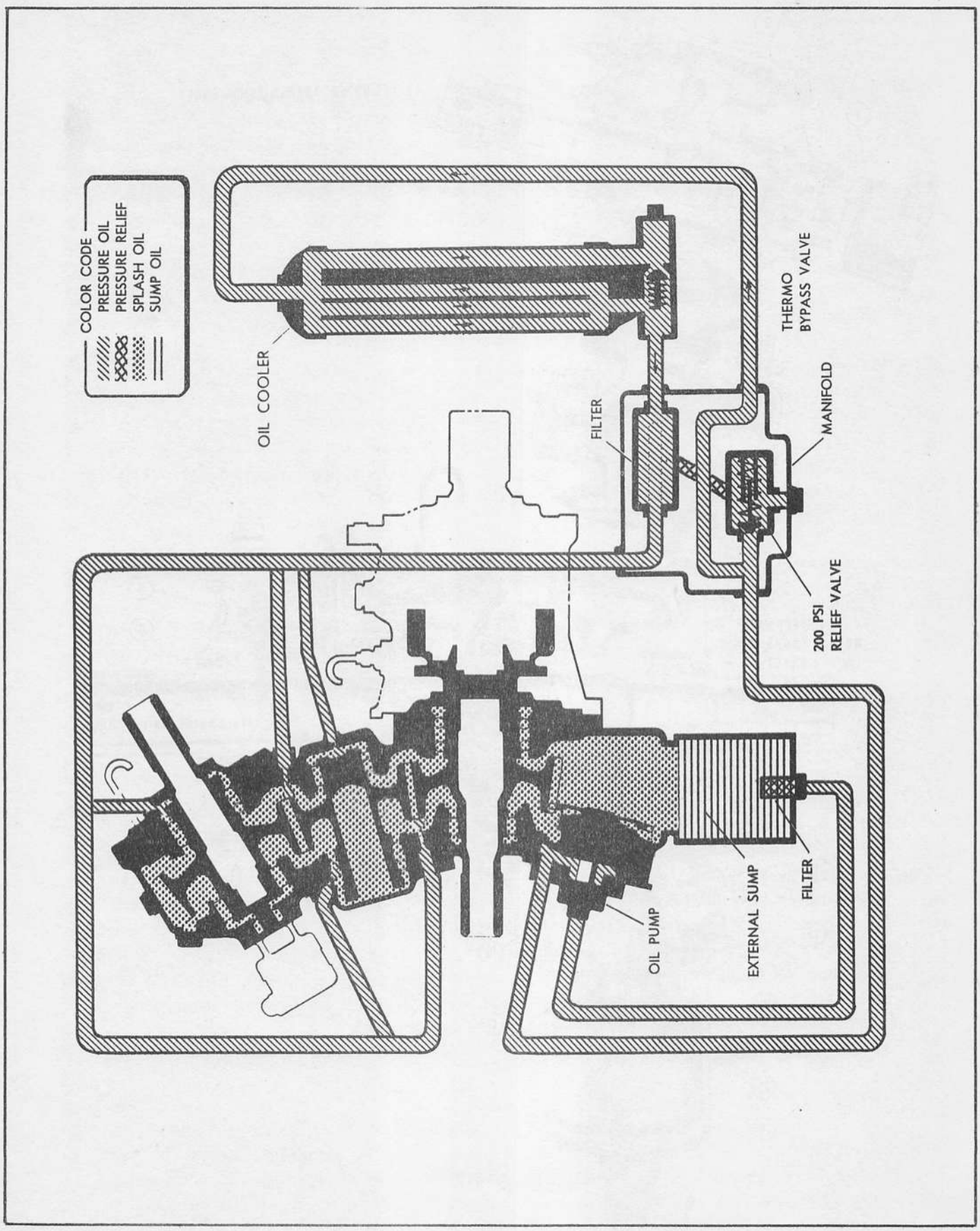
B. MAIN CLUTCH ASSEMBLY

The main clutch assembly consists generally of a friction clutch, which permits the engine torque to be gradually transmitted to the rotor drive system, and a positive-locking jaw clutch, which provides a means of positive drive. Engine torque is transmitted through the drive shaft to an externally splined clutch shaft. An externally splined drum and a jaw clutch driver coupling, both internally splined, are designed to slide longitudinally on this shaft. Internally splined steel driving plates are driven by the externally splined drum and are alternately spaced with externally splined bronze covered steel driven plates. These driven plates mesh with and drive an internally splined housing attached to the driver gear of the central transmission. Jaw teeth on the driver coupling mesh with teeth on the driven coupling attached to the driver gear of the central transmission. Clutch engagement and disengagement is actuated by an electric motor through direct linkage to an arm and cam arrangement mounted on a pivot on the outside of the clutch case. This motor, located in the clutch actuator, is energized by a friction clutch switch and a jaw clutch switch located in the cockpit. When the friction switch is moved to the ENGAGE position, the electric actuator applies pressure to the friction clutch plates through the cam arrangement. The increased pressure between the plates brings the rotor drive shaft speed up to the engine speed. The jaw switch is then moved to the ENGAGE position and the driver coupling, which is spring loaded, moves forward until its jaw teeth engage those of the driven coupling, thus causing a positive drive between the engine and the transmissions. When the jaw clutch is completely engaged, the cam arrangement automatically disengages the friction clutch. The teeth of both jaw clutch couplings are designed to provide overrunning for autorotation in case of power failure. The entire clutch assembly is mounted inside a case partly filled with oil and vented at the top to relieve any internal pressures. The friction clutch may be used as a rotor brake to stop the rotors in case of emergency. The clutch is an integral part of the central transmission and is accessible for service and adjustment from the passenger compartment.

CENTRAL TRANSMISSION
INDEX



CENTRAL TRANSMISSION



CENTRAL TRANSMISSION OIL SYSTEM SCHEMATIC

C. CENTRAL TRANSMISSION

The central transmission distributes the engine torque to the forward and aft rotor transmissions by means of the rotor transmission drive shafting. The engine torque is transmitted through the clutch, which is an integral part of the central transmission, to the aft end of the driver gear. The forward end of the driver gear is connected to the forward rotor transmission drive shafting, thus driving the forward transmission. The driver gear also meshes with and drives the idler gear and the oil pump gear. The idler gear meshes with and drives the driven gear in the same direction as that of the driver gear. The aft end of the driven gear is connected to the aft rotor transmission drive shafting, thus driving the aft transmission. The forward end is coupled to and drives the tachometer generator. The gears, bearings and other parts in the transmission are lubricated by a self-contained lubrication system. A breather tube is installed in the driven gear cover to relieve internal pressures. The transmission is accessible from the main cabin and is attached to the fuselage structure over the fuel tank.

D. ROTOR TRANSMISSIONS

The rotor transmission assemblies provide the means for transmitting the engine torque from the rotor drive shafting to the rotor hub assemblies. The drive shafting is connected to the driving bevel pinion gear which drives the bevel ring gear that is bolted to the sun gear shaft. The sun gear drives the four planetary pinion gears which mesh with the stationary ring gear. The planetary pinion gears are mounted in the carrier, which is splined to the rotor shaft, so that as the planetary pinion gears are rotated and travel around the inside of the stationary ring gear, the rotor drive shaft is rotated. The over-all gear reduction results in the rotor shaft turning one turn to approximately every 9-1/2 turns of the driving bevel pinion gear. The gears, bearings and other parts in the transmissions are lubricated by a self-contained lubrication system. The flight controls hydraulic pump and the hoist hydraulic pump are mounted on the lower case and driven by bevel pinion gears which mesh with the accessory drive bevel ring gear. These pumps are on the forward transmission only. Access to both the forward and aft transmissions may be gained by removing the cowling surrounding them.

E. TRANSMISSION LUBRICATION

Each transmission assembly is equipped with a complete and separate lubrication system. Lubricating oil pressure is supplied by an oil pump which circulates the oil through an individual cooling core of a common oil cooler to a manifold where it is distributed to various oil jets.

F. TRANSMISSION LUBRICATION ACCESSORIES

1. CENTRAL TRANSMISSION OIL PUMP

The central transmission oil pump is a positive displacement, variable delivery type, mounted on the transmission case below the driver gear. It is driven by a gear which meshes with the driver gear.

2. ROTOR TRANSMISSION OIL PUMP

The rotor transmission oil pump is a positive displacement, variable delivery type, mounted in the transmission sump. It is driven by a gear which is attached to the lower end of the rotor drive shaft.

3. CENTRAL TRANSMISSION PRESSURE RELIEF VALVE

The central transmission pressure relief valve is located in the manifold housing which is attached to the transmission case. This relief valve opens and passes oil through the manifold assembly to the oil jets, bypassing the oil cooler, when an extremely large pressure rise occurs.

4. ROTOR TRANSMISSION PRESSURE RELIEF VALVE

The rotor transmission pressure relief valve is located in the sump. This relief valve opens and passes oil to the manifold which distributes it to the oil jets, bypassing the oil cooler, when an extremely large pressure rise occurs.

5. TRANSMISSION LUBRICATION JETS

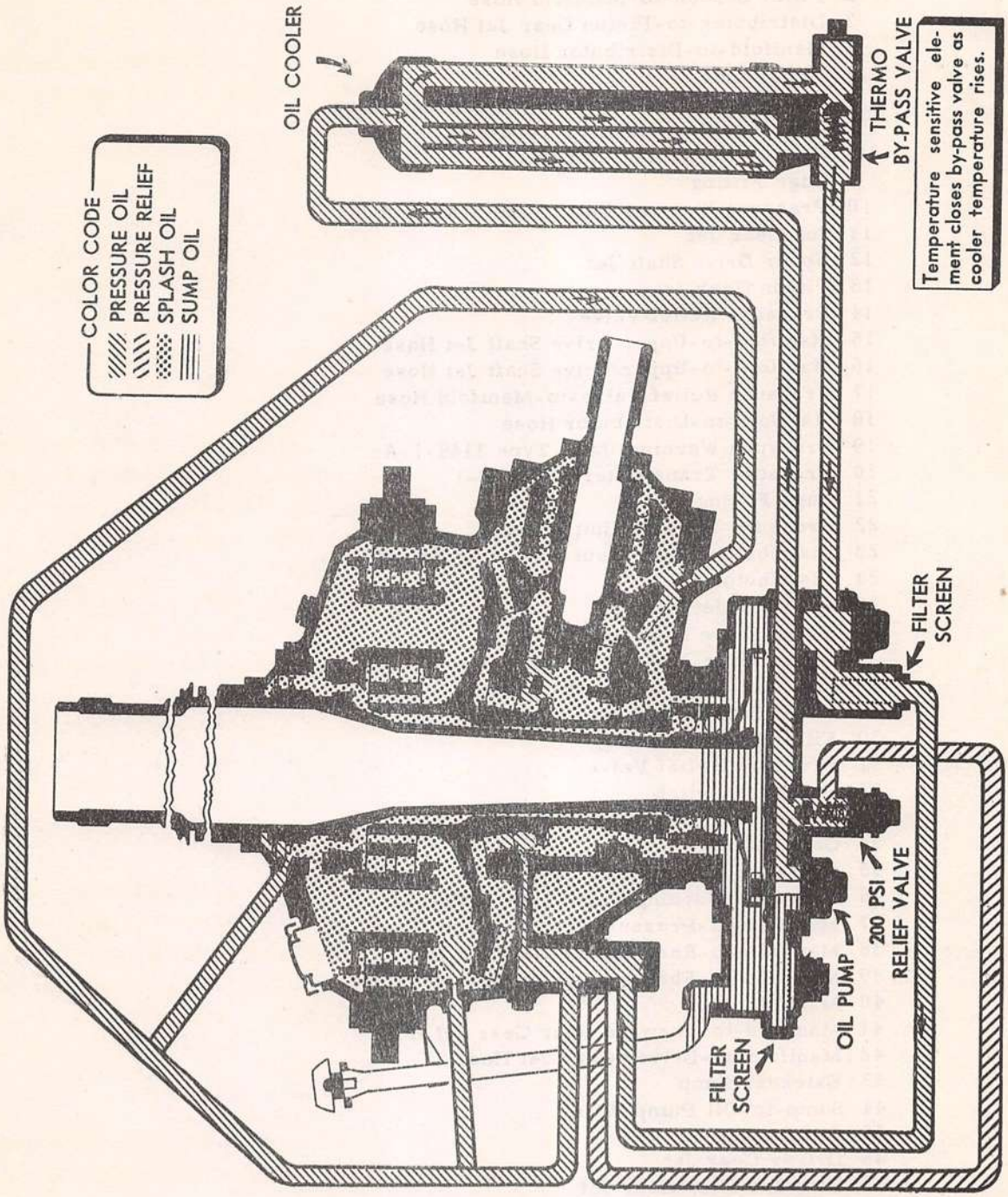
The transmission lubrication jets receive their oil supply from external oil lines and distribute an adequate supply of oil to the bearings and gears of the transmission. There are five oil jets on the central transmission and four on each rotor transmission. Each oil jet is a fixed-orifice type and designed to maintain constant oil pressure in the system.

6. OIL PRESSURE SWITCHES

Each transmission lubrication system is equipped with an oil pressure switch which operates an oil pressure warning light to warn the pilot of excessive oil pressures.

7. OIL PRESSURE TRANSMITTERS

Each transmission lubrication system is equipped with an oil pressure transmitter which actuates an oil pressure indicator in the cockpit.

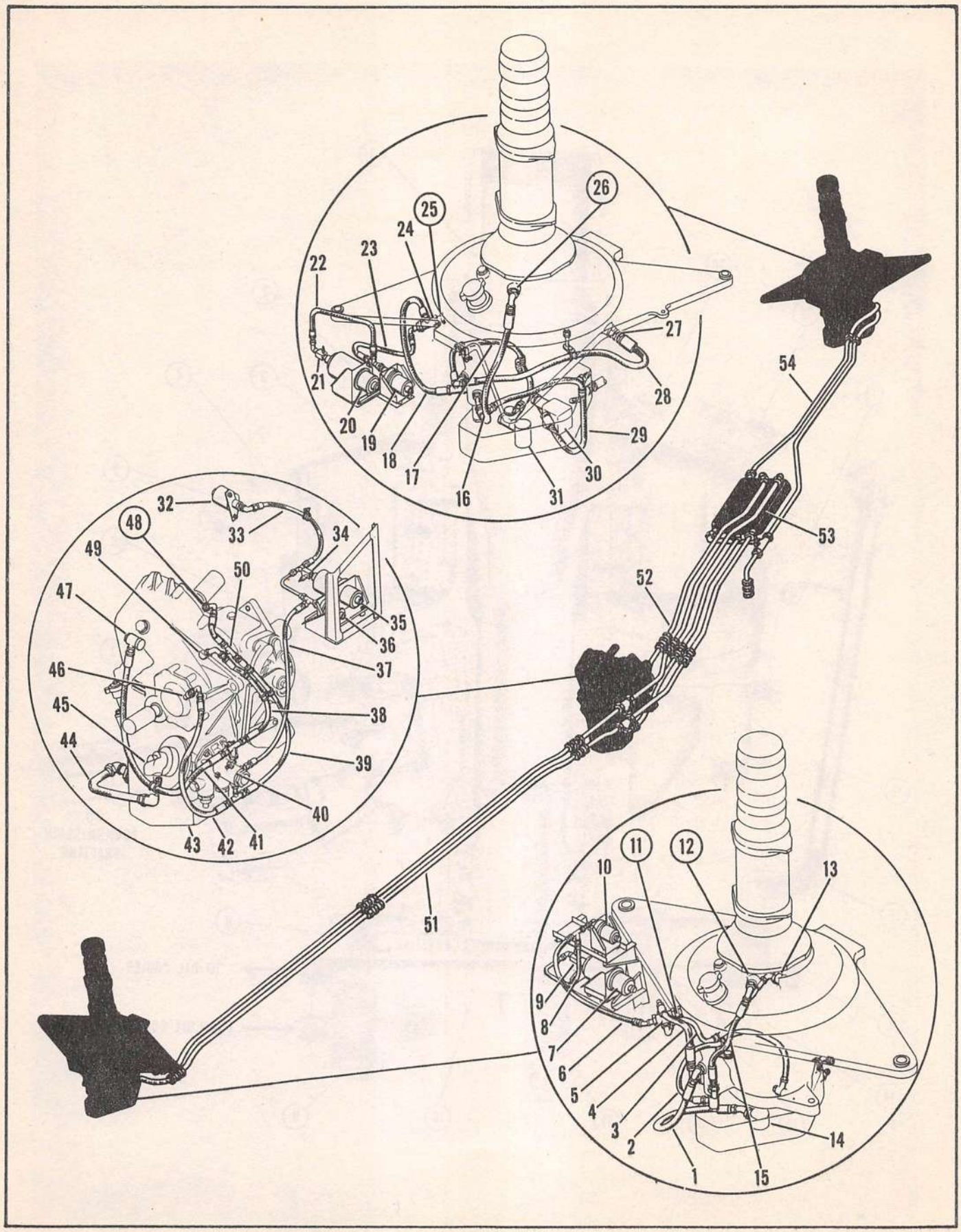


ROTOR TRANSMISSION OIL SYSTEM SCHEMATIC

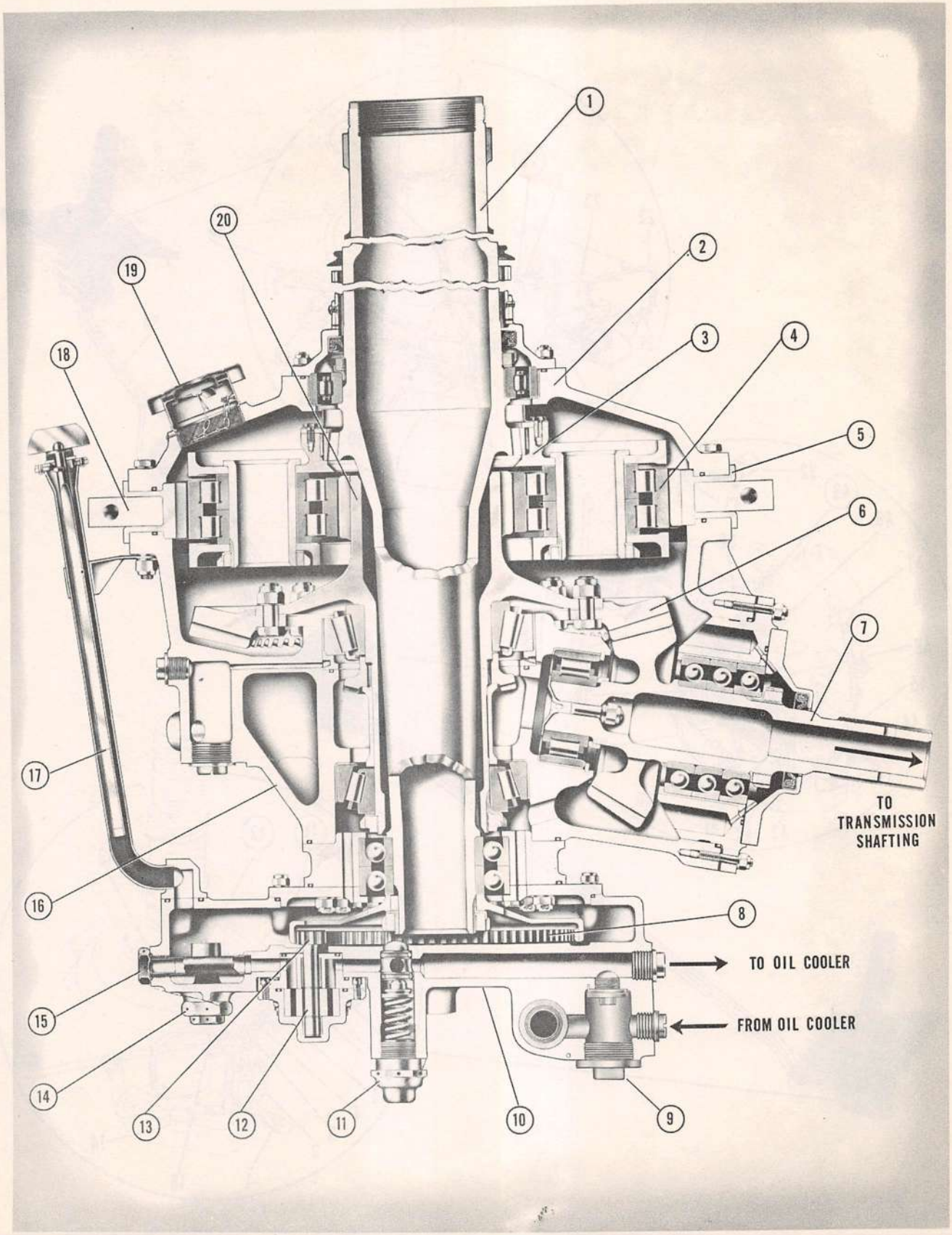
TRANSMISSION LUBRICATION SYSTEM
INDEX

1 Pressure Relief Valve-to-Manifold Hose
2 Filter Screen-to-Manifold Hose
3 Distributor-to-Pinion Gear Jet Hose
4 Manifold-to-Distributor Hose
5 Distributor
6 Distributor-to-Pressure Warning Unit Hose
7 Pressure Transmitter, Type F-3
8 Pressure Warning Unit Hose
9 Gage Fitting
10 Pressure Warning Unit, Type 3149-1-A
11 Sun Gear Jet
12 Upper Drive Shaft Jet
13 Pinion Gear Jet
14 Pressure Relief Valve
15 Manifold-to-Upper Drive Shaft Jet Hose
16 Manifold-to-Upper Drive Shaft Jet Hose
17 Pressure Relief Valve-to-Manifold Hose
18 Manifold-to-Distributor Hose
19 Pressure Warning Unit, Type 3149-1-A
20 Pressure Transmitter, Type F-3
21 Gage Fitting
22 Pressure Warning Unit Hose
23 Distributor-to-Pressure Warning Unit Hose
24 Distributor
25 Sun Gear Jet
26 Upper Drive Shaft Jet
27 Pinion Gear Jet
28 Manifold-to-Pinion Gear Jet Hose
29 Filter Screen-to-Manifold Hose
30 Filter Screen Housing
31 Pressure Relief Valve
32 Pressure Switch
33 Pressure Switch Hose
34 Gage Fitting
35 Pressure Transmitter, Type F-3
36 Pressure Warning Unit, Type 3149-1-A
37 Manifold-to-Pressure Warning Unit Hose
38 Manifold-to-Rear Driven Gear Jet Hose
39 Manifold-to-Forward Driven Gear Jet Hose
40 Manifold
41 Manifold-to-Forward Idler Gear Jet Hose
42 Manifold-to-Driver Gear Jet Hose
43 External Sump
44 Sump-to-Oil Pump Hose
45 Oil Pump
46 Driver Gear Jet
47 Forward Idler Gear Jet
48 Forward Driven Gear Jet
49 Rear Driven Gear Jet
50 Rear Idler Gear Jet
51 Forward Rotor Transmission-to-Oil Cooler Lines
52 Center Transmission-to-Oil Cooler Lines
53 Oil Coolers
54 Rear Rotor Transmission-to-Oil Cooler Lines

Note: Circled key numbers indicate removable lubrication jets.

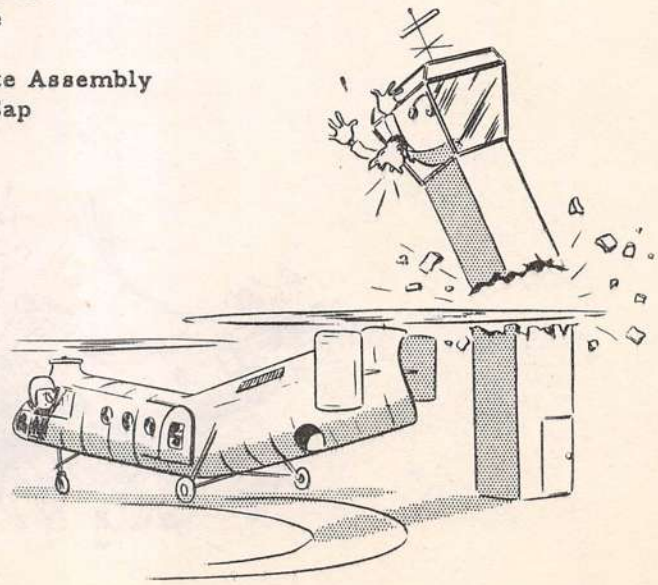


TRANSMISSION LUBRICATION SYSTEM



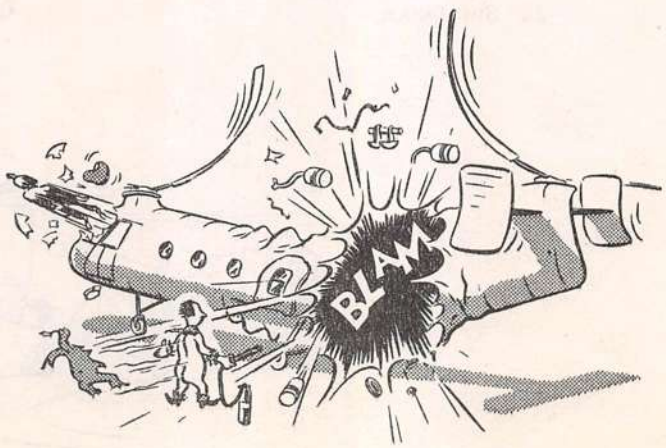
ROTOR TRANSMISSION (Sheet 1 of 2)

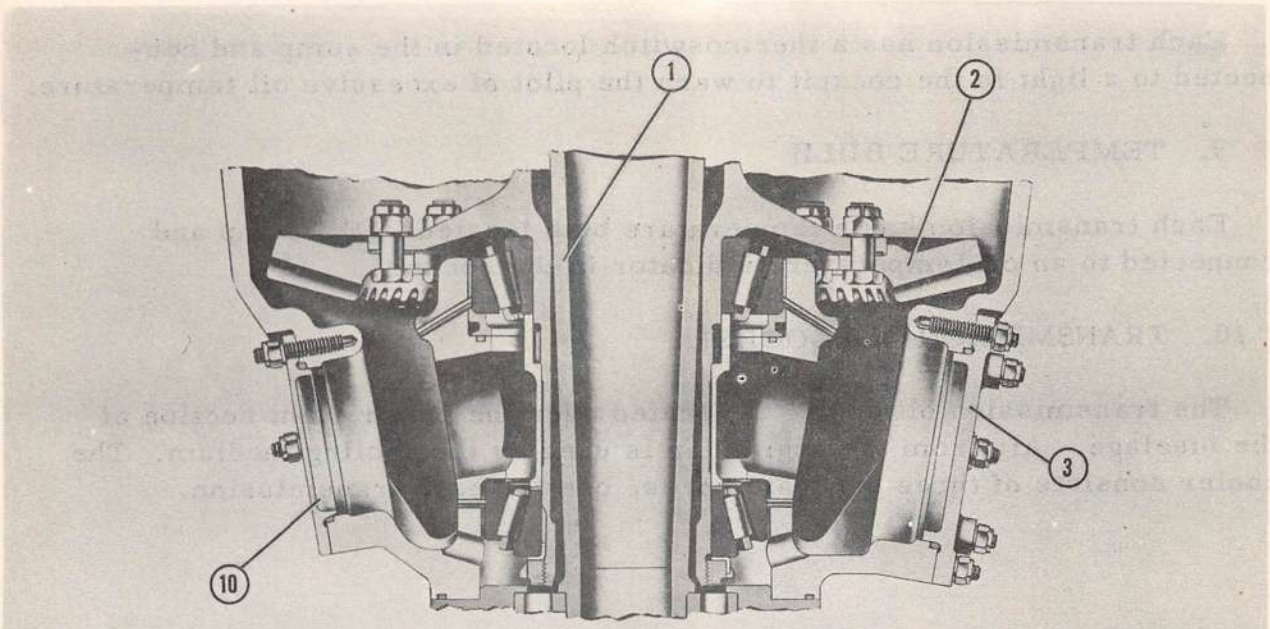
ROTOR TRANSMISSION
INDEX
(Sheet 1 of 2)



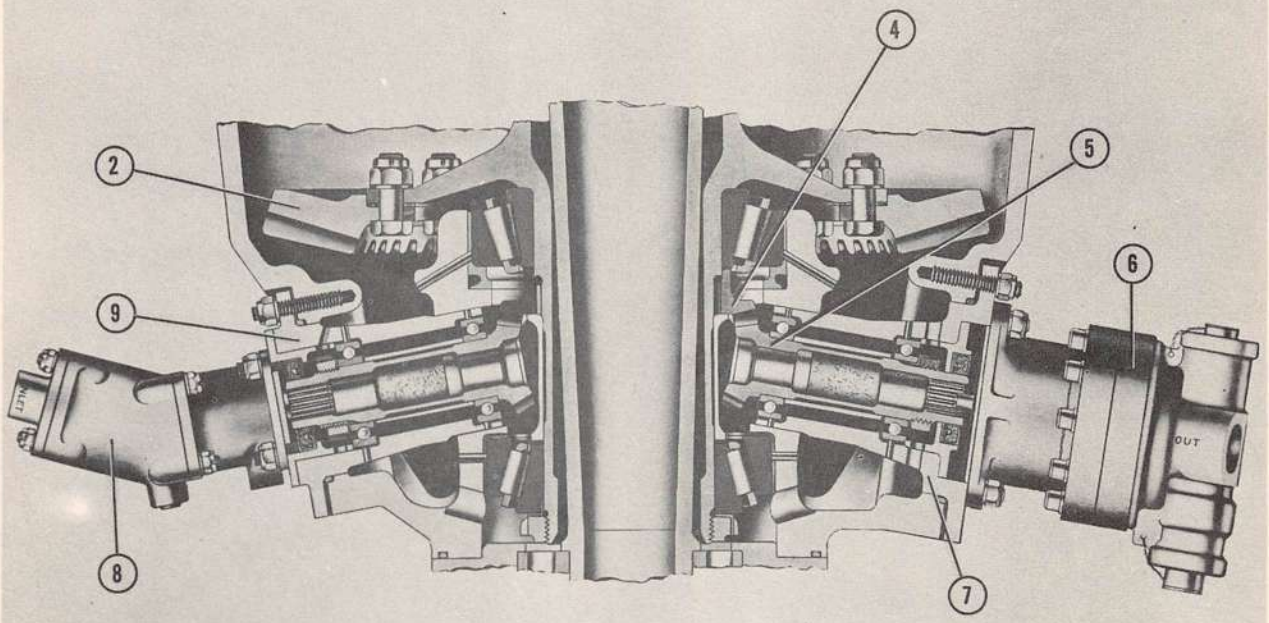
ROTOR TRANSMISSION
INDEX
(Sheet 2 of 2)

1 Rotor Drive Shaft
2 Bevel Ring Gear
3 Cover
4 Accessory Drive Bevel Ring Gear
5 Bevel Pinion Gear, Accessory Drive Assembly
6 Flight Controls Hydraulic Pump
7 Adapter Drive Assembly
8 Hoist Pump
9 Adapter Assembly
10 Cover





AFT TRANSMISSION - SUMP REGION



FORWARD TRANSMISSION - SUMP REGION

ROTOR TRANSMISSION (Sheet 2 of 2)

8. THERMOSWITCHES

Each transmission has a thermoswitch located in the sump and connected to a light in the cockpit to warn the pilot of excessive oil temperature.

9. TEMPERATURE BULB

Each transmission has a temperature bulb located in the sump and connected to an oil temperature indicator in the cockpit.

10. TRANSMISSION OIL COOLER

The transmission oil cooler is located over the power plant section of the fuselage. Air from the engine fan is used as the cooling medium. The cooler consists of three separate cores, one for each transmission.

ROTOR GROUP

A. BLADES

Three rotor blades are attached to each of the two rotor hub assemblies. Either wood or metal blades can be used.

A wooden blade consists primarily of a steel spar, split sleeve, socket and leading edge protective strips; an aluminum alloy tip cover, trailing edge reinforcement, fairing and trim tab, and the following wooden components; spar halves, leading edge laminate, ribs, trailing edge and blocks. With the exception of the socket, split sleeve and tip cover, all the wooden and metal components are bonded together to form a single unit.

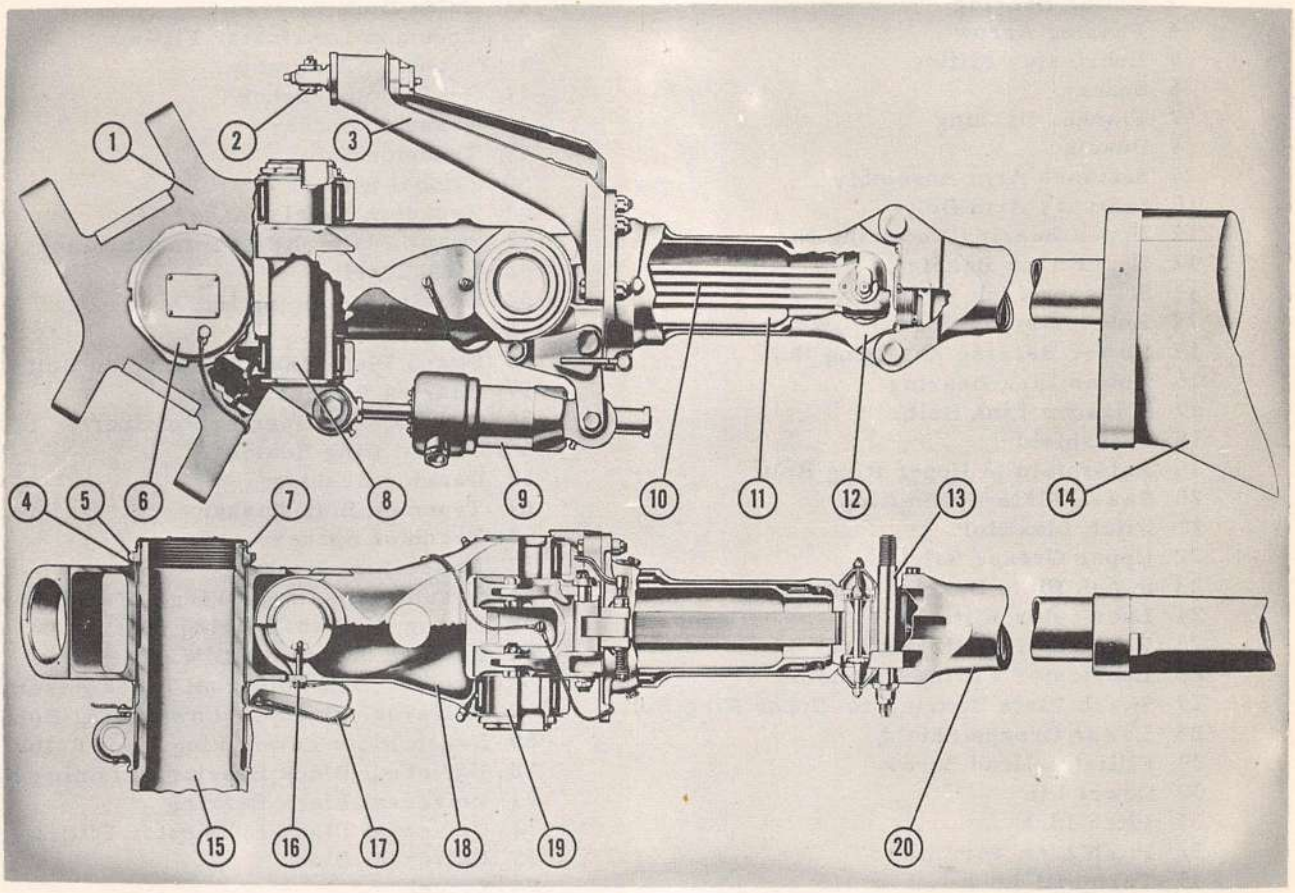
A metal blade consists primarily of a spar, an attachment yoke, 17 trailing edge boxes, a tip cover assembly, balancing weights and a trim tab. The spar is a D-shaped extrusion of steel and forms the leading edge of the blade. The fork-type steel attachment yoke is shim fitted to the root end of the spar with pins, and has holes at the root end for blade to rotor hub attaching pins. The trailing edge boxes are bonded to the spar and have their adjacent edges bonded and sealed. The tip cover assembly is attached to the blade with screws and may be removed for access to the balancing weights, which are mounted on studs at the spar tip. An adjustable trim tab is riveted to the trailing edge boxes.

B. ROTOR HUB ASSEMBLY

The rotor hub assembly provides a means of transmitting drive shaft torque to the rotor blades. The steel hub assembly is splined to the rotor drive shaft and secured by a lock nut, washer, and lock ring. Each of three extension links is connected to the rotor hub by a horizontal pin supported on two needle bearings pressed into the rotor hub. This hinging arrangement allows the blades to flap in a vertical plane, and blade stops on the top and bottom of the hub limit the flapping to approximately 30 degrees upward and 4-1/2 degrees downward. The pitch shaft in each of the three pitch bearing assemblies is connected to an extension link by a vertical pin supported on two needle bearings pressed into the outboard lugs of the extension link. This hinging arrangement allows the blades to lead and lag in a horizontal plane and a lag damper connected between the horizontal pin and the pitch shaft limits the lead and lag travel of the blades. Tension loads are taken by a stack of tension-torsion straps located inside the pitch bearing assembly and pinned at their inboard end to the pitch shaft and at their outboard end to the pitch bearing housing.

ROTOR HUB
INDEX

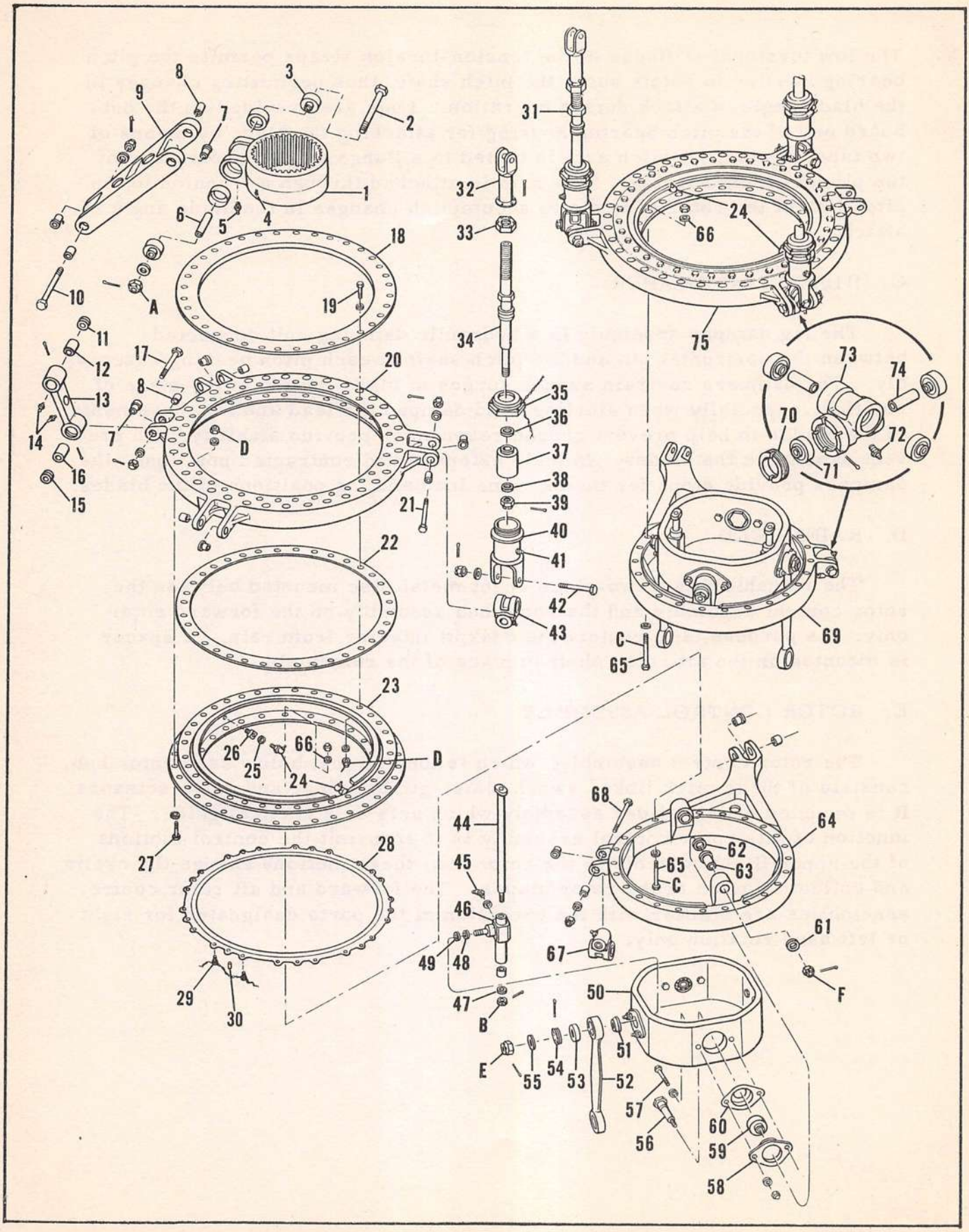
1 Hub Sub-Assembly
2 Pitch Link
3 Pitch Arm
4 Washer
5 Lock Nut
6 Cap
7 Lock Ring
8 Horizontal Pin
9 Lag Damper
10 Tension-Torsion Straps
11 Pitch Shaft
12 Pitch Bearing Housing
13 Taper Pin
14 Rotor Blade
15 Rotor Drive Shaft
16 Droop Stop
17 Bonding Jumper
18 Extension Link
19 Vertical Pin
20 Blade Root Socket



ROTOR HUB

ROTOR CONTROL ASSEMBLY
INDEX

1 Collar Assembly
2 Scissor Collar Bolt
3 Collar Bearing
4 Phasing Arrow
5 Lubricator Fitting
6 Spacer
7 Flanged Bushing
8 Bushing
9 Scissors Arm Assembly
10 Scissors Arm Bolt
11 Upper Bearing Retaining Nut
12 Upper Link Bearing
13 Scissors Link Assembly
14 Lubricator Fittings
15 Lower Bearing Retaining Nut
16 Lower Link Bearing
17 Scissors Link Bolt
18 Rainshield
19 Rainshield to Upper Ring Bolt
20 Swash Plate Upper Ring
21 Pitch Link Bolt
22 Upper Grease Shield
23 Swash Plate Bearing Assembly
24 Lubricator Fitting
25 Lubricator Fitting Gasket
26 Lubricator Fitting Extension
27 Swash Plate Bearing-to-Upper Ring Bolt
28 Lower Grease Shield
29 Fillister Head Screw
30 Dowel Pin
31 Pitch Link
32 Pitch Link Terminal
33 Terminal Lock Nut
34 Pitch Link Shaft
35 Pitch Link Nut
36 Pitch Link Washer
37 Pitch Link Bearing
38 Washer
39 Pitch Link Shaft Nut
40 Pitch Link Bearing Housing
41 Pitch Link Bearing Lubricator Fitting
42 Universal Block-to-Pitch Link Bolt
43 Pitch Link Universal Block Assembly
44 Guide Bolt
45 Trunnion Lubricator Fitting
46 Trunnion Assembly
47 Guide Bolt Washer
48 Trunnion Spacer
49 Trunnion Shim
50 Gimbal Ring
51 Trunnion Bevel Washer
52 Swash Plate Slider Actuating Link Assembly
53 Link Bearing
54 Bearing Retaining Nut
55 Washer
56 Swash Plate Bearing Trunnion Bolt
57 Bearing Retainer Bolt
58 Gimbal Ring Bearing Retainer
59 Gimbal Ring Bearing
60 Bearing Bushing
61 Trunnion Bolt Washer
62 Trunnion Spacer
63 Lower Ring Bushing
64 Swash Plate Lower Ring - Fwd Rotor
65 Lower Ring-to-Bearing Bolt
66 Beveled or Small OD Washer
67 Lateral Link Universal Block Assembly
68 Universal Block-to-Lower Ring Bolt
69 Swash Plate Lower Ring - Aft Rotor
70 Universal Block Bearing Retaining Nut
71 Universal Block Bearing
72 Universal Block Lubricator Fitting
73 Universal Block
74 Spacer
75 Swash Plate Assembly - Aft Rotor
A Torque to 125-175 pound-inches
B Torque to 80-100 pound-inches
C Torque to 35- 40 pound-inches
D Torque to 20- 25 pound-inches
E Torque to 30- 40 pound-inches
F Torque to 60- 70 pound-inches



ROTOR CONTROL ASSEMBLY

The low torsional stiffness of the tension-torsion straps permits the pitch bearing housing to rotate about the pitch shaft, thus permitting changes in the blade angle of attack during operation. Lugs are provided on the outboard end of the pitch bearing housing for attaching the blade by means of two tapered pins. A pitch arm is bolted to a flange on the inboard end of the pitch bearing housing. This arm is attached through a trunnion to the pitch link of the rotor controls to accomplish changes in the blade angle of attack.

C. BLADE LAG DAMPER

The lag damper assembly is a hydraulic damping unit connected between the horizontal pin and the pitch shaft of each pitch bearing assembly. The dampers restrain sudden surges of blade motion in the plane of rotation, especially when starting, and dampen the lead and lag movements of the blades to help prevent ground resonance, provide stability, and prevent damage to the blades. In their extended and contracted positions, the dampers provide stops for the extreme lead and lag positions of the blades.

D. RAINSHIELD

The rainshield is a two-piece sheet metal disc mounted between the rotor control assembly and the rotor hub assembly on the forward rotor only. Its purpose is to protect the cockpit interior from rain. A spacer is mounted on the aft rotor shaft in place of the rainshield.

E. ROTOR CONTROL ASSEMBLY

The rotor control assembly, which is located just below each rotor hub, consists of three pitch links, swash plate, gimbal ring, and drive scissors. It is mounted over a slider assembly which acts as a vertical guide. The function of this rotor control assembly is to transmit the control motions of the upper flight controls to the rotor hub; these motions change the cyclic and collective pitch of the rotor blades. The forward and aft rotor control assemblies are similar with the exception of the parts designated for right or left hand rotation only.

FLIGHT CONTROLS

A. GENERAL DESCRIPTION

Basically, the helicopter is controlled by changing the angle of the blades either collectively or individually. The controls required to obtain these changes include the cyclic stick, collective pitch lever, directional pedals, and longitudinal trim mechanism. The controls can be operated with or without hydraulic assist. However, the flight controls are normally hydraulically operated to reduce the force necessary for displacement of the controls. When the hydraulic system is on, the hydraulic pressure is about 1000 psi, varying as the controls are displaced. The valves and passages within the four hydraulic actuators are so arranged that movement of the cockpit flight controls will direct fluid, under pressure, to either side of the actuator pistons. These pistons are linked to the lower flight controls and position them to transfer movement to the upper flight controls for the desired flight condition. The lower differential controls are located beneath the cockpit flooring. The upper flight controls are located at the forward and aft rotors. Positioning of the directional and cyclic controls when the hydraulic flight controls are functioning is accomplished by means of adjustable magnetic brakes. Mechanical overriding of these brakes is permitted by centering springs which connect the brakes to the various controls.

The ON-OFF hydraulic boost control valve is located on the pilot's collective pitch lever shield assembly. When the valve is turned to the ON position, pressure will be indicated and the system will operate with movement of any one of the flight controls. The slightest movement of the control will operate the corresponding hydraulic actuator and allow the pressure to move the actuator in the desired direction.

An auto-pilot is installed in the flight control system of the H-21B and H-21C helicopters. The system is a combination of mechanical, electrical and electronic units which will automatically maintain the specific course and attitude selected by the pilot. The auto-pilot system consists of the turn and pitch controller, pistol grip controller, amplifier unit, servo motors, and attitude trim adapter. The turn and pitch controller provides the pilot with a means for controlling the helicopter with a minimum of effort in coordinated turns, pitch trim, yaw trim and roll trim. The controller contains the master ON-OFF switch and a push button type switch for engaging the auto-pilot system. The pistol grip controller is similar in appearance to the grip on the cyclic sticks and provides a means for controlling the helicopter through all maneuvers. A "BEEP" trim control button located at the top of the pistol grip is a means of providing trim electrically when the auto-pilot is engaged. The control is operated by

pressing the button forward or aft for longitudinal trim (nose up or down) and left or right for lateral trim (roll left or right).

B. CYCLIC STICKS

The pilot's and co-pilot's sticks are metal tubes provided with a hard rubber grip into which switches for the centering spring magnetic brakes, ICS/radio, rescue hoist, auto-pilot cut-out and external cargo release are incorporated. The co-pilot's grip does not always have all the above named switches, but will definitely carry a centering spring switch and an ICS/radio switch.

C. COLLECTIVE PITCH LEVERS

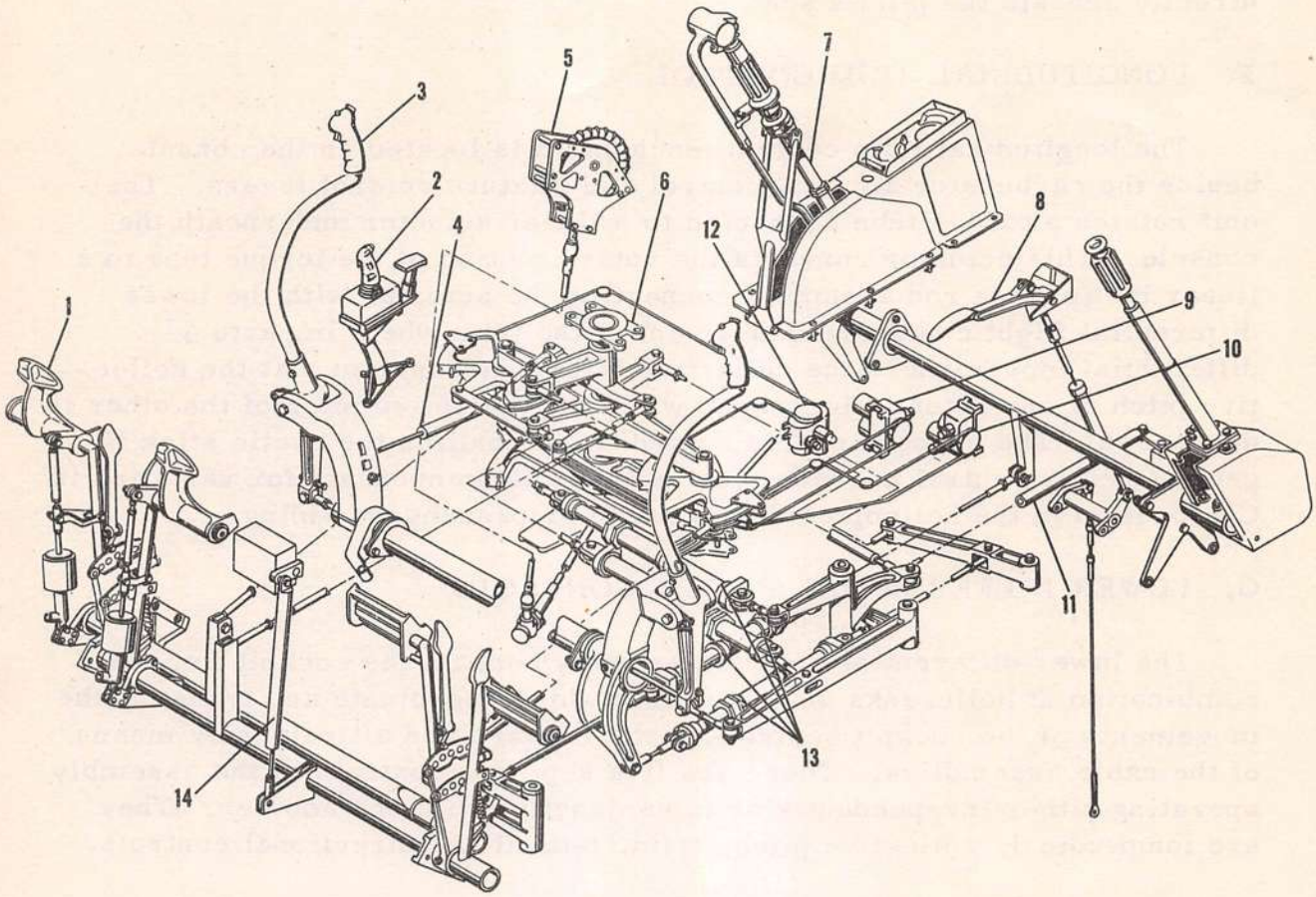
The pilot's and co-pilot's collective pitch levers consist of a light alloy tube and a cast gear housing base. The two housings are connected by torque tubes. A turnable motorcycle type hand grip is mounted on the end of each lever to control throttle action. The pilot's lever also contains a throttle lock, a collective pitch friction lock, and a collective pitch down lock. An assembly, mounted on the pilot's lever, contains landing light, search light, and engine starter control switches. The collective pitch levers control the pitch change of all blades simultaneously. The levers also actuate a throttle collective pitch synchronization unit which adds engine power with pitch increase, thereby helping to maintain a constant rpm. The throttle grip on each lever can be rotated to vary throttle settings by overriding the synchronization mechanism.

D. DIRECTIONAL CONTROLS

The directional control pedals actuate the upper flight controls differentially at the forward and aft rotors to obtain directional control of the helicopter. The pilot's and co-pilot's pedals are interconnected by torque tubes. A pin latch is provided on each pedal so that it may be adjusted by the pilot or co-pilot for greater operating comfort. The hydraulic wheel brake master cylinders are attached to the pilot's pedal assemblies and operate the brakes when the toe pedals are depressed. The right and left pedal can be depressed individually for turning or both pedals may be depressed simultaneously for moderate deceleration or parking.

E. CENTERING SPRINGS AND MAGNETIC BRAKES

Three centering springs and magnetic brakes are attached to the cyclic sticks and directional pedals. The centering springs connect the flight controls to the magnetic brakes which are normally in the locked position. The purpose of the centering springs is to provide artificial "feel" in the controls. Normal "feel" is lost due to the hydraulic flight control system. The magnetic brakes are provided to allow the neutral position to be shifted to meet the various flight conditions. The magnetic brakes are released by a switch located on the cyclic stick. The directional centering spring as-



1 Directional Pedals Assembly
2 Automatic Pilot Controller, H-21B and H-21C
3 Cyclic Stick
4 Longitudinal Centering Spring
5 Longitudinal Stick Positioner
6 Lower Differential Controls
7 Collective Pitch Lever
8 Nose Wheel Lock Lever
9 Directional Servo Motor, H-21B and H-21C
10 Longitudinal Servo Motor, H-21B and H-21C
11 Lateral Centering Spring
12 Lateral Servo Motor, H-21B and H-21C
13 Hydraulic Actuators
14 Directional Centering Spring

COCKPIT AND LOWER DIFFERENTIAL FLIGHT CONTROLS

sembly is located on the forward end of the control pedal assembly. The lateral centering spring assembly is located on the first bulkhead aft of the collective pitch lever assembly and under the cockpit floor. The longitudinal centering spring assembly is located under the cockpit flooring directly beneath the pilot's seat.

F. LONGITUDINAL TRIM CONTROL

The longitudinal trim control mechanism is located on the console beside the carburetor air heat control and mixture control levers. The unit rotates a torque tube connected to a linear actuator underneath the console. This actuator converts the rotary motion of the torque tube to a linear motion in a rod assembly connecting the actuator with the lower differential flight controls. Movement of the trim wheel imparts a differential movement to the collective pitch quadrants so that the collective pitch of one rotor is increased while the collective pitch of the other is decreased. The purpose of this control is to position the cyclic stick in a geometrically neutral position longitudinally to compensate for variation in CG location in the helicopter due to cargo or passenger loading.

G. LOWER DIFFERENTIAL FLIGHT CONTROLS

The lower differential control assembly beneath the cockpit floor is a combination of bellcranks and quadrants which coordinate and transmit the movements of the cockpit controls to the forward and aft rotors by means of the cable assemblies. There are five separate controls in the assembly operating either independently or in conjunction with one another. They are longitudinal, collective pitch, trim, lateral and directional controls.

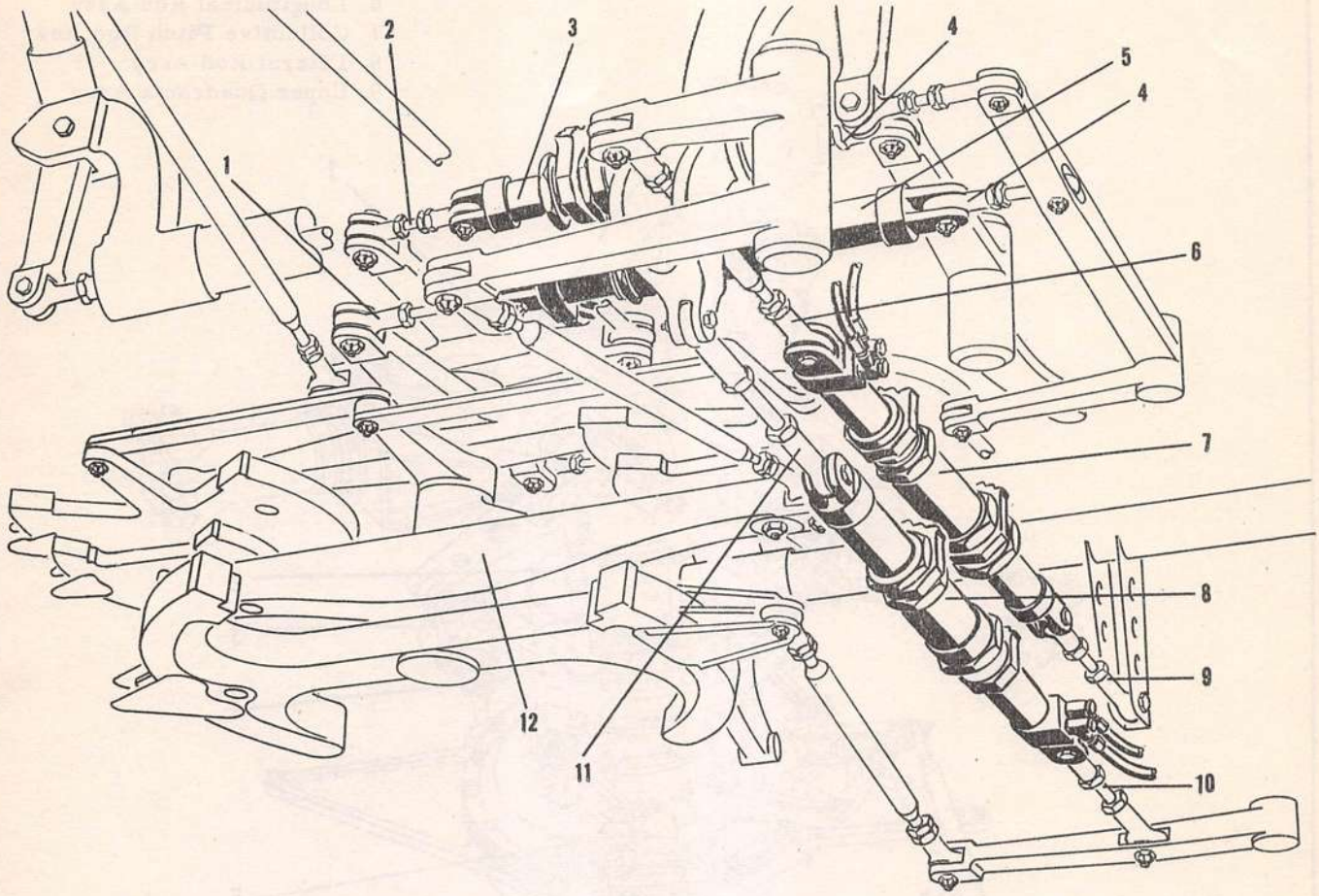
H. UPPER FLIGHT CONTROLS

The upper flight controls located at the forward and aft rotors transmit the movement of the control cables to the rotor control assemblies. These upper flight controls include the lateral, longitudinal and collective pitch controls, each having a quadrant to which their respective cables are attached. The assembly consists of three quadrants which operate on a common shaft plus a series of bellcranks and links which also operate on a common shaft. The quadrants are connected to the bellcranks by three push-pull rods and the bellcranks are connected to the swash plate of the rotor control assembly by short links.

I. BUNGEES

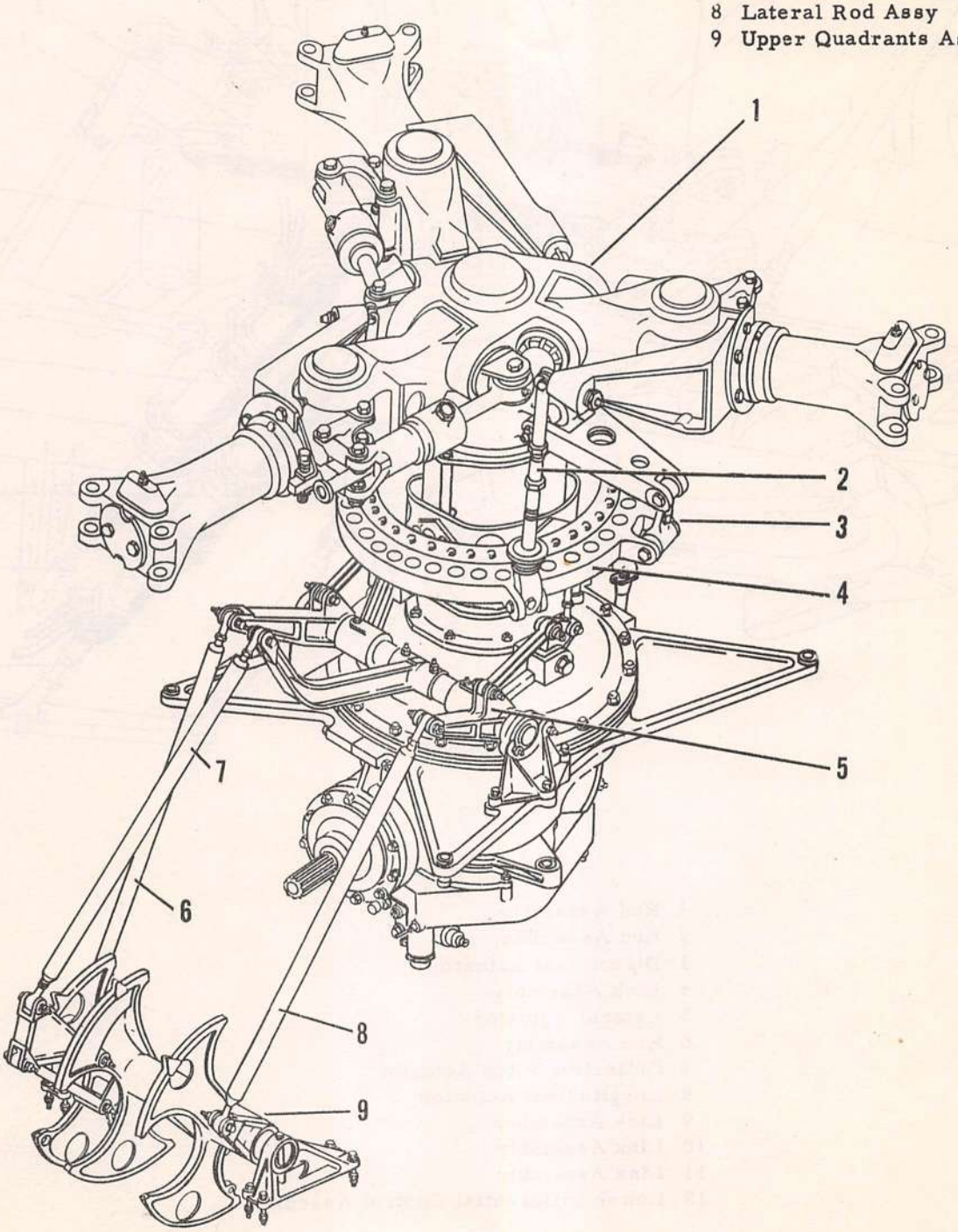
The longitudinal bungee aids in moving the longitudinal flight controls of the helicopter when the hydraulic flight control system is not operating. It is located under the cabin flooring just aft of the canted bulkhead.

The collective pitch bungee assemblies are attached to forward and aft upper flight control assemblies. They aid the pilot in moving the collective pitch lever when the hydraulic flight control system is not operating.

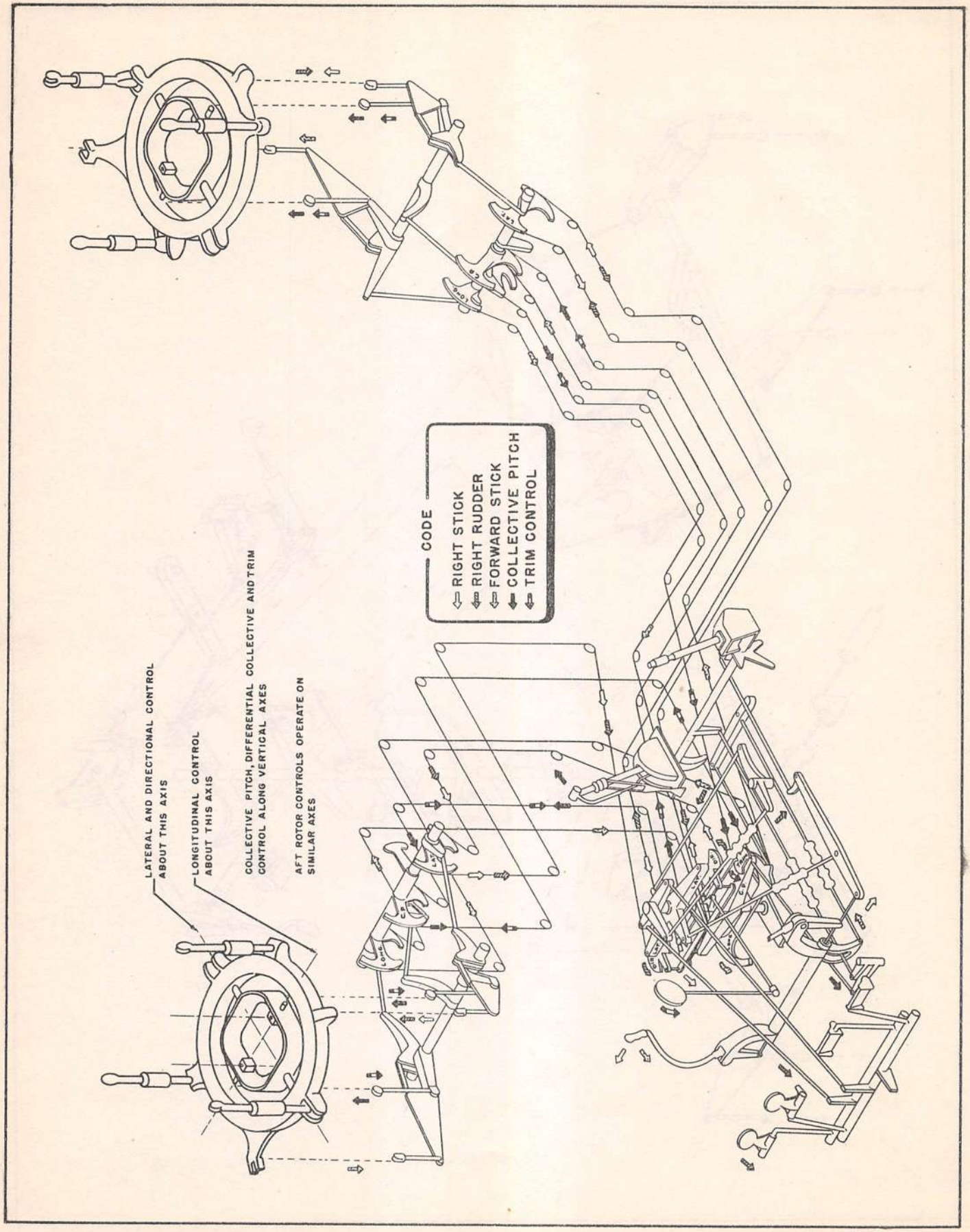


1 Rod Assembly
2 Rod Assembly
3 Directional Actuator
4 Link Assembly
5 Lateral Actuator
6 Rod Assembly
7 Collective Pitch Actuator
8 Longitudinal Actuator
9 Link Assembly
10 Link Assembly
11 Link Assembly
12 Lower Differential Control Assembly

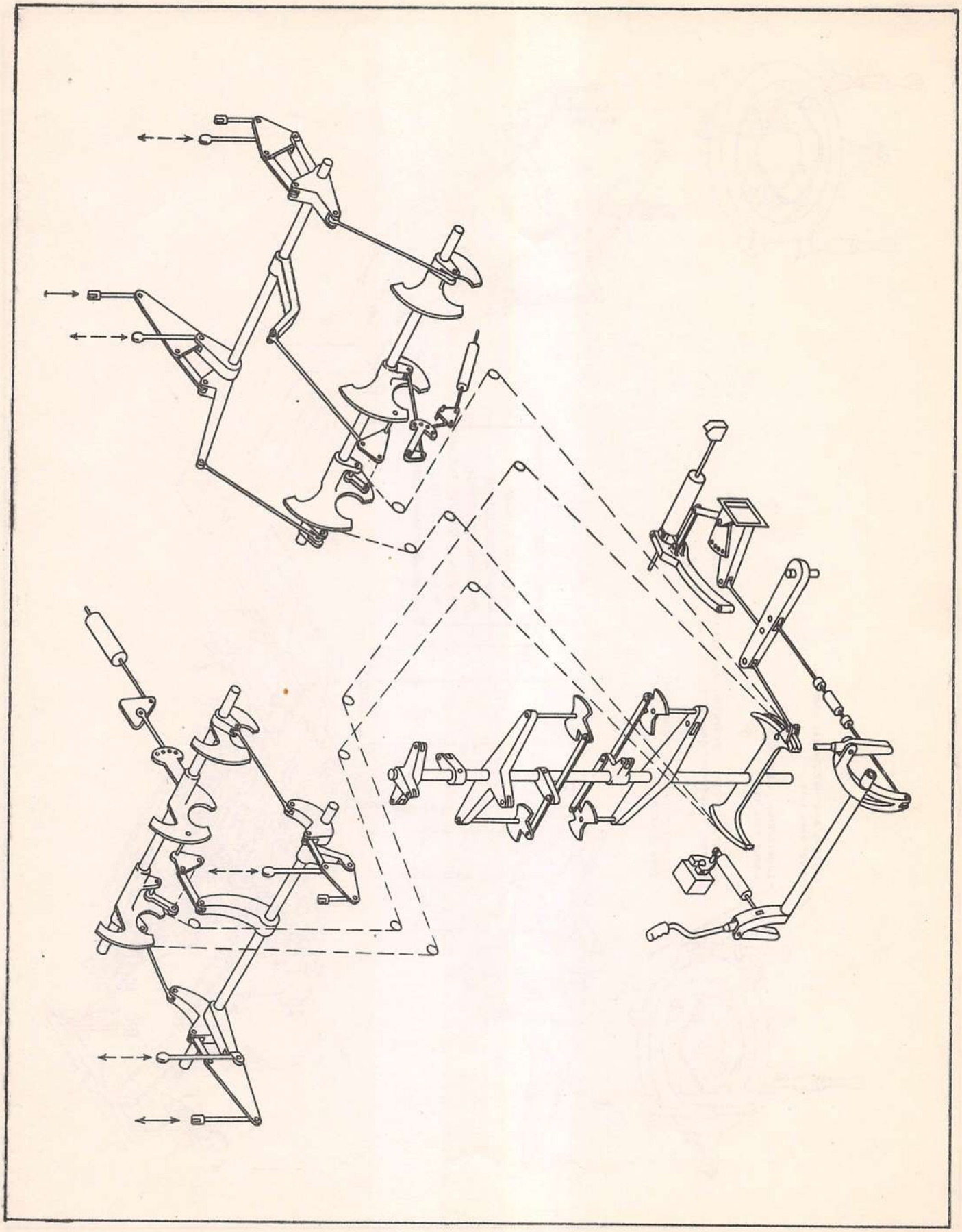
HYDRAULIC FLIGHT CONTROL ACTUATORS



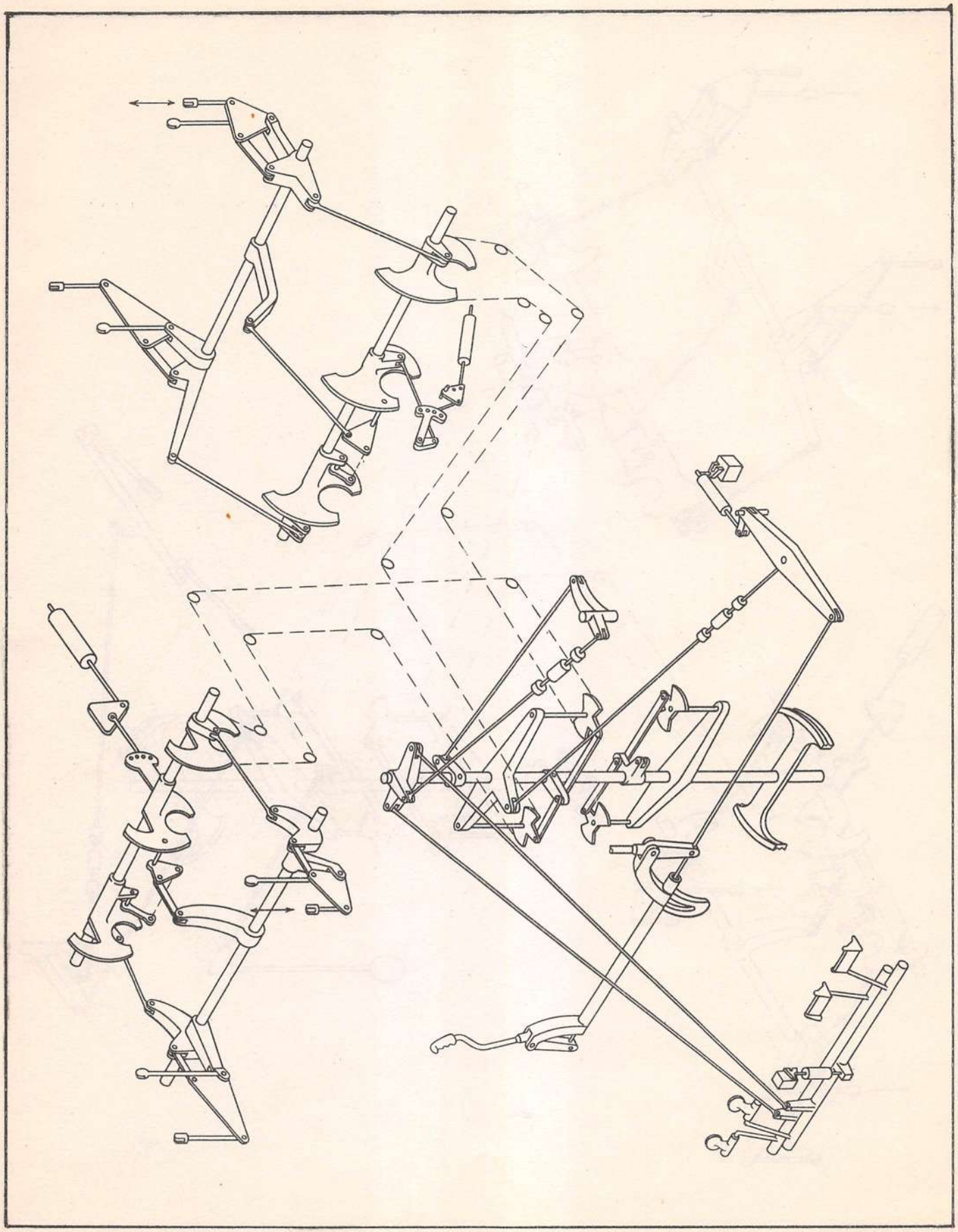
UPPER FLIGHT CONTROLS



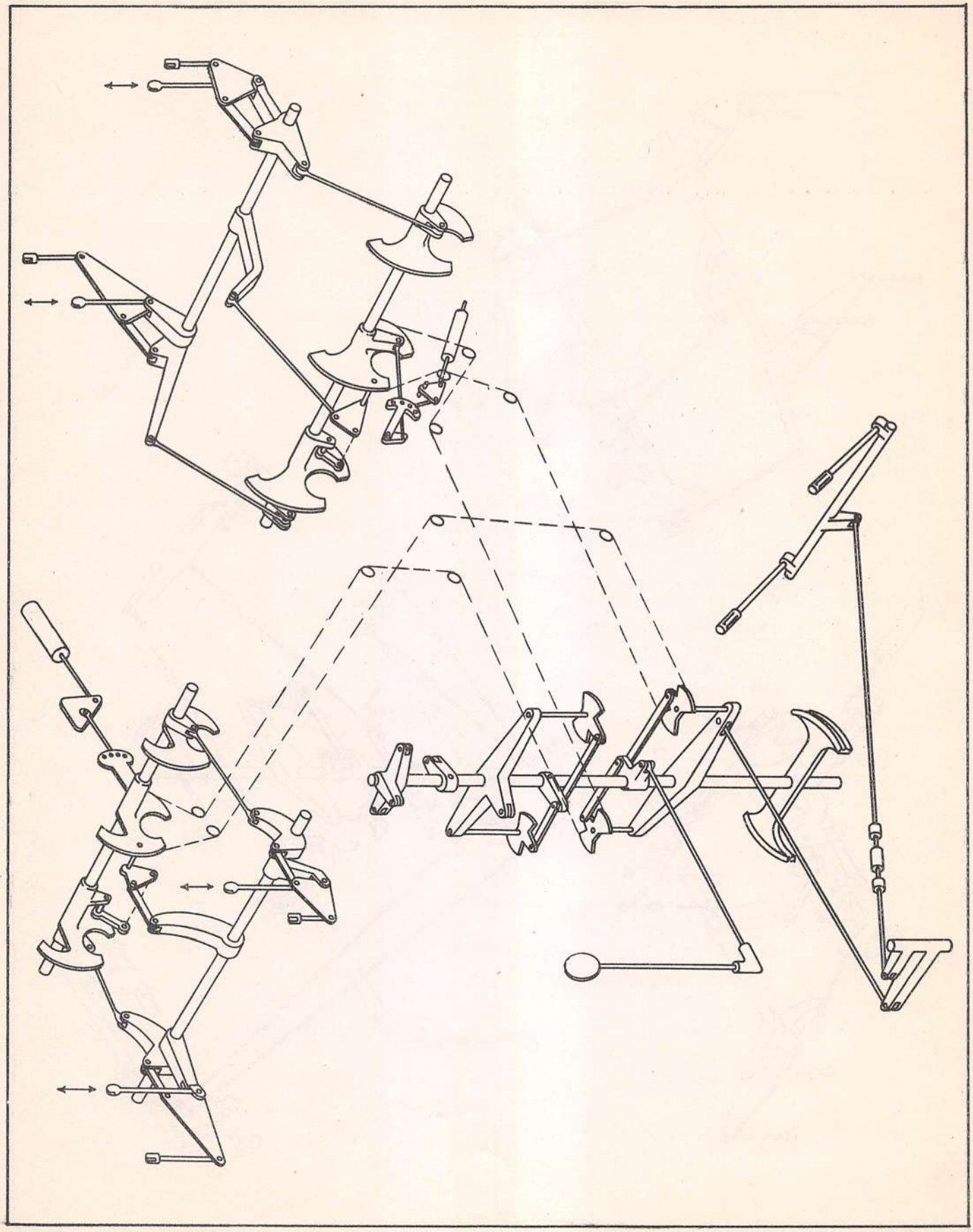
CONTROL SYSTEM SCHEMATIC



LONGITUDINAL—DIFFERENTIAL COLLECTIVE PITCH CONTROL SCHEMATIC



LATERAL—DIRECTIONAL CONTROL SCHEMATIC



COLLECTIVE PITCH—TRIM CONTROL SCHEMATIC

ELECTRICAL AND INSTRUMENTS

A. ELECTRICAL

The helicopter is equipped with a 28 volt, direct current electrical system. The primary sources of power are the 24 volt, 34 ampere hour battery and an engine driven 30 volt, 400 ampere generator. For ground operation, external power may be supplied to the helicopter by means of a receptacle accessible through a hinged panel located aft of the cabin door on the left side of the fuselage. Once the engine has been started, power is supplied to the system by the generator when the generator switch is turned "ON" and the battery switch in "BAT" position.

All circuits in the helicopter are single wire with a common ground return. The generator and battery are, however, grounded to the structure.

Power from the battery and generator is fed to the circuit breakers, fuses and relays in the aft distribution box located in the fuel cell compartment and to the circuit breakers and fuses located in the console. To prevent excessive voltage in the circuit and insure that the proper value of voltage is supplied to the system, the following protective devices are used:

1. The Voltage Regulator, which maintains a preset value of voltage regardless of speed and load requirements by automatically controlling the generator field current. A rheostat on the voltage regulator permits adjustment of the regulated voltage between 26-30 volts.

2. The Overvoltage Relay, which operates within a range of 31-33 volts, automatically cuts the generator out of the system, if the generator output rises above 31 volts, and energizes the generator warning light relay warning the pilot of this condition.

3. The Reverse Current Relay, which prevents the battery from discharging through the generator when the generator voltage falls below that of the battery.

4. The Generator Field Control Relay, which controls the current in field windings of the generator. When the generator output is greater than 31 volts, the field control relay, through the overvoltage relay, will disconnect the generator from the electrical system.

Alternating current is supplied by the two inverters, one inverter being a standby. The inverter is a motor-generator set used to convert direct current to alternating current. It consists mainly of a d-c motor and a-c generator enclosed in a common housing. The main and spare inverters are

identical, having outputs of 115 volts, 400 cycles, and 3 phase, each with a capacity of 500 volt amperes. An auto transformer is used in the "A" phase of each inverter to reduce the a-c voltage to 26 volts for the operation of engine and transmission magnesyn transmitters and indicators.

In the event of inverter failure, the standby inverter is connected to the system by the operation of the inverter change over control located in the a-c junction box. An inverter switch, located in the console, is used for ground testing the spare inverter. The standby inverter is operated directly by the battery and will, in turn, operate the following equipment:

1. Fuel Quantity Indicator
2. Fuel Pressure Indicator
3. Engine Oil Pressure Indicator
4. Transmission Oil Pressure Indicator
5. Attitude Gyro
6. J-2 Compass

In addition to operating the standby inverter, the battery will also operate directly the following equipment, if the battery switch is placed in the Emergency position:

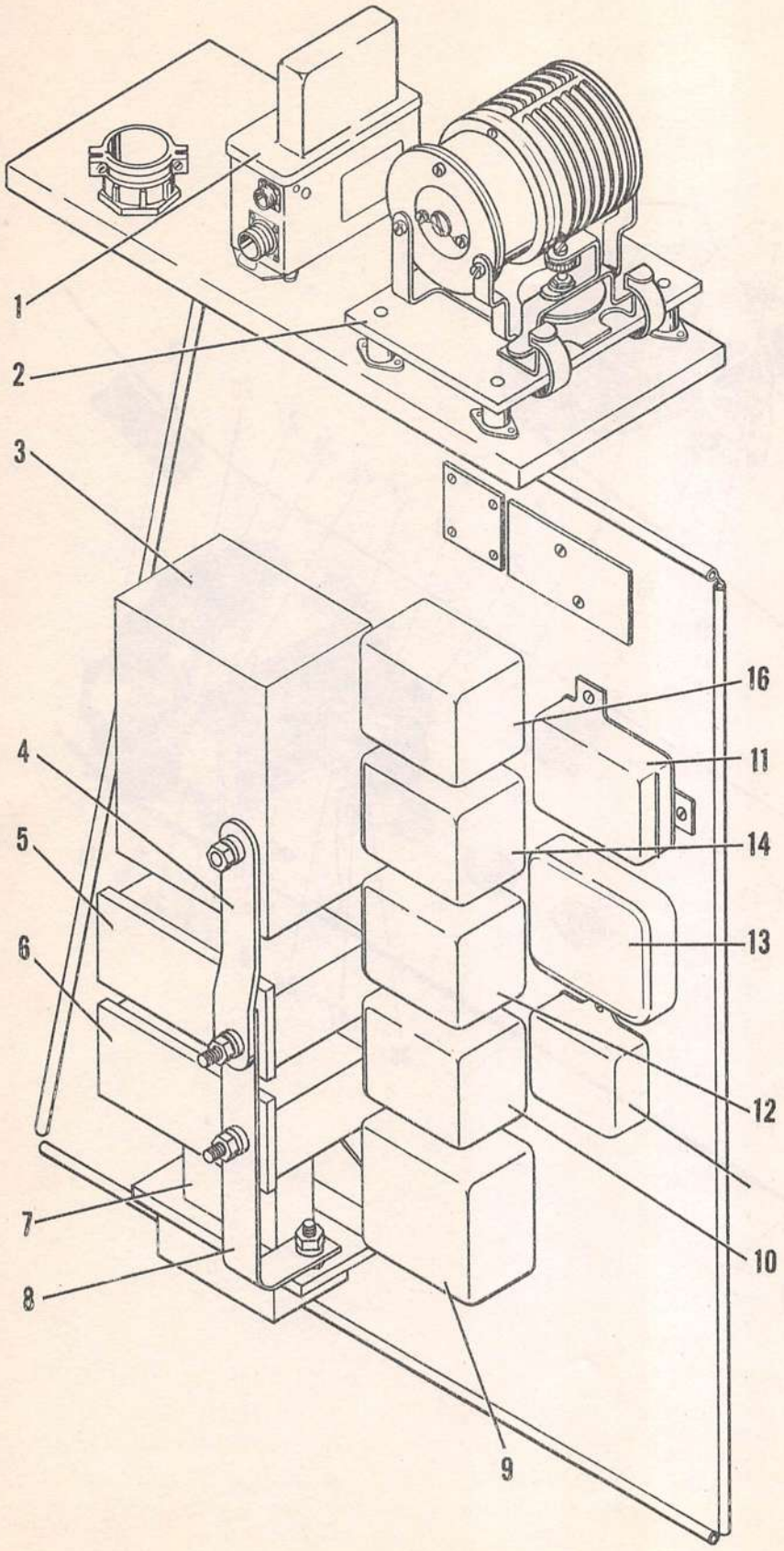
1. Pilot's Utility Lights
2. Turn and Bank Indicator
3. Indicator (Warning) Lights
4. Fire Detector Warning Light
5. Instrument Lights

Switches used to control the various electrical units are mounted on the console and the overhead switch panels in the cockpit. Circuit breakers and fuses used to protect the various circuits against overloads are located in the console circuit breaker and fuse panels, a fuse box located on the bulkhead aft of the co-pilot, aft distribution box, and the a-c junction box.

The electrical system is broken into 25 different circuits, each of which is coded to identify its circuit function, cable size, and ground letter.

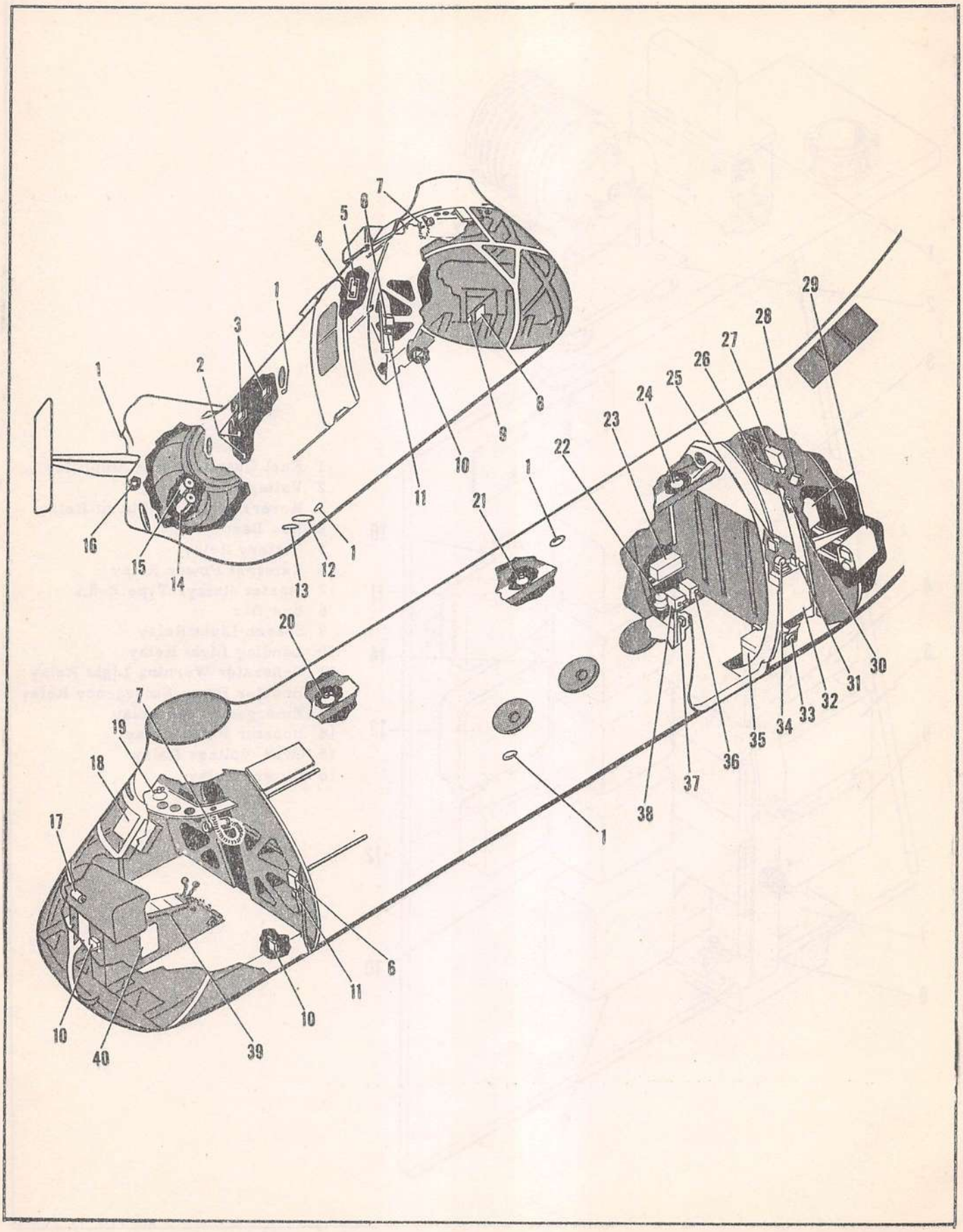
B. INSTRUMENTS

Flight, engine, and transmission instruments are located on the instrument panel attached to the top of the console, and in the overhead panel located on the upper portion of the nose enclosure. The majority of the flight instruments are located on the right side of the panel in front of the pilot. The engine and transmission instruments are grouped to the left of the pilot's flight instruments. Located on the left side of the panel in the H-21 and H-21A are three primary flight instruments for use by the co-pilot. These three instruments have been eliminated in the H-21B and H-21C helicopter. All instruments are installed from the front of the panel. The flight instruments have individual light shields and the engine and transmission instruments are illuminated by small lamps.



1 Fuel Quantity Gage Amplifier
2 Voltage Regulator
3 Reverse Current Cutout Relay
4 Bus Bar
5 Battery Relay
6 External Power Relay
7 Starter Relay, Type B-8A
8 Bus Bar
9 Search Light Relay
10 Landing Light Relay
11 Generator Warning Light Relay
12 Booster Pump Emergency Relay
13 Emergency Bus Relay
14 Booster Pump Relay
15 Over-Voltage Relay
16 Blower Relay

AFT DISTRIBUTION BOX



MAJOR ELECTRICAL UNITS—YH-21, H-21A

MAJOR ELECTRICAL UNITS—YH-21, H-21A
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MAJOR ELECTRONIC UNITS—YH-21, H-21A
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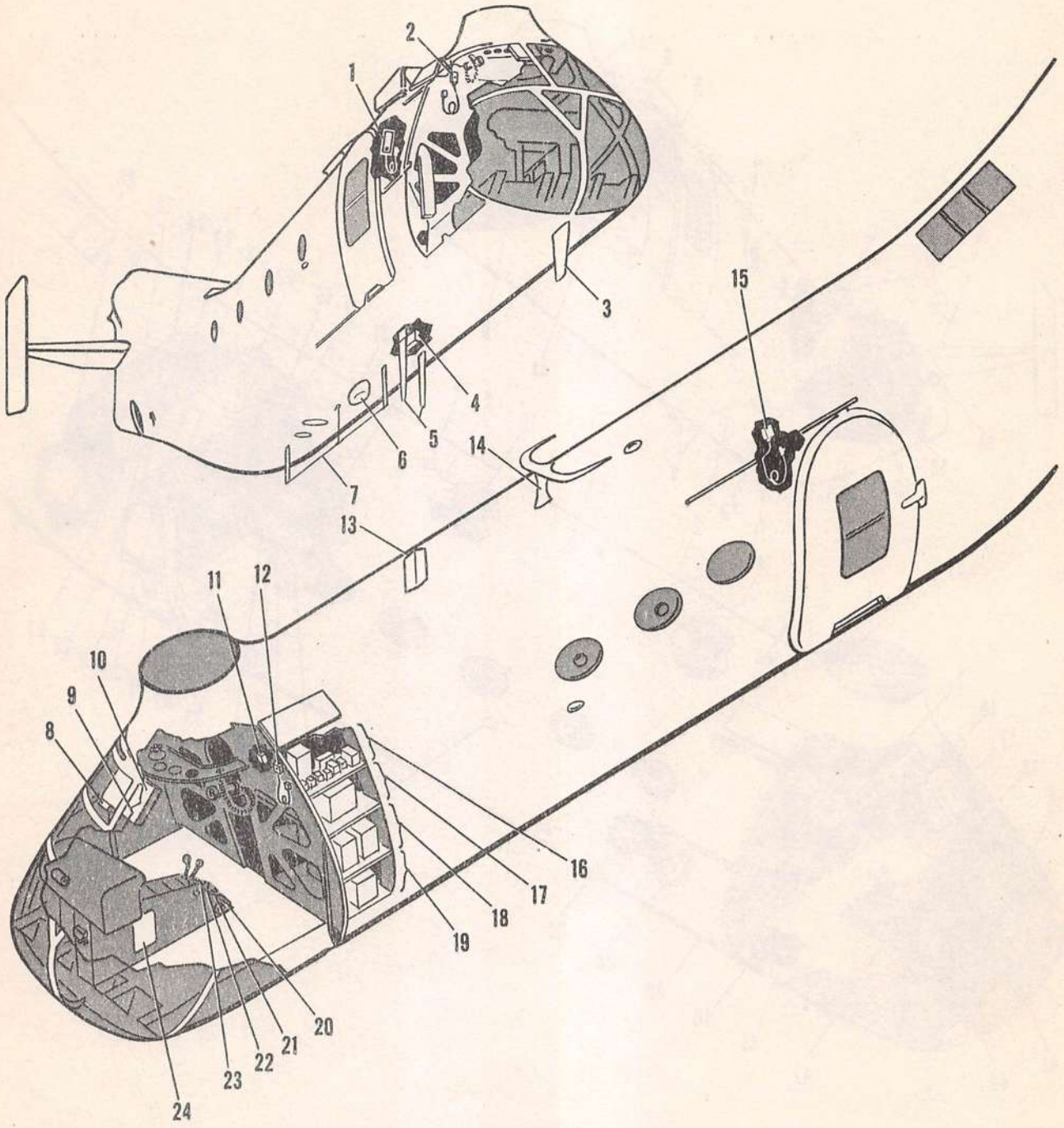
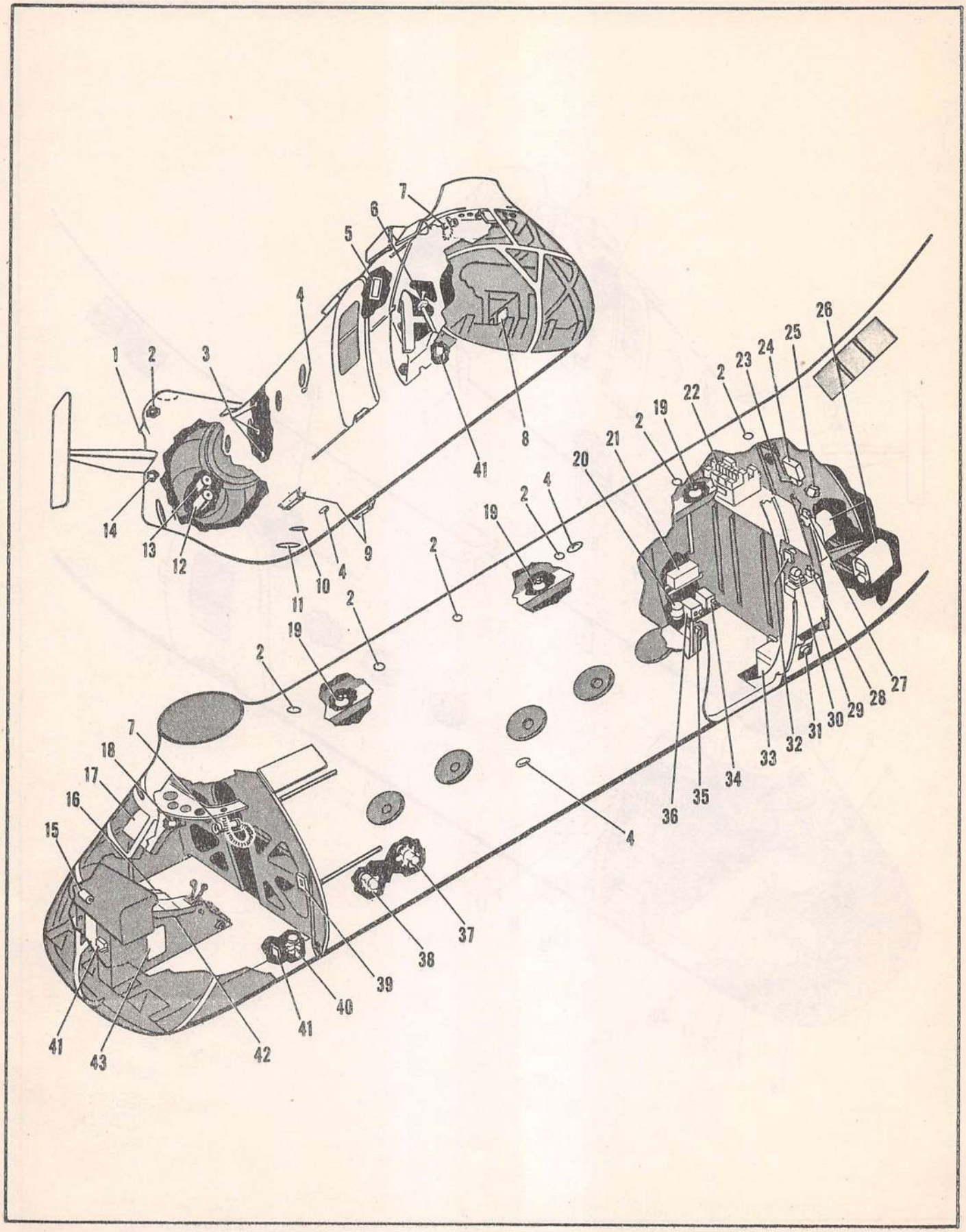


MAJOR ELECTRONIC UNITS—YH-21, H-21A



MAJOR ELECTRICAL UNITS—H-21B, H-21C

MAJOR ELECTRICAL UNITS—H-21B, H-21C
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1 Tail Light
2 Formation Light
3 Litter Lights
4 Navigation Light
5 Hoist Operator's Switch Panel
6 Pistol Grip Actuated Flight Controller
7 Utility Light
8 Circuit Breaker Panel—Right Side
9 External Fuel Tank
10 Fixed Landing Light
11 Controllable Search Light
12 Engine-Driven Generator
13 Engine Electric Starter
14 C-2 Transmitter (J-2 Compass)
15 Windshield Wiper Motor
16 Knob Actuated Flight Controller
17 Overhead Switch Panel
18 Cockpit Dome Light
19 Cabin Dome Light
20 Control Gyro Type S-3 (J-2 Compass)
21 Control Vertical Gyro Type K-4
22 Auto-Pilot Calibrator and Amplifier
23 C-2 Navigation Light Flasher
24 A-C Junction Box
25 Fire Detector Control Box
26 Main and Spare Inverters
27 Fuel Quantity Bridge Unit
28 Fuel Quantity Amplifier
29 Aft Distribution Box and Circuit Breaker Panel
30 Voltage Regulator
31 External Power Receptacle
32 Generator Field Control Relay
33 Battery
34 Amplifier Type B-7A
35 Main Door Dome Light Switch
36 Amplifier Type A-2 (J-2 Compass)
37 Auto-Pilot Longitudinal Servo
38 Auto-Pilot Directional Servo
39 A-C Fuse Box
40 Lateral Servo
41 Magnetic Brake
42 Console Switch Panel
43 Circuit Breaker Panel—Left Side

MAJOR ELECTRONIC UNITS—H-21B, H-21C
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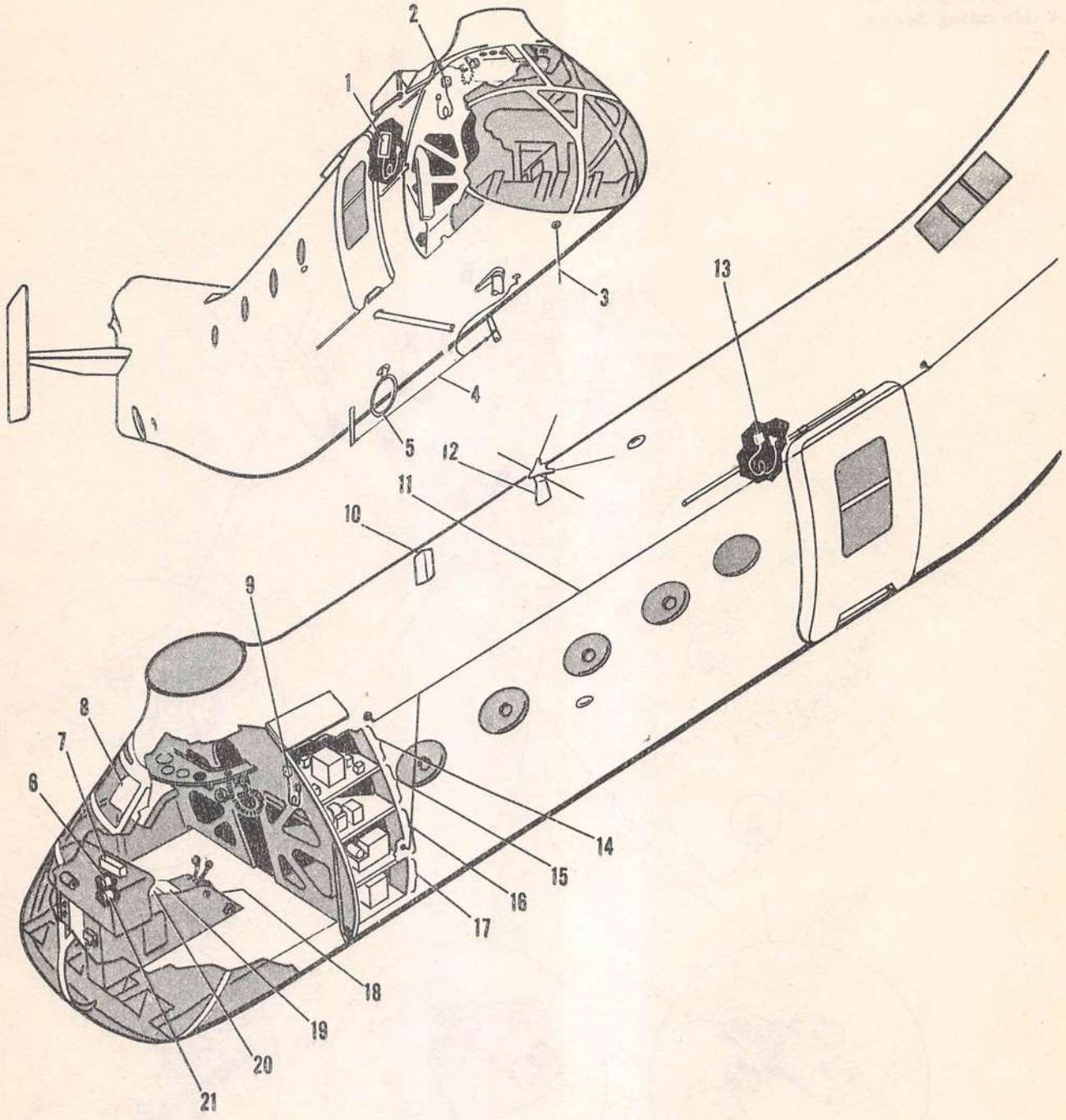
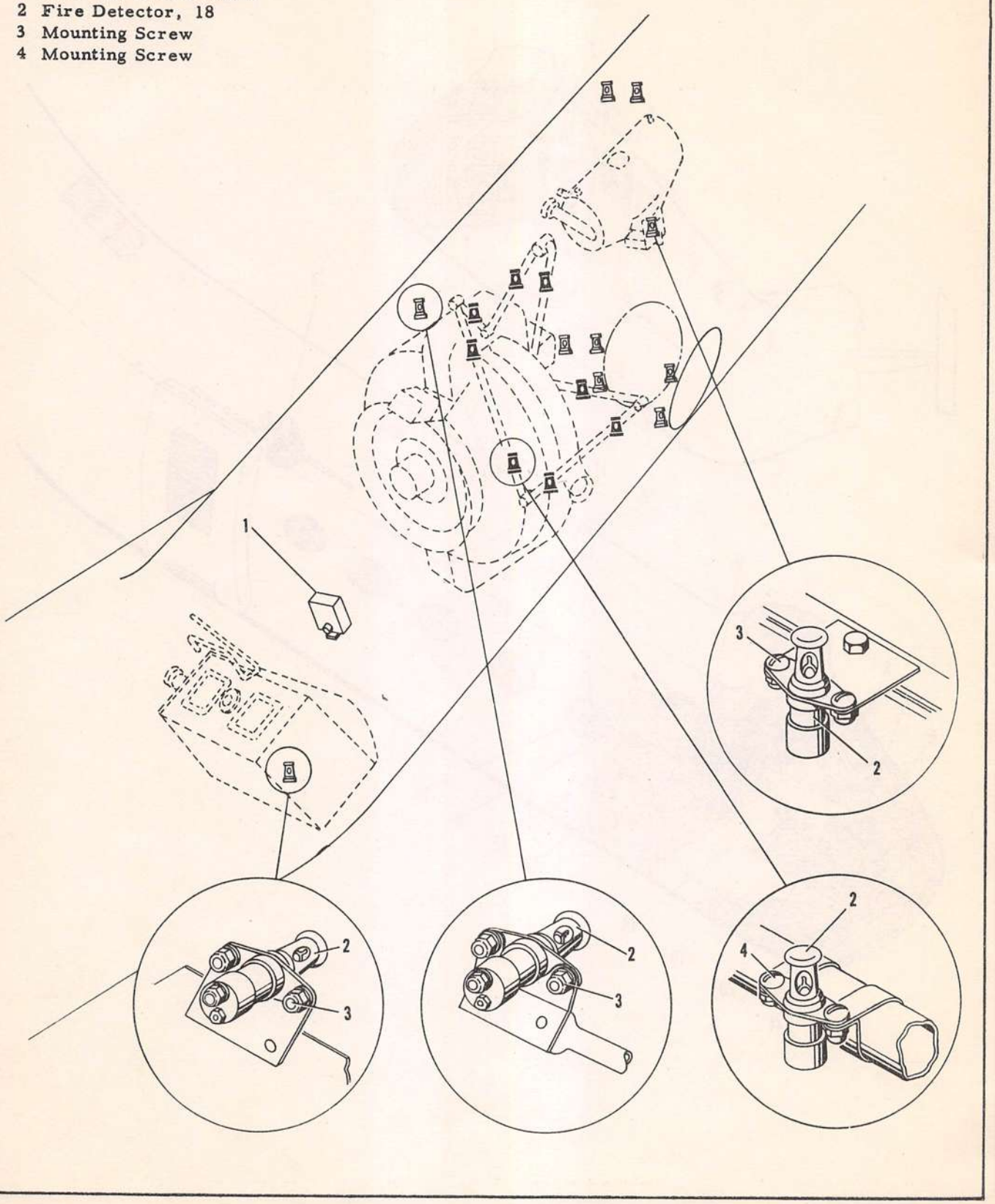


MAJOR ELECTRONIC UNITS—H-21B, H-21C

1 Fire Detector Control
2 Fire Detector, 18
3 Mounting Screw
4 Mounting Screw



FIRE DETECTION SYSTEM