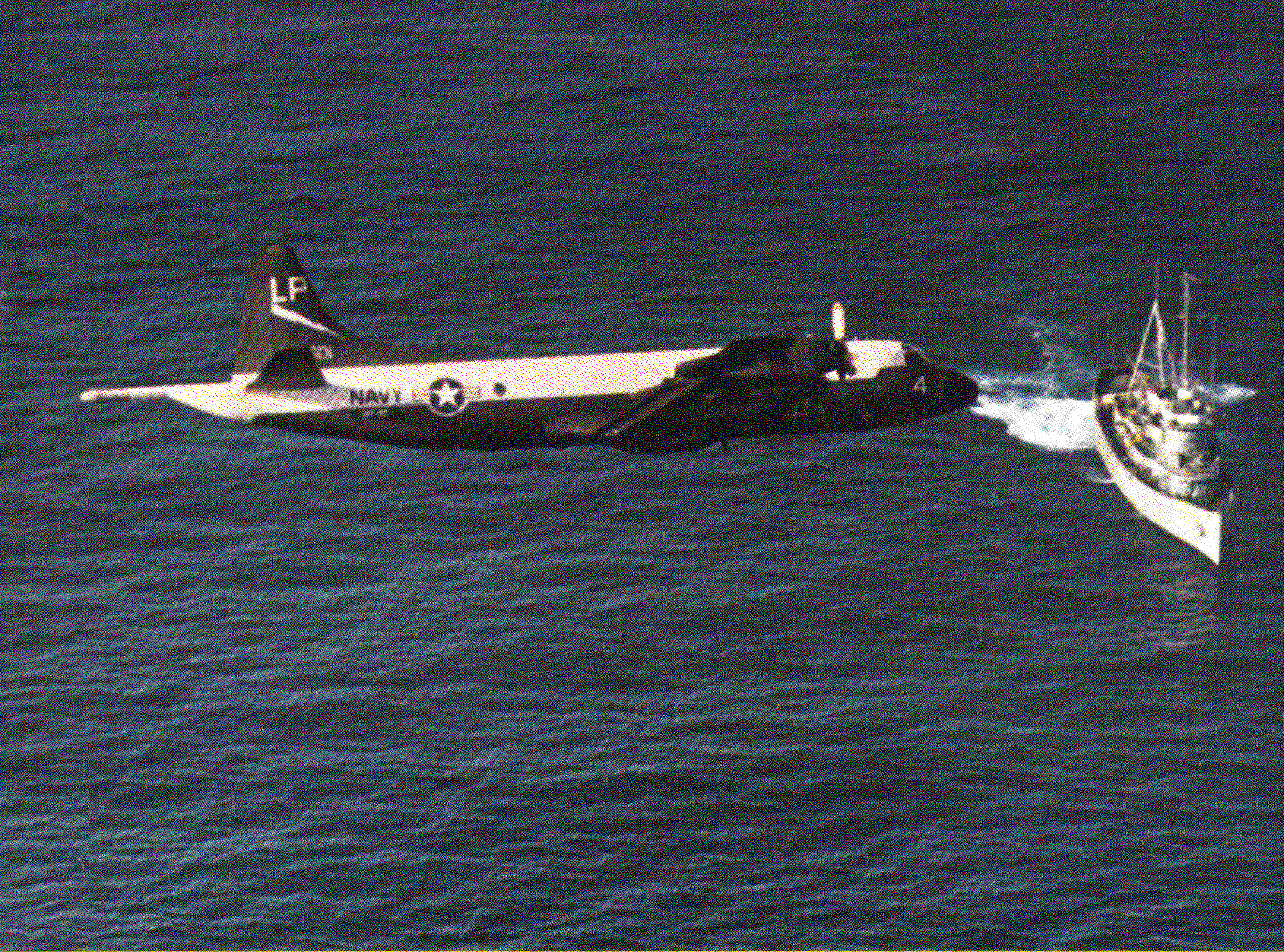

ORION

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ORION

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FRONT AND BACK COVERS When Patrol Squadron Forty-nine received its first Lockheed P-3A Orion on 1 August 1963, a new era began. By the end of that month the last of their SP-5B Marlins had been turned in, and for the first time in its history VP-49 became a land-plane squadron.

When it was formed twenty years ago, the squadron was designated Patrol Squadron Nineteen. Within one month their flying boats were conducting missions within 100 miles of the Japanese mainland and, shortly thereafter, in support of the Iwo Jima campaign. Most significant of the squadron's immediate post-war activities were surveys leading to the famous "Operation Crossroads" at Bikini. In 1946 the squadron reported to the Atlantic coast where it operated two years as Medium Seaplane Squadron Nine — before its redesignation as Patrol Squadron Forty-nine in 1948. June 1951 saw VP-49 move to the island paradise of Bermuda.

After taking up residence in Bermuda, the squadron ranged the Atlantic and the Caribbean, participating in exercises and special assignments so numerous that only a few of the most important can be mentioned: Back in 1955 PATRON 49 assisted with evaluation trials of our first nuclear submarine, the **Nautilus**. During the Mercury program VP-49 went game hunting, successfully vectoring surface units to the splash point of "Enos," America's space ape. The squadron also performed shipping surveillance flawlessly during the recent quarantine of Communist Cuba. While fulfilling its many commitments, Patrol Squadron Forty-nine claimed four Navy "E's" for Excellence and the 1960 Arnold Jay Isbell trophy.

August 1963 found VP-49 moving from beautiful Bermuda to Patuxent River, Maryland, for familiarization and training with the P-3A Orion; meanwhile, VP-8 reluctantly spent part of the winter in Bermuda.

Now Patrol Squadron Forty-nine has returned to Bermuda for deployment, and with new equipment their motto "No Sanctuary in the Deep" can be demonstrated even more effectively.

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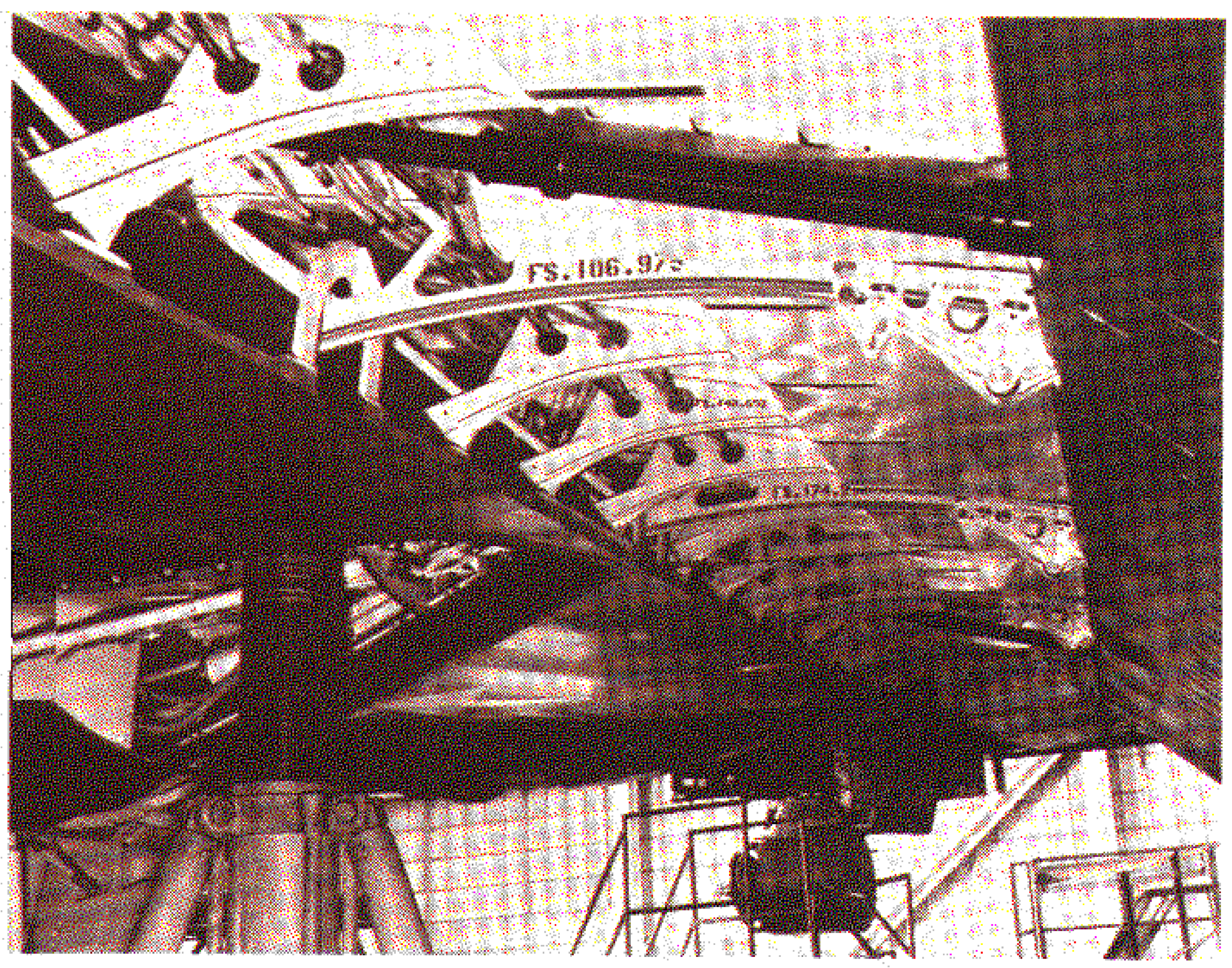
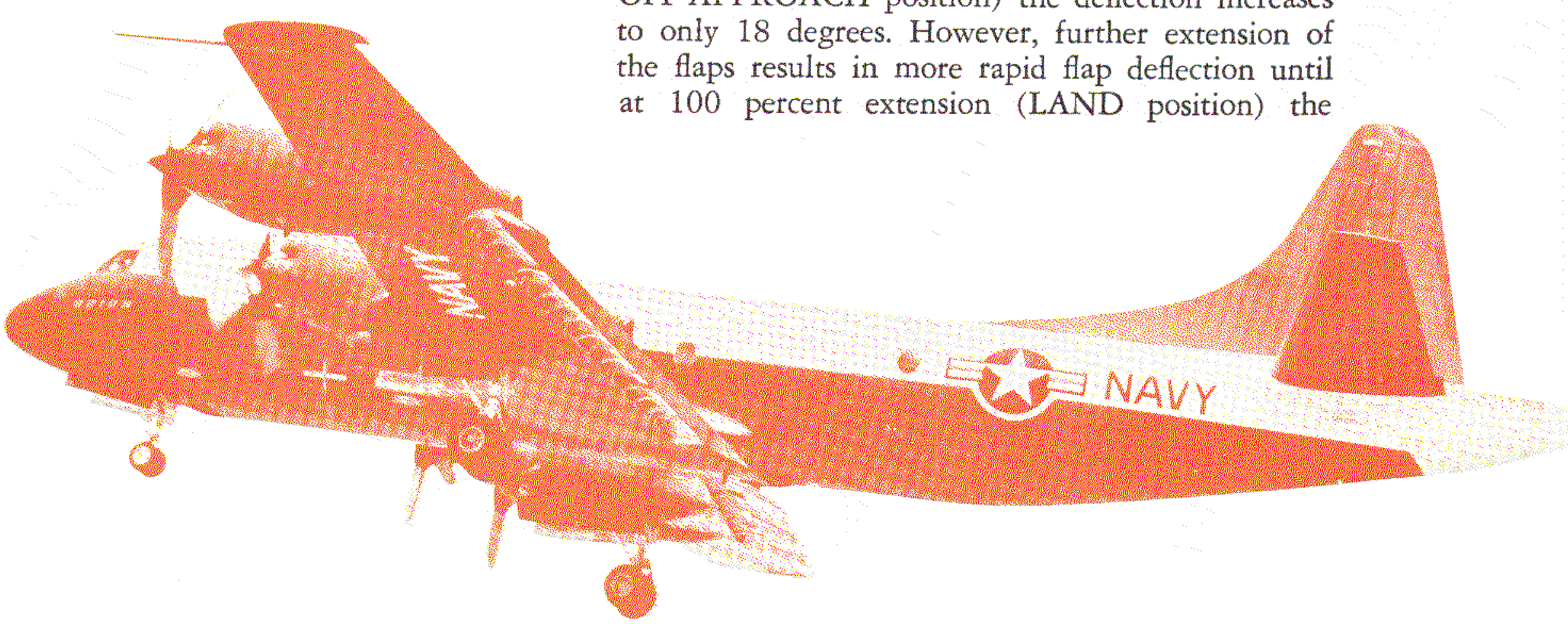
P-3 WING FLAPS



AMONG ITS MANY attributes the P-3 Orion is noted for its agility. To the casual observer the Orion seemingly leaps into the air from the runway, and it lands on the proverbial dime. This aircraft can swiftly reach its destination, but it also will cruise at drastically reduced speed for hours on end. The incorporation of Lockheed-Fowler type flaps in the design of the P-3 has helped make possible this wide range of performance by enabling the effective wing area to be increased for low speed flight.

The P-3 has one large flap panel on each wing which moves on tracks attached to the wing rear beam. When retracted into bays in the aft wing structure, the trailing edges of the flaps become part of the wing trailing edge. The flaps are extended and retracted by telescoping ballscrew type actuators connected through a series of torque tubes to two hydraulic motors located in the aircraft's hydraulic service center. Since the torque tube system (including the flap drive output shaft) is continuous from the outboard end of one wing flap to the outboard end of the other, the flap panels are driven symmetrically.

During the first portion of flap extension, flap movement is aft with a gradual downward deflection following the general camber of the wing to increase the wing area. At 40 percent flap extension (MANEUVER position) the flap deflection is merely 10 degrees, and at 77 percent flap extension (TAKE-OFF-APPROACH position) the deflection increases to only 18 degrees. However, further extension of the flaps results in more rapid flap deflection until at 100 percent extension (LAND position) the



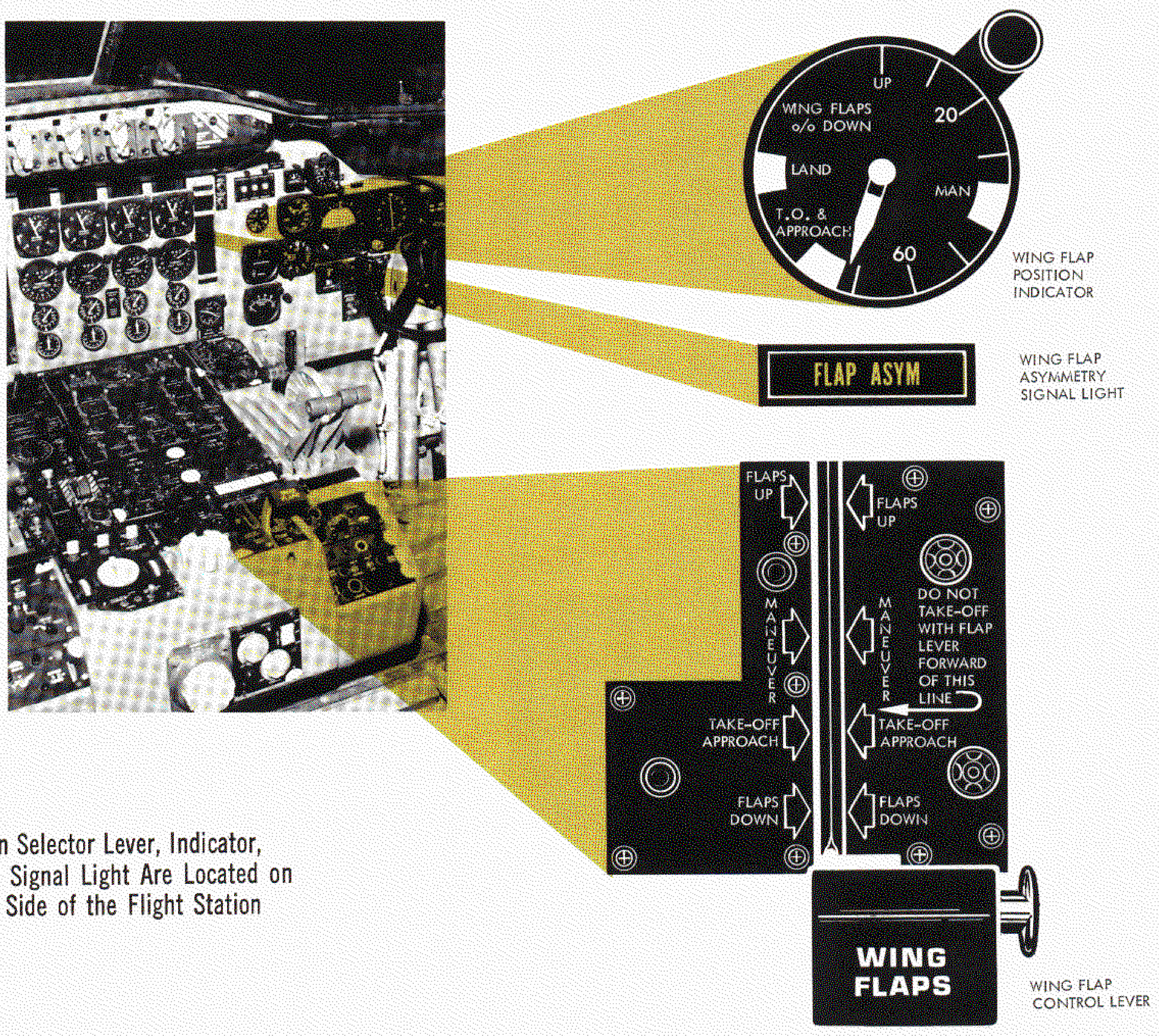


Figure 1 The Flap Position Selector Lever, Indicator, and Asymmetry Signal Light Are Located on the Right-Hand Side of the Flight Station

flap deflection is 40 degrees. The airspeed limits are 275 knots IAS when the flaps are set at MANEUVER, 190 knots IAS at TAKEOFF-APPROACH, and 170 knots IAS when the flaps are fully extended (LAND).

Flap position is selected by moving the airfoil-shaped control lever located on the right side of the pilot's control pedestal to the desired flap setting. Adjacent to the control lever on the pedestal is a placard for the common flap settings. Lever movement is transmitted through a cable system to the Flap Position Selector Valve in the hydraulic service center where all flap system hydraulic components are located. This selector valve ports fluid from two separate 3000-psi hydraulic systems to two reversible hydraulic motors which drive the flap mechanical system. Each flap motor uses fluid from a separate hydraulic system. Since either motor is capable of driving the flaps independently, failure of one system would not render the flaps inoperative.

The direction of flap movement is determined by the direction of flap motor rotation. When the desired flap position is reached, the Wing Flap Drive Follow-up Unit turns off the flap position selector valve. This stops hydraulic flow to the flap motors and, in effect, stops flap movement. Mounted on top of the follow-up unit is a smaller unit composed of the Rudder Booster Shutoff Gearbox and the Wing Flap Rudder Booster Shutoff Valve Switch. Actuation of this switch shuts off the No. 2 hydraulic system pressure to the rudder booster when the flap position is less than 60 percent while either of the No. 1 hydraulic system pumps is selected "ON". The purpose of this Wing Flap Rudder Booster Shutoff Valve circuit is to reduce the boosted power available to move the rudder during high flight speeds. Note that this circuit will still function, even if the No. 1 hydraulic system is inoperable, so long as one of the No. 1 system pump switches is selected "ON."

Mounted on top of the Rudder Booster Shutoff Gearbox is an autosyn transmitter that senses flap position. An indicator located on the co-pilot's instrument panel shows the flap position as percentage of flap extension. There is an input from the Wing

Flap Position Transmitter to the elevator control channel of the autopilot system. The signal from this circuit is used to give the aircraft a nose-down attitude when the flaps are lowered while the autopilot system is in use, thereby preventing the aircraft from ballooning.

A "calibrated eyeball" means of determining the degree of flap deflection (not flap extension) is also present. Painted on the upper surface of each flap are the numbers 10, 18, and 40, plus index lines, to show approximate flap deflection in degrees. These markings may be viewed through the aft observation windows.

Should an asymmetric flap condition — unequal flap extension or retraction, or a skewed flap — begin to occur during flap operation, flap asymmetry detectors will electrically close a hydraulic valve (Asymmetry Shutoff Valve), turning off hydraulic power to the flap drive system. When the Asymmetry Shutoff Valve closes, it also energizes the FLAP ASYM signal light located on the vertical signal light assembly in the cockpit. In addition, disc brakes located at the extremities of the torque tube system are applied to prevent further rotation of the torque tubes, thus preventing further flap movement. The shutoff valve and both flap brakes will remain actuated until they are manually reset.

FLAP SYSTEM COMPONENTS

The wing flap panel assemblies are of aluminum alloy construction. Each one is approximately 29-feet long and has a total area of 104.05 sq. ft. Five carriage assemblies are attached to the leading edge of each flap panel, enabling the flaps to ride fore and aft on the flap tracks. The main non-metallic parts of the flap panels are the rub strips on the flap trailing edge. These rub strips, made of teflon, prevent the wings from abrading the trailing edges of the flaps. One flap panel is mounted on each side of the aircraft, and the basic panels are interchangeable. As installed on the aircraft, the left and right wing flaps do have minor differences. On the inboard upper flap surface of both flaps are painted markings that indicate the approximate degree of flap deflection (see Figure 3). Each flap also has an asymmetry detector cable anchor and a fairlead attached to it slightly outboard from the center of the flap. The only other item is a fuel deflector that is mounted on the inboard trailing edge of the left flap. The cable anchor, the fairlead, and the fuel deflector can easily be installed, removed, or relocated. The markings can be added during installation of the flap panel.

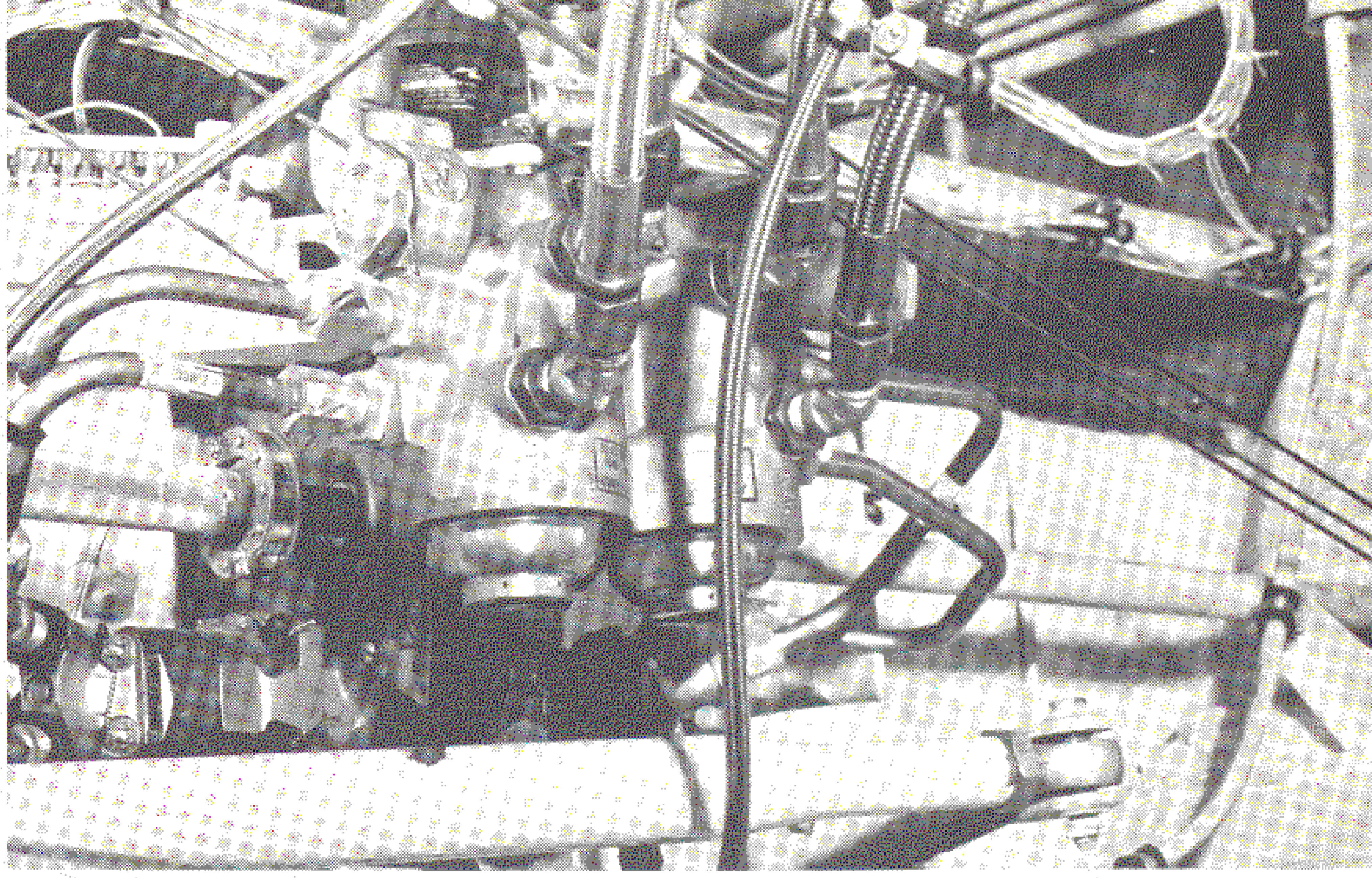
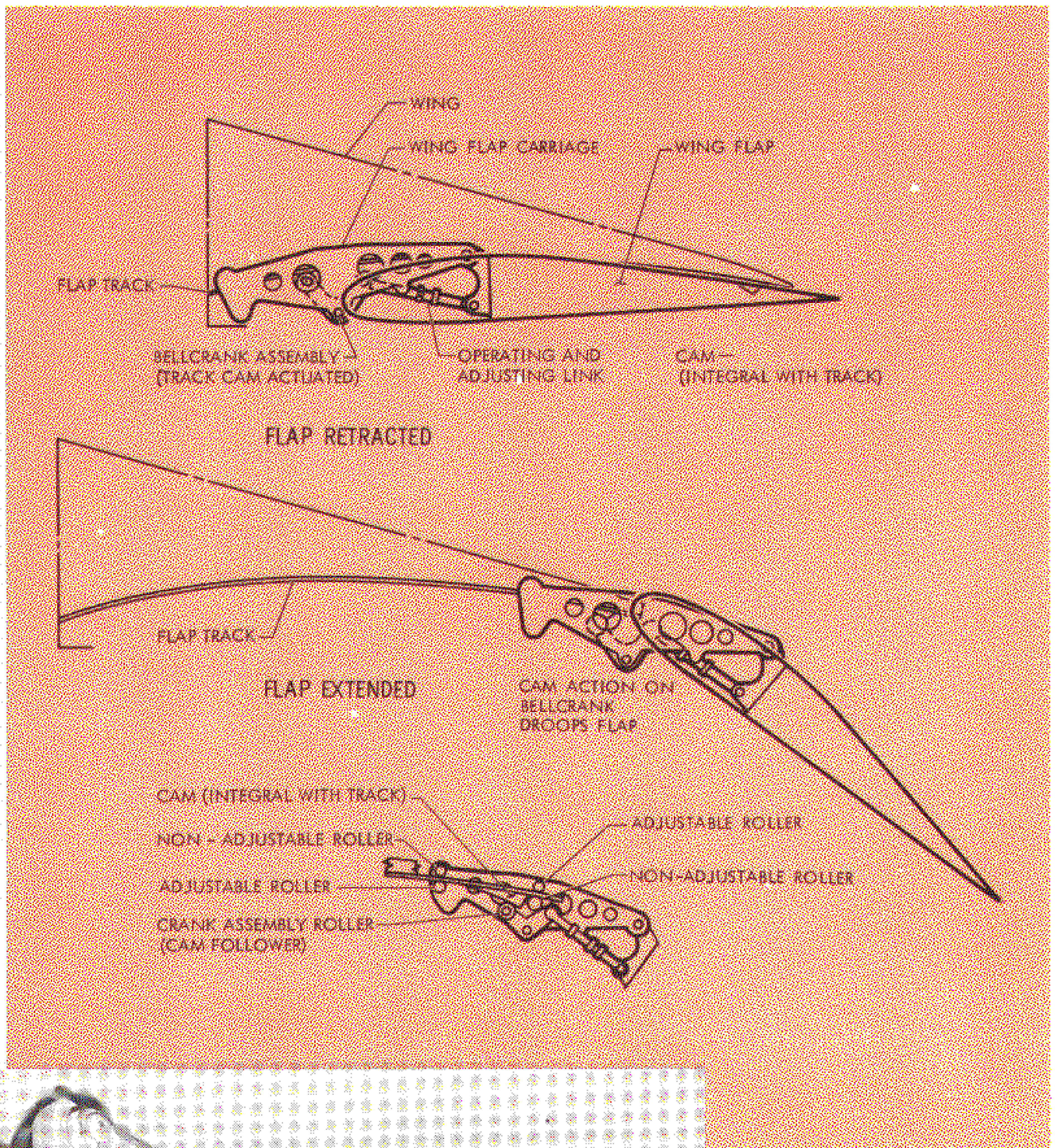


Figure 2 Wing Flap Drive Unit Installation in the Hydraulic Service Center

Figure 3 Markings on Wing Flaps Indicate Degree of Flap Deflection — Not Percent of Flap Extension

Five flap tracks, located in each flap bay, are attached to the flap track ribs and the wing rear beam, providing a path and guide for the wing flap carriages. The tracks are fabricated from high heat-treat steel forgings that have an inverted "T" cross section. The flap tracks have a constant arc that causes the flaps to deflect gradually and maintain the general camber of the wing during the first 77 percent of flap extension. A cam which is integral with the aft end



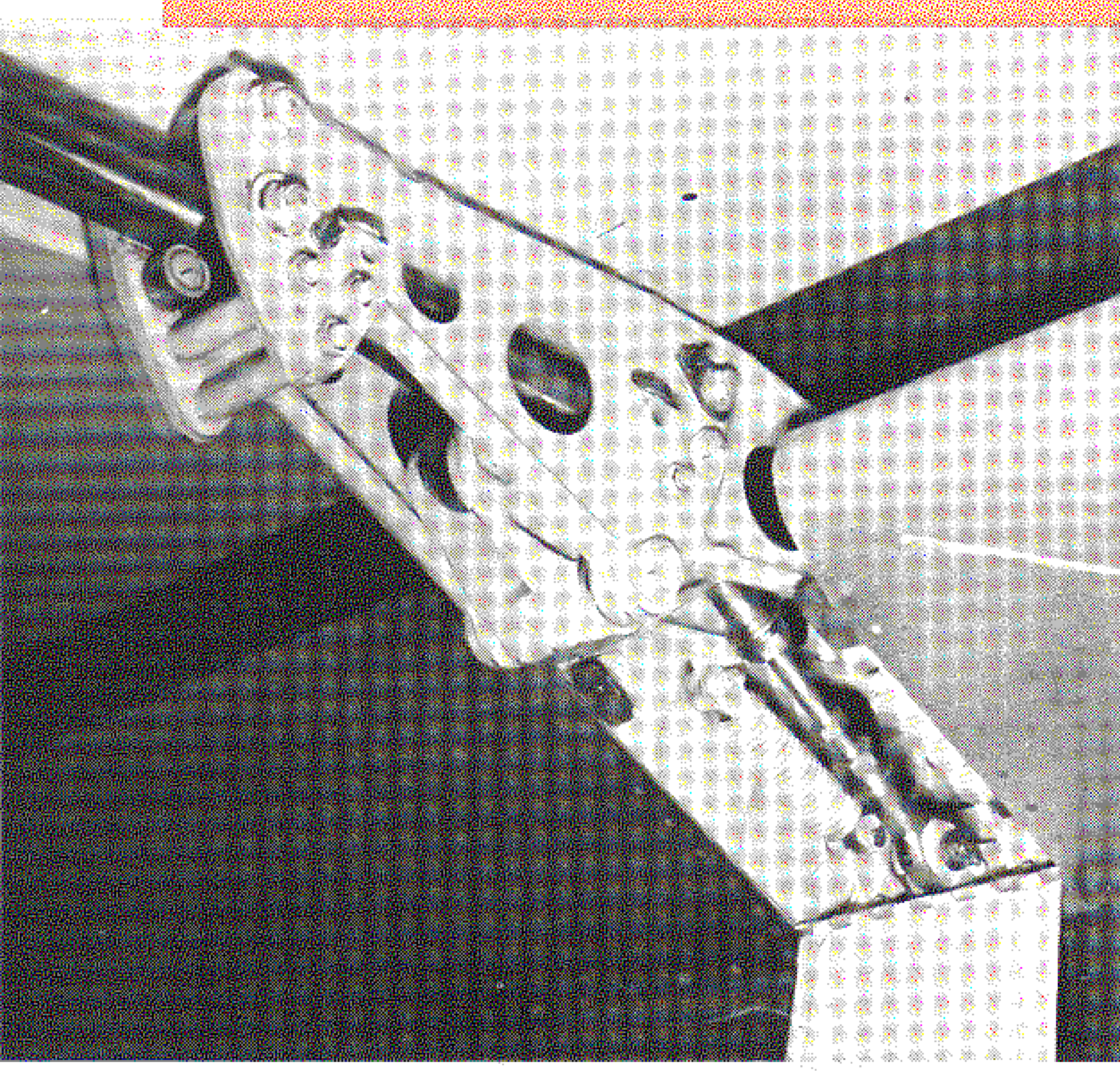


Figure 4
Operation of the
Flap Carriages

of each flap track increases the downward angular flap deflection to 40 degrees at the limit of flap extension.

Five carriage assemblies support each wing flap panel, transferring the static and aerodynamic loads from the flaps to the wing structure. Each carriage assembly is made up of two side frame assemblies that are joined by spacers and bolts, two weight reaction spring assemblies, and a bellcrank assembly. Figure 4 depicts the operation of a carriage assembly.

Two pairs of laterally-mounted needle bearing rollers are mounted on each side frame, one pair at the forward end and the other pair near the center. These rollers ride the upper and lower surfaces of the wing flap tracks. One roller of each pair can be adjusted to compensate for flap track wear. Each carriage side frame assembly also has two guide rollers that contact the sides of the flap track, controlling the lateral position of the flap assembly. There are no provisions for adjustment of these guide rollers since it has been determined that the light running loads do not cause any appreciable side track wear.

A bellcrank is mounted on each carriage assembly on the lower of the two carriage center spacers. The forward bellcrank arm supports a wide roller that rides on the lower surface of the flap track. The other arm of the bellcrank is anchored to a bracket on the flap front beam by an adjustable tie rod. As the flaps are extended or retracted, the roller on the forward arm of each bellcrank follows the contour of its flap track cam. Bellcrank rotation forces the flaps to pivot around the bellcrank attachment points, changing the angular deflection of the flaps as they move along the flap tracks.

Because the flaps are supported at their leading edges, they have a tendency to droop around the carriage attachment points. To counteract this tendency, two weight reaction spring assemblies (spring loaded cartridges) are mounted between each carriage and the bottom of the wing flap front beam. The spring force is transmitted by the flap to the bellcrank assemblies, forcing the forward bellcrank arms against the flap tracks.

The wing flap control lever is located on the right aft side of the pilot's control pedestal (see Figure 1). The lever handle, formed like a flap airfoil, is readily distinguished from other handles by its unusual shape. "WING FLAPS" is also inscribed upon the handle.

The flap lever may be moved when the release button located on the right side of the lever is depressed. Depressing this button relieves the friction load imposed upon the flap lever quadrant by a wedged roller locking device. When the lever is moved to the TAKEOFF-APPROACH position (77 percent flaps), a detent is engaged, giving a feeling of restraint upon lever movement and making it unnecessary to visually locate this position. The MANEUVER position (40 percent flaps) has a half detent that can be felt *only* when the lever is moved towards FLAPS DOWN. Lever motion is transmitted from an arm on the lever assembly, through a linkage, to the wing flap and emergency brake control quadrant which drives the flap control cable system.* The cable system extends from the flight station to a cable drum in the hydraulic service center, transmitting lever movement to the hydraulic control valve through the follow-up mechanism.

The follow-up unit starts and stops the flap motors by opening and closing the wing flap hydraulic control valve. This unit, a sub-assembly of the flap main drive gearbox, contains a planetary gear train driven off the main drive gear output shaft at a gear reduction ratio of 326 to 1, as measured at the cam on the planetary ring gear.

When the flap position selector lever is moved, a cable drum rotates the follow-up unit planetary gear train, rotating the ring gear. Movement of the ring gear causes the cam on this gear to disengage itself from an operating mechanism connected to the flap hydraulic control valve, rotating this mechanism and the valve to *an* "open" position. (Note that there are *two* open positions). The mechanism is held open by an over center spring. When the control valve is opened, fluid is ported to the hydraulic motors, the main flap drive is set in motion, and the flaps move.

Rotation of the flap main drive returns the follow-up ring gear to its original position. As the gear reaches this position, its cam engages the hydraulic control valve operating mechanism, returning the valve to the "closed" position and removing hydraulic pressure from the flap motors.

In effect, what has happened is that the flap motors have been turned *on* through the follow-up mechanism and the flaps have been moved to the selected position, at which time the follow-up unit stops flap actuation by turning the flap motors *off*. The control cable drum can be rotated in either direction, permitting extension or retraction of flaps. Rotation of this drum is limited by adjustable stops. In this manner the range of flap travel is controlled. The operation of the follow-up unit is shown in Figure 8.

**The "emergency brake control" portion of this nomenclature is a relic from the past when usage of dive brakes was being evaluated (and subsequently abandoned when found superfluous) on the P-3's commercial antecedent, the Electra. For the same reason, a switch which presently is connected to nothing is mounted on this quadrant. Proposals that involve the use of this switch are under consideration by Lockheed's Engineering Department.*

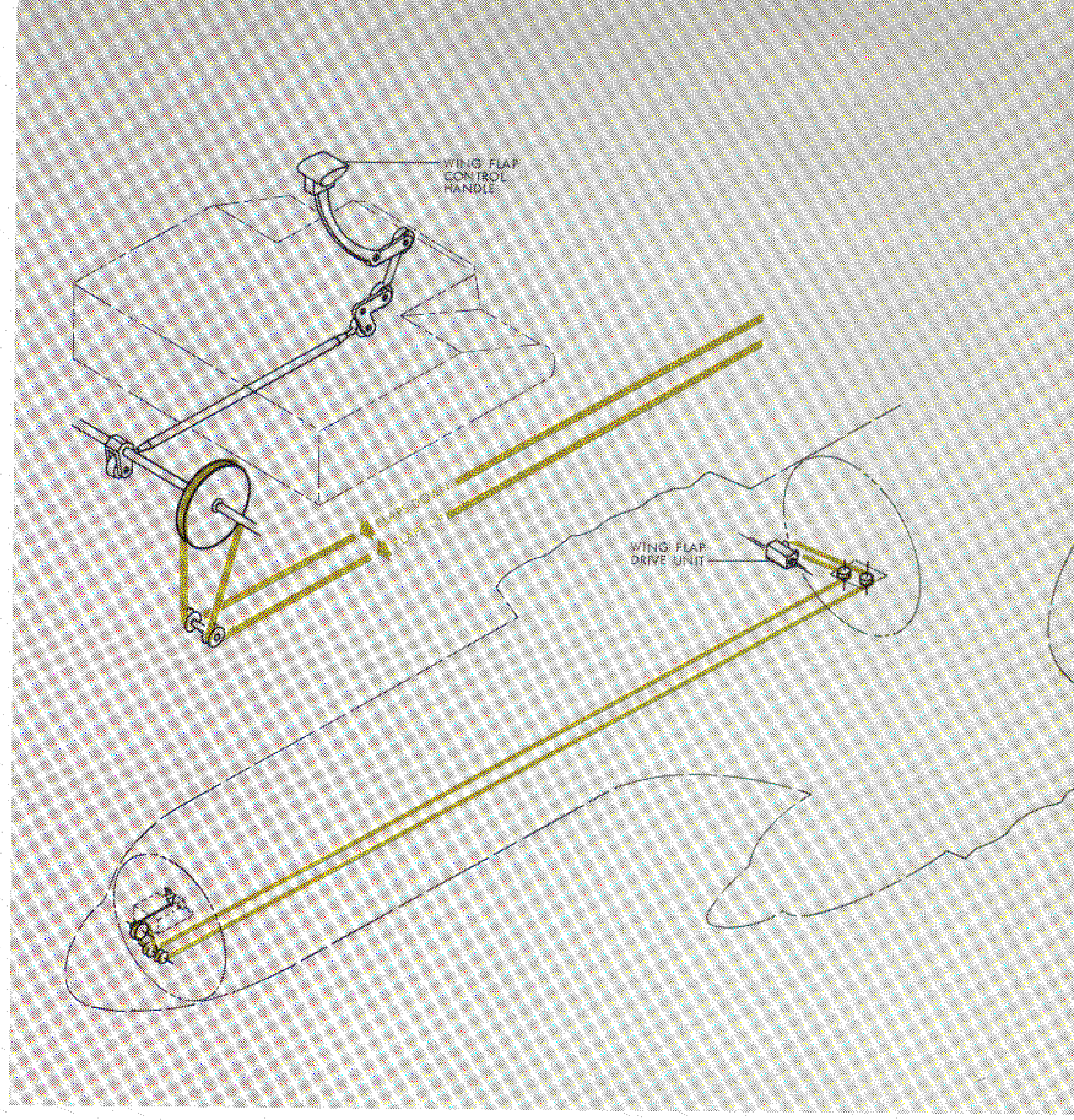


Figure 5 Wing Flap Control System

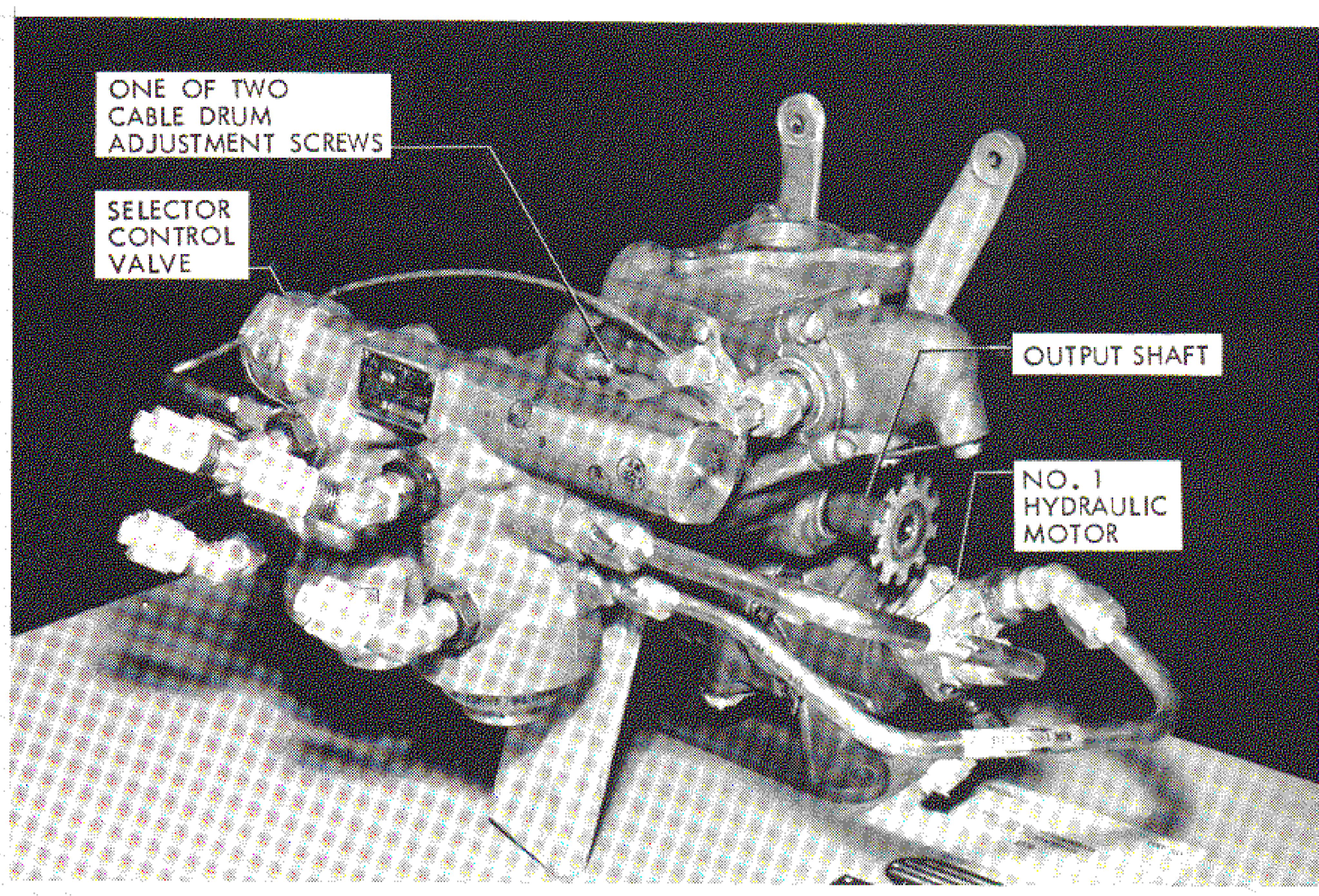


Figure 6 Wing Flap Drive Unit — Flap Position Transmitter and Rudder Booster Shutoff Switch and Gearbox not Installed

The wing flap hydraulic control valve (flap position selector valve) is a spool-type dual control valve and manifold assembly that ports hydraulic fluid from the No. 1 and No. 2 hydraulic systems to the desired side of the No. 1 and No. 2 flap drive motors. The single-spool valve is segmented, keeping the fluids of the two hydraulic systems separate. When the control valve operating mechanism is rotated by the follow-up unit ring gear cam, it rotates a shaft in the control valve housing which moves an actuating arm attached to the valve spool. This moves the spool to either an open or closed position. The maximum torque necessary to operate the control valve is 2.5 lb. in. when 3000 psi hydraulic pressure is applied.

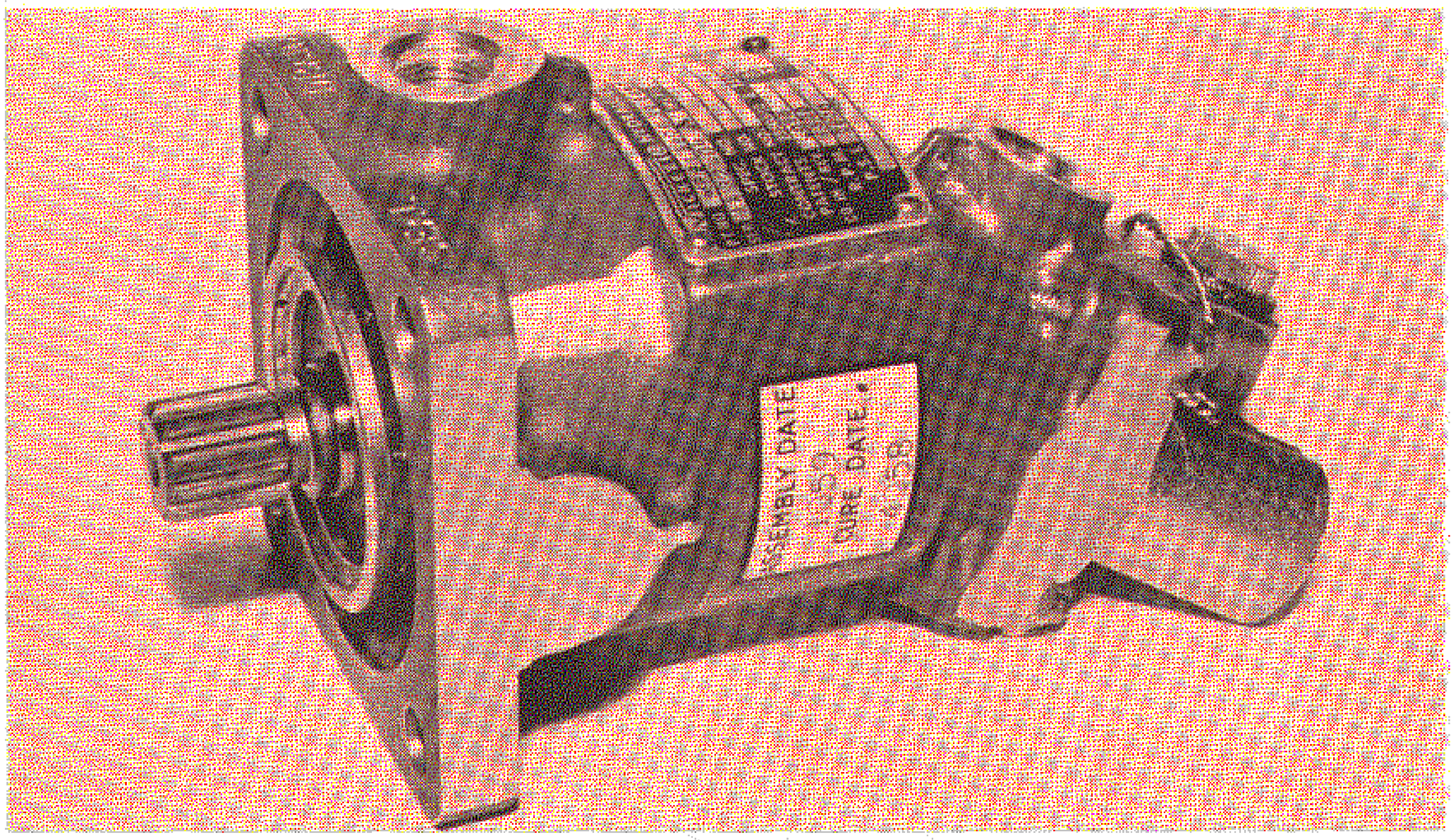


Figure 7
Vickers Hydraulic Motor. Motor shown is similar to those used on the Orion

The manifold has two check valves, one between the pressure and return ports of each hydraulic system. If one hydraulic system is shut down or fails, the check valve allows the fluid to recirculate between the motor of the inactive system and the control valve while the flaps are being driven by the other motor. The flap hydraulic system is shown on the Wing Flap System Master Diagram in the center of this magazine.

Two wing flap main drive filters are part of the control valve and manifold assembly—one filter for each hydraulic system. These filters, made of convoluted stainless steel wire cloth, are designed to remove foreign particles that are 10 microns or greater in size. The control valve and manifold assembly is designed so that the filter elements can be removed for cleaning or replacement. Each filter is rated at a maximum rate of flow of 4 gallons per minute, and must be able to withstand a differential pressure of 3850 psi without structural failure of the element.

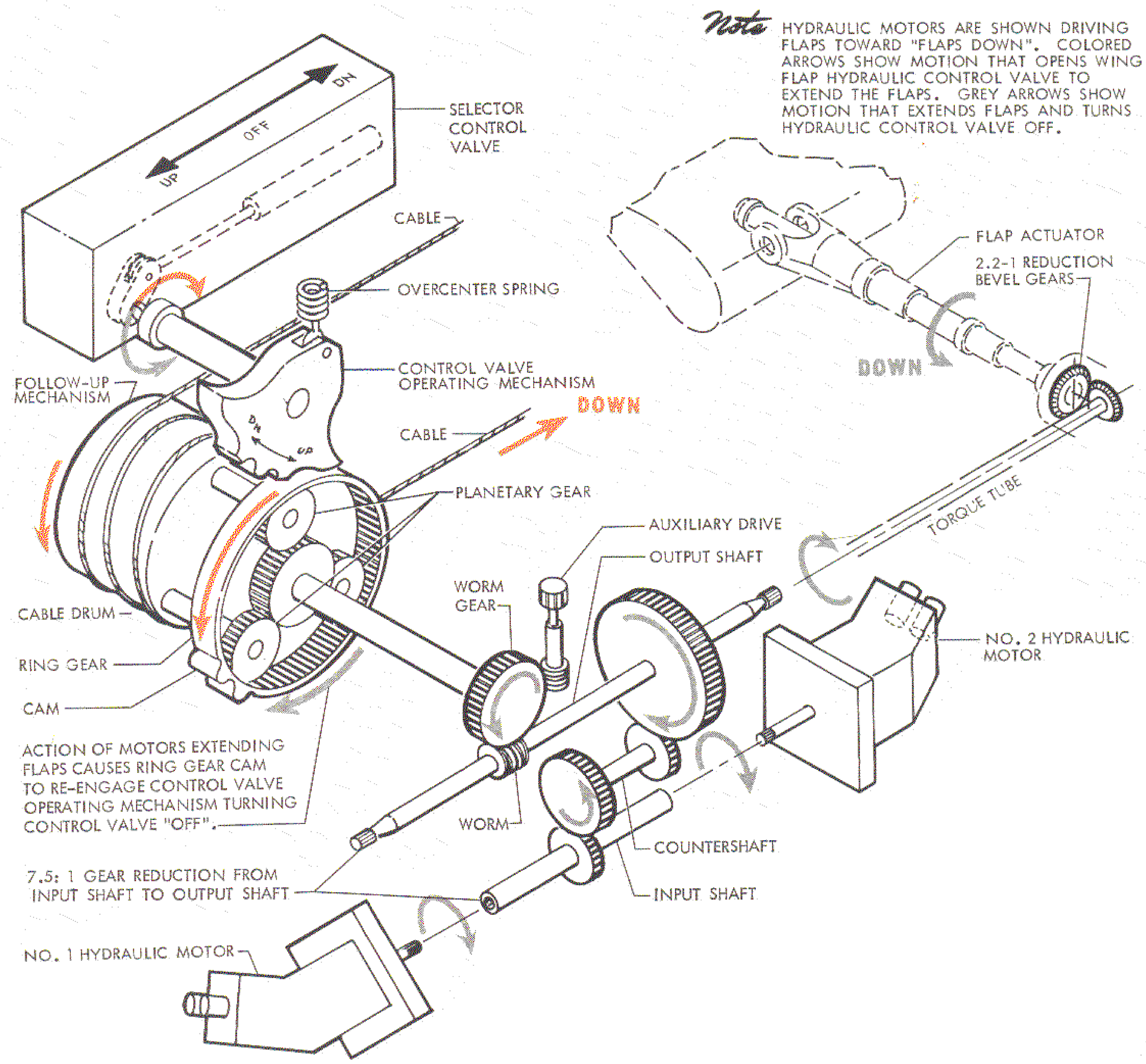


Figure 8
Schematic of the Wing Flap Drive System and Follow-up Unit

Two Vickers hydraulic motors convert hydraulic flow to the rotary mechanical motion that is required to operate the wing flaps. These motors are constant displacement type motors, are interchangeable, and may be operated intermittently or continuously, suddenly reversed, or stalled without incurring motor damage. The motors are set into motion when pressure is directed to one of the ports on either or both motors. A Vickers hydraulic motor similar to those used on P-3 aircraft is shown in Figure 7.

Each motor has two main ports from which lines are run to the flap control manifold, and a clearly marked drain port from which a return line is routed to the hydraulic reservoir of the system that drives the motor. When pressure is applied to one of the main ports, the other main port serves as a return port.

Naturally, the most efficient situation is when pressure is directed to both motors. During normal conditions (both hydraulic systems operable) the flaps may be fully extended or retracted within approximately 20 seconds at airspeeds up to 170 knots. However, one hydraulic motor is adequate to fully extend the flaps within 33 seconds if the airspeed is reduced to 132 knots. Since air loads tend to retract the flaps, failure of one hydraulic system would not be of great significance with regard to flap retraction during flight.

Each motor has nine radially arranged cylinders in a block assembly that is canted 30 degrees with respect to the motor output shaft, and the pistons in these cylinders are coupled to the output shaft by a universal linkage. The rated operating speed for this motor is 6300 rpm for continuous operation at a continuous hydraulic pressure of 3000 psi. At the rated operating speed, each motor will produce 39.0 in. lb. torque with 2500 psi input pressure, 45.0 in. lb. torque at 3000 psi, and 54.0 in. lb. torque (maximum) at 3450 psi.

The wing flap drive gearbox consists of the main housing and gears and the follow-up gear train subassembly. The main housing of this assembly is made of magnesium alloy, while the gears are made of nitralloy.

The gears are arranged to drive the torque tubes at a reduction ratio of 7.5 to 1 between the motor input shaft and the gearbox output shaft (to which the torque tubes are connected). The gear configuration is as follows: (1) the *input shaft* extends between the mounting pads of the two hydraulic motors; (2) a gear on the input shaft drives a gear on the *countershaft* in the housing; (3) another gear on the countershaft meshes with a gear on the *ouput shaft*; and (4), the output shaft extends through the housing to drive the *torque tube system.*

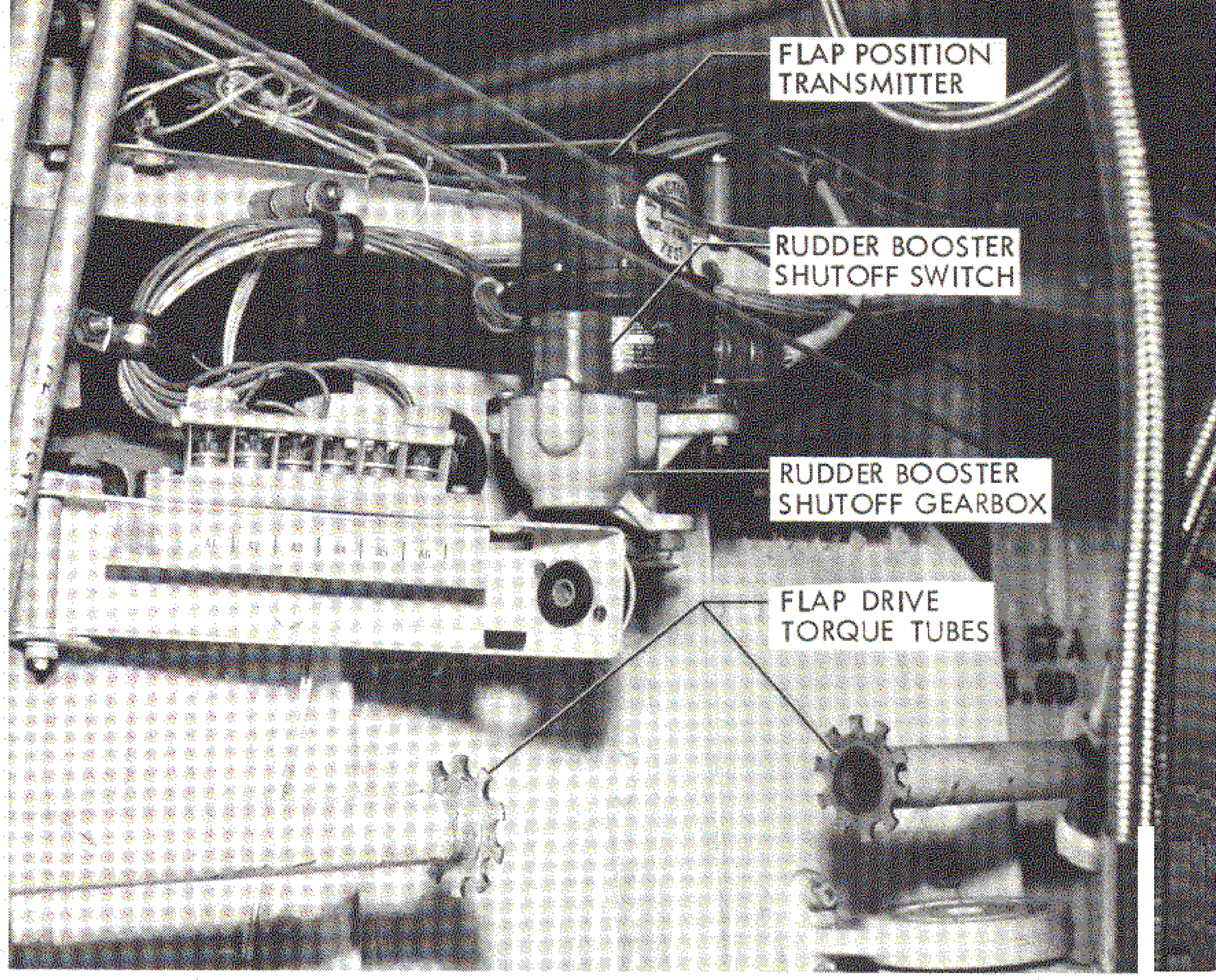


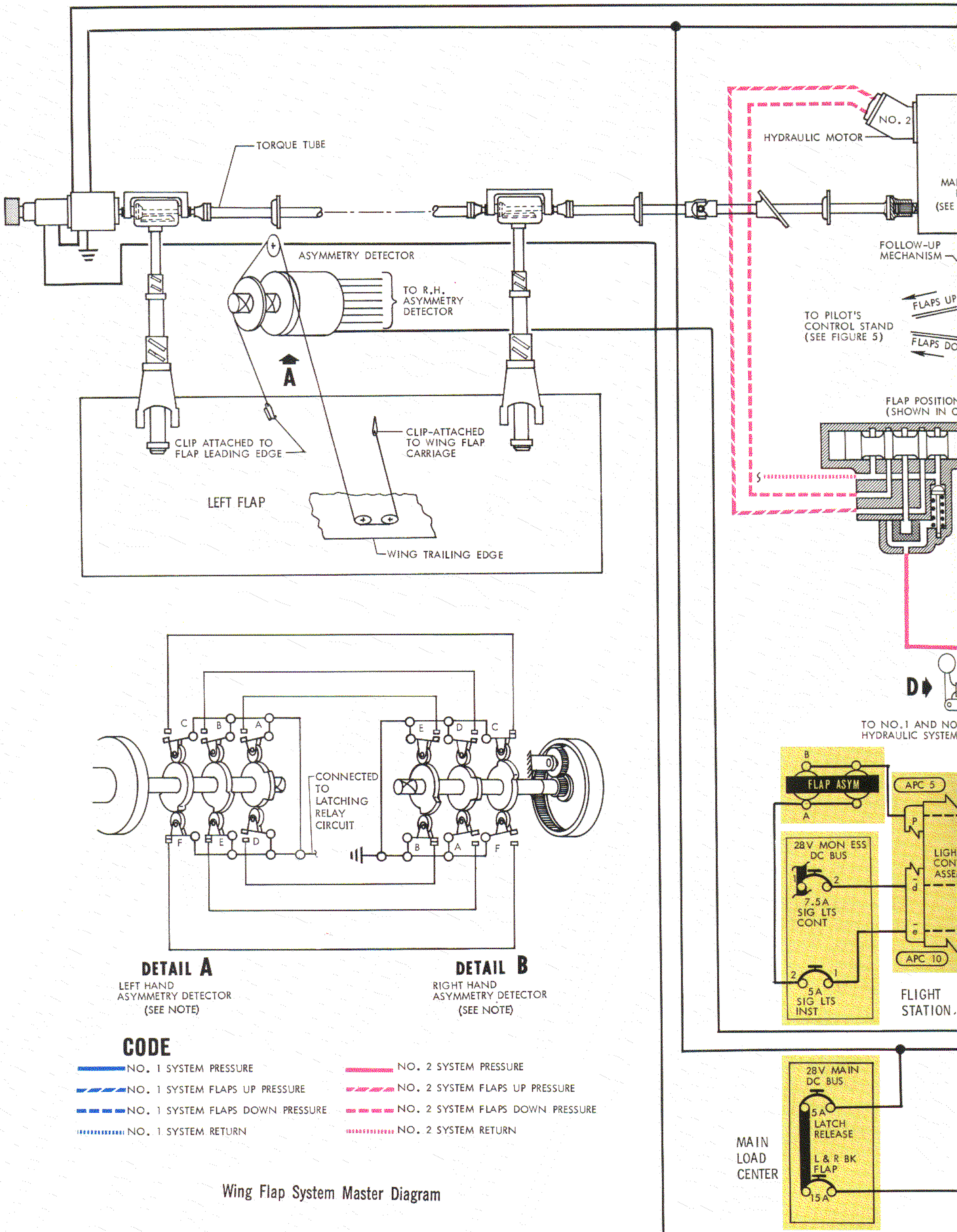
Figure 9 Flap Position Transmitter Mounted on Rudder Booster Shutoff Gearbox in Hydraulic Service Center — Flap Drive Unit Installation Not Shown

The output shaft also has a worm which drives the follow-up system worm gear. The gear shaft drives the follow-up unit planetary system. The worm gear also drives an auxiliary shaft that drives the flap position indicating system transmitter and the rudder booster shutoff gearbox gear train. Figure 8 shows the operation of the flap drive system.

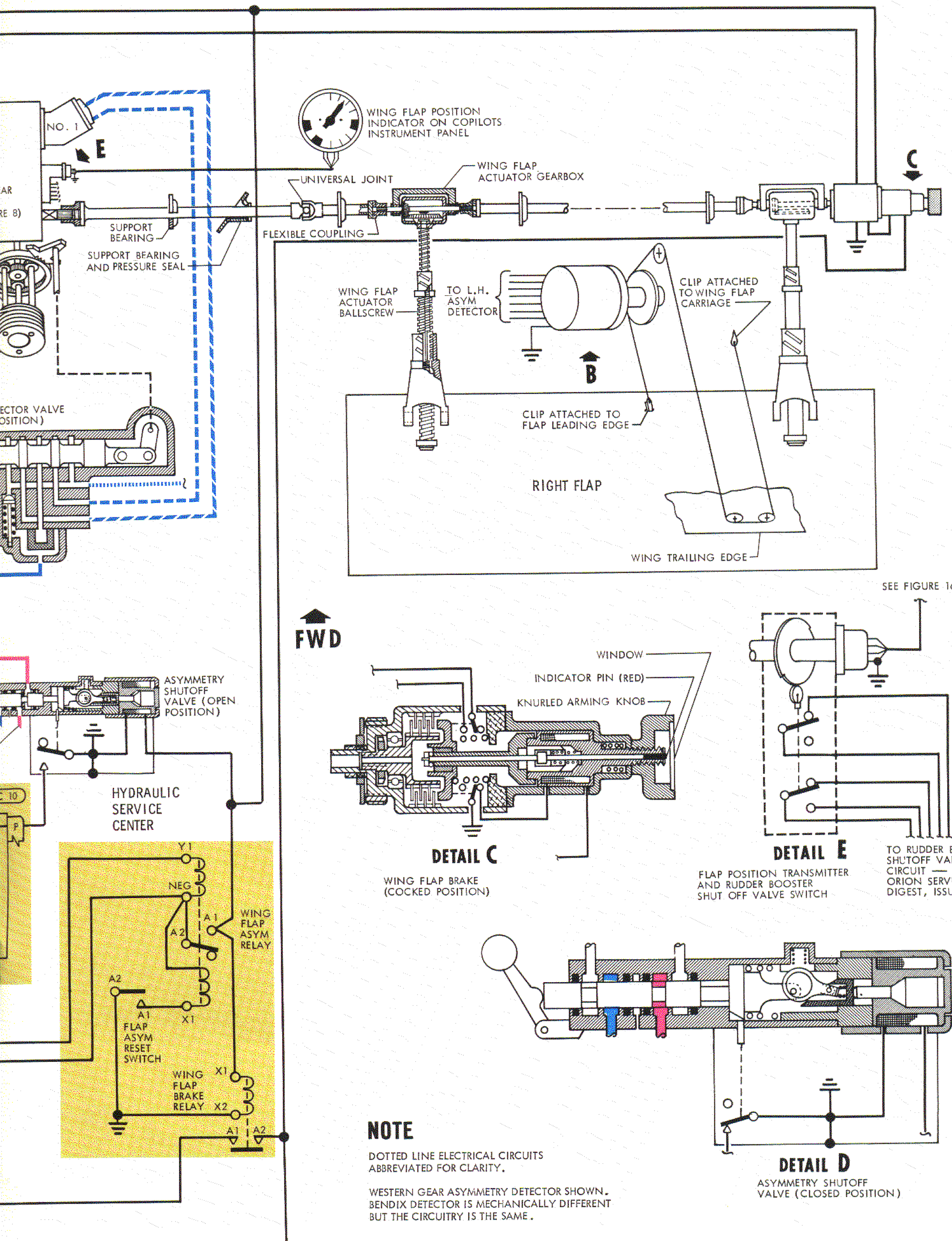
Wing flap position is indicated by an autosyn system. The indicator is located on the co-pilot's instrument panel in the flight station, while the position transmitter is mounted on top of the rudder booster shutoff gearbox in the hydraulic service center. The transmitter senses flap movement from a splined shaft that extends from the flap drive mechanism through the rudder booster shutoff gearbox. This information is sent to the indicator, where it is repeated on a dial as percentage of flap extension.

The flap position transmitter also sends a signal to the autopilot elevator control channel to prevent perverse changes of aircraft attitude if the flaps are operated while the autopilot is engaged.

The rudder booster shutoff gearbox is mounted on top of the follow-up unit. The same splined shaft that drives the flap position transmitter drives the rudder booster shutoff gear train. The gear train mechanically operates a double-pole, double-throw switch mounted on this gearbox which is a component of the rudder booster shutoff valve circuit. The rudder booster shutoff system is treated in detail in Issue No. 8 of the *Orion Service Digest.*



Wing Flap System Master Diagram



NOTE

DOTTED LINE ELECTRICAL CIRCUITS ABBREVIATED FOR CLARITY.

WESTERN GEAR ASYMMETRY DETECTOR SHOWN. BENDIX DETECTOR IS MECHANICALLY DIFFERENT BUT THE CIRCUITRY IS THE SAME.

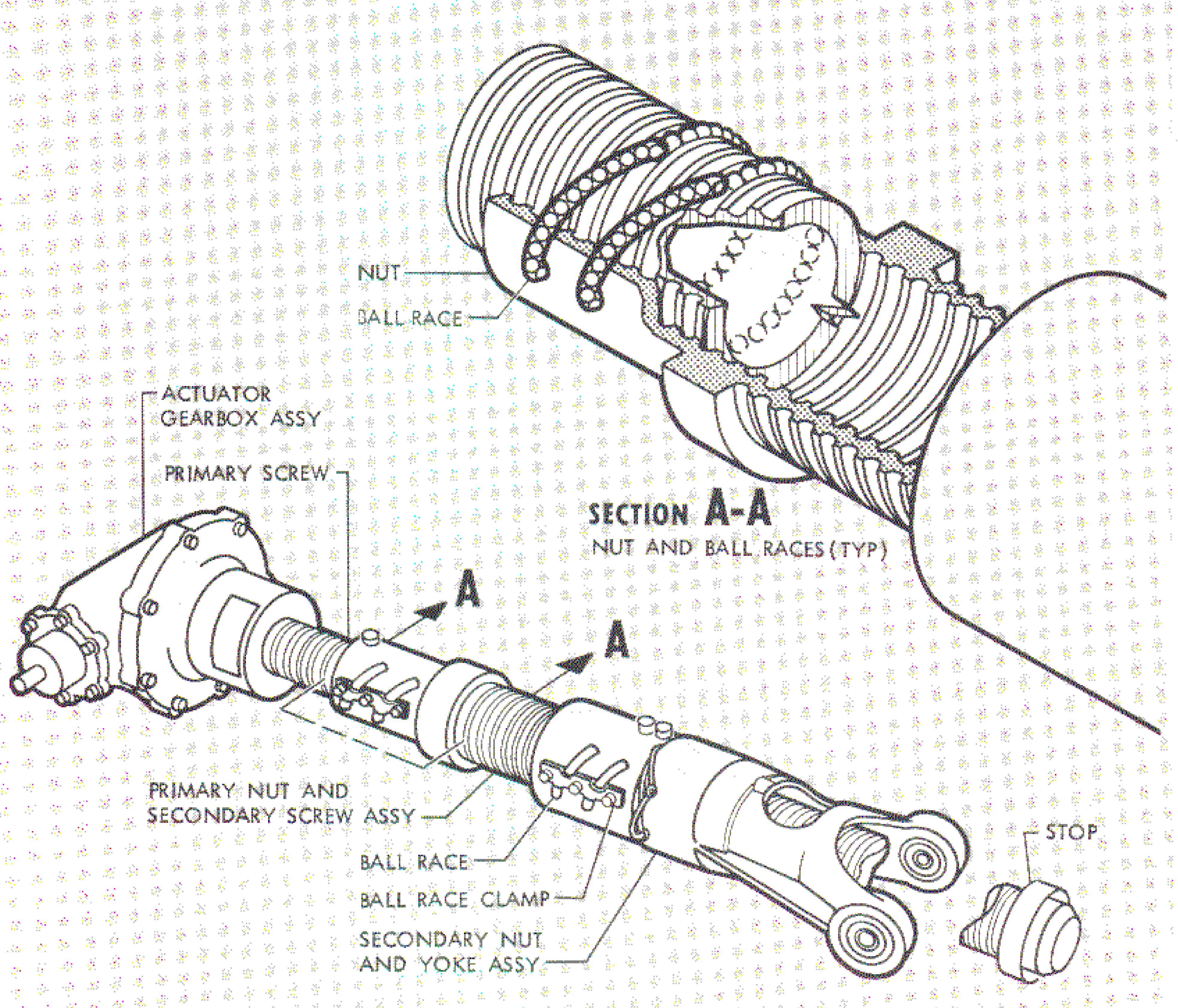


Figure 10 Diagram of Typical Wing Flap Actuator

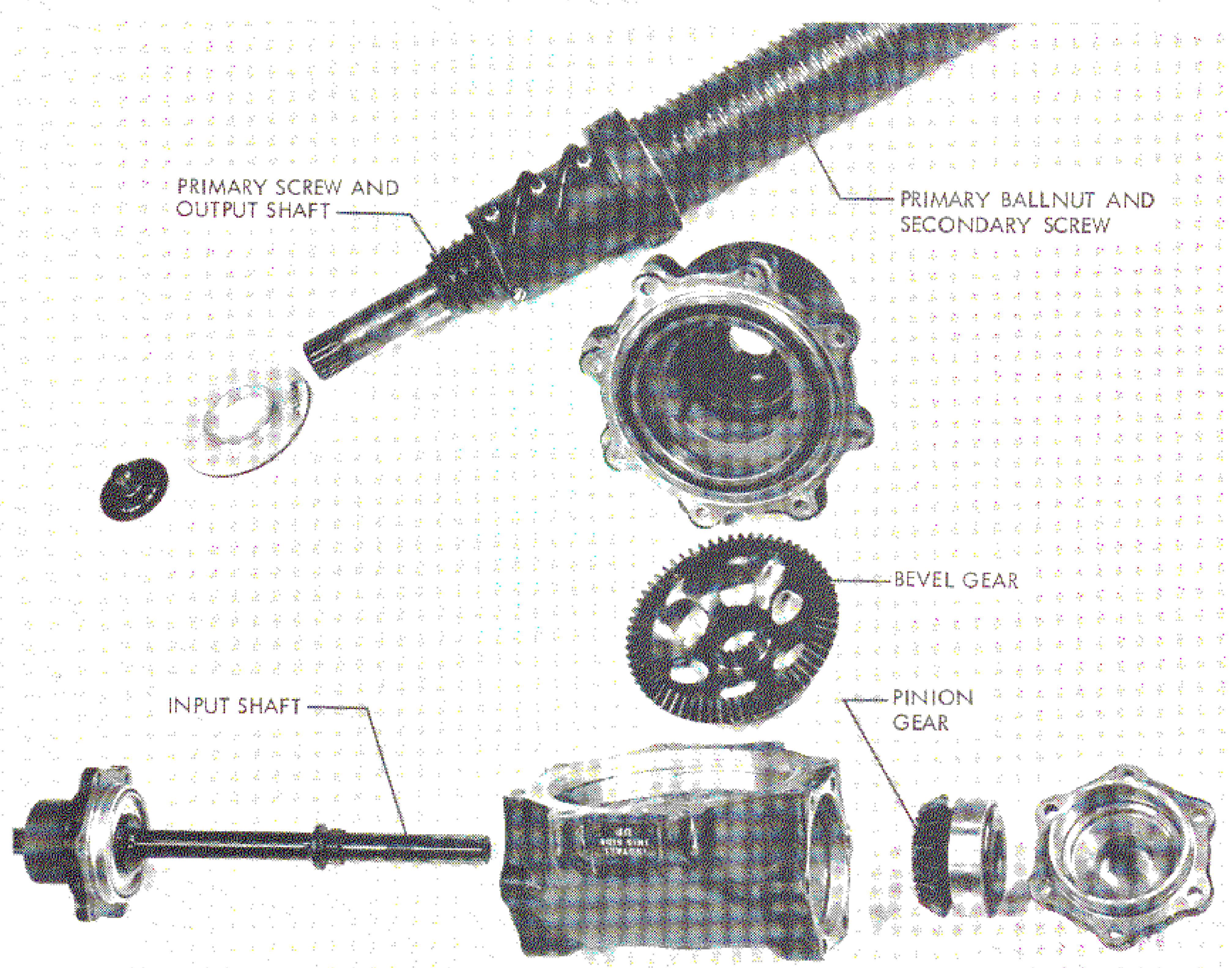


Figure 11 Partially Disassembled Actuator Gearbox

The torque tube system transfers power from the flap main drive, outboard through the fuselage wall along the wing rear beam to the gearbox of each inboard flap actuator, and continues to the gearbox of each outboard actuator. The torque tubes are held in place by support assemblies fastened directly to the wing rear beam. These support assemblies have self-aligning sealed ball bearings which prevent the torque tubes whipping when they are rotated.

A universal joint is installed on each side of the torque tube system just outside the fuselage, allowing the torque tube line of drive to follow the wing dihedral. The tubes are supported by bearing and housing assemblies where they pass through the fuselage wall, the housings being part of the fuselage structure. The bearing seals also serve to minimize escape of cabin pressure from the hydraulic service center.

Telescoping screw type actuators (jackscrews) are operated by rotary motion of the torque tubes and two are used to drive each wing flap panel. A segment of the torque tube system extends from the gearbox of each inboard actuator to the gearbox of each outboard actuator. The actuators are trunnion mounted on the wing rear beam, and their yoke ends are connected to brackets on the flap panel front beam. Each actuator consists of a gearbox (the housing of which incorporates the trunnion), a telescoping screw assembly, and the yoke (see Figure 10).

The gearbox has an input shaft that extends completely through the gearbox. The pinion gear on the input shaft drives a bevel gear at the end of the primary screw of the telescoping screw assembly at a reduction ratio of 2.2 to 1. The major components of a typical gearbox are shown in Figure 11.

The telescoping screw assembly consists of a primary screw and ballnut and a secondary screw and ballnut. The primary screw is mounted in the gearbox and rotates within the primary ballnut which is integral with the secondary screw of the actuator assembly. The secondary screw rotates within the secondary ballnut which is integral with the actuator yoke (see Figure 10). The balls in the ballnuts recirculate through the ball-race tubes and act as threads for the actuator screws. The actuators convert the rotary motion of the torque tubes to linear motion at the actuator yokes, making it possible to extend or retract the flaps.

During actuator operation, the ball-race nut that offers the least resistance will travel along its screw unit until it reaches its stop, at which point actuator movement will continue with travel of the other ball nut over its screw. Stops are located at the end of the primary and secondary screws to preclude excessive screw rotation. The yoke, which attaches to the flap panel front beam, is equipped with rubber bushings to absorb shock transmitted through the yoke by jackscrew actuation.

The jackscrews are exposed to dirt when the flaps are extended, particularly during takeoff and landing. Since dirt that adheres to jackscrew threads will be carried to the ballnuts and accelerate jackscrew wear, frequent maintenance is necessary to prolong the service life of the actuators. The Daily and Calendar Maintenance Requirements Cards provide instructions for servicing the flap actuators.

Actuator backlash is another factor that must be considered. If an actuator is permitted to wear beyond its prescribed limits (as measured in backlash), the actuator may continue to function with apparent normality. However, use of an actuator with excessive backlash results in jackscrew wear that can become so excessive that the jackscrew portion of the actuator would be rendered irreparable. The backlash of an actuator that has been removed from an airplane can be accurately measured with a special backlash test machine available at A-level maintenance facilities at NAS Norfolk, Virginia and NAS Alameda, California. Figure 12 shows a test machine similar to those presently in use.

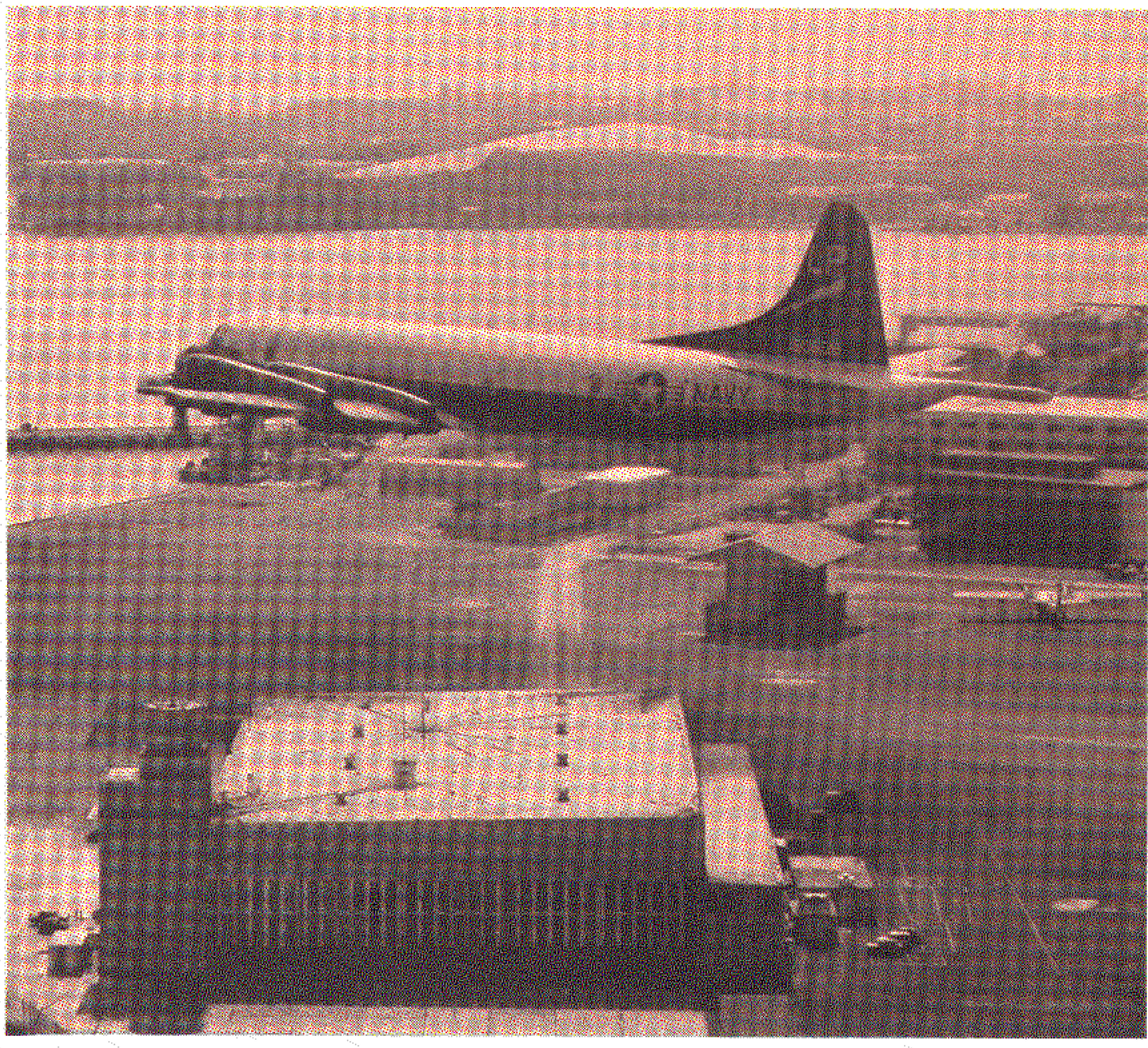
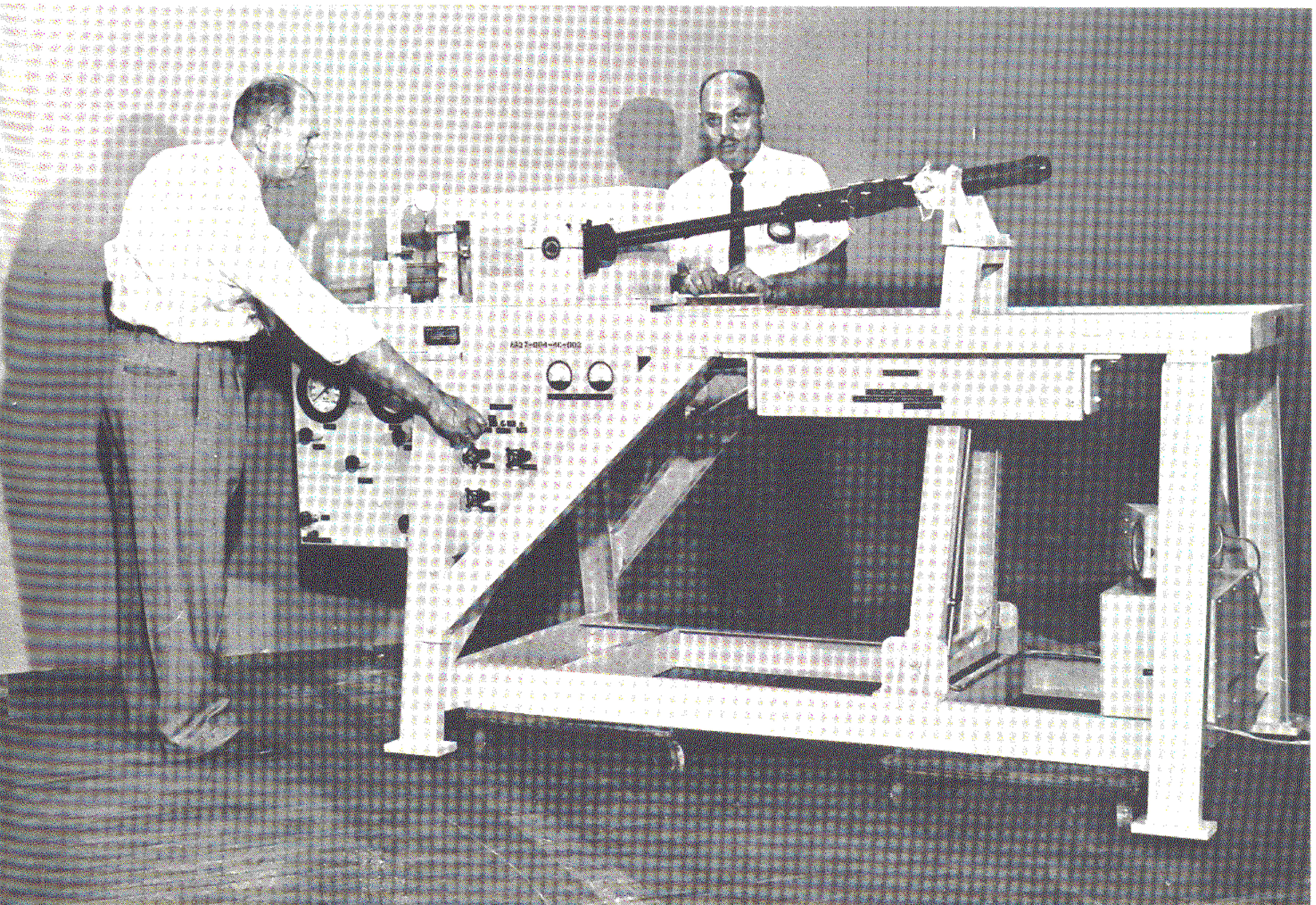


Figure 12 Flap Actuator Test Machine Demonstrated by Inventor Dirk Bodemeijer (l.) of Service Engineering and John Feola (r.), Section Supervisor of Lockheed's Customer Support, Repair, and Overhaul Unit.



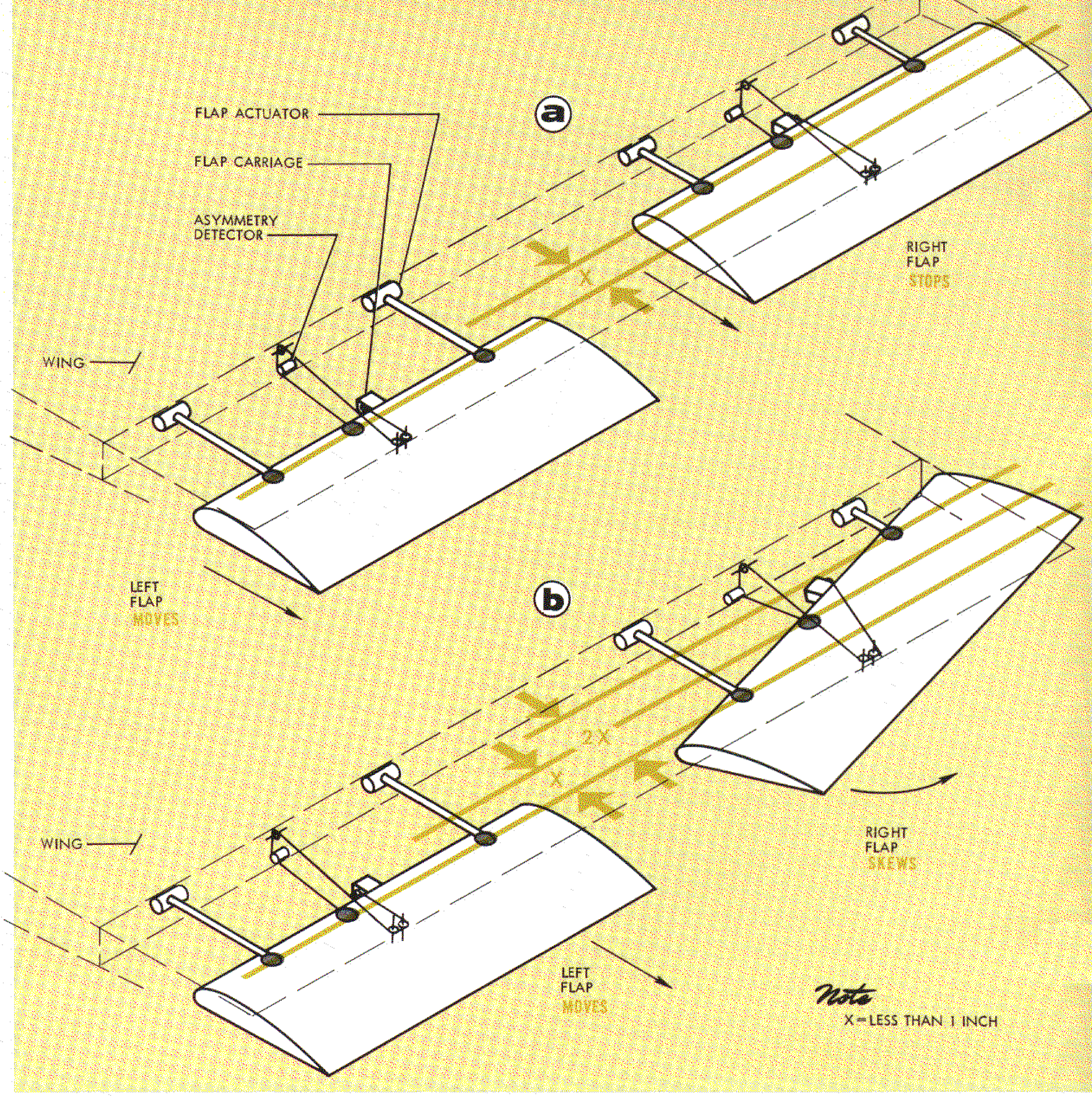


Figure 13 Diagram of Two Asymmetrical Flap Conditions — (a) Unequal Flap Extension and (b) The Skewed Flap

FLAP ASYMMETRY

The purpose of the flap asymmetry system is to detect an abnormal mis-match of flap position or alignment during flight, and then to automatically prevent further abnormal operation of the flaps long before flight attitude can be seriously affected. Two chain-driven asymmetry detectors, one mounted near the center of each flap well, are the heart of the asymmetry system. If an asymmetrical condition is detected, a circuit is completed through the detectors, actuating a solenoid operated dual shutoff valve (asymmetry shutoff valve). Actuation of this valve cuts off hydraulic pressure to the two flap motors, stopping further extension or retraction of the flaps. At the same time, a signal light in the flight station is illuminated and will remain so until this valve is manually reset, or until the signal light circuit is de-energized.

Should an asymmetrical flap condition occur during flight, no hydraulic power would be available to maintain flap position after the asymmetry trip. In fact, the loads on the flap surfaces would tend to drive the flaps toward the retracted position. To prevent an asymmetrical condition from increasing in magnitude through unwanted flap retraction, a multiple disc brake is installed adjacent to the outboard flap actuator of each flap panel. These brakes are applied whenever the asymmetry detectors sense an asymmetric flap condition, bringing the flap torque tube system to an immediate halt. The flap system remains immobilized until the brakes and shutoff valve are reset. In-flight maintenance to correct flap asymmetry is not possible because most of the components that would have to be checked are not accessible during flight. This task belongs to the ground crew.

Figure 13 shows two asymmetrical flap conditions: (a) unequal flap extension, and (b) the skewed flap. Either of these conditions will result in an asymmetry trip when the detector chain movement of one flap lags enough to put the two asymmetry detectors' circuitry in phase and actuate the asymmetry system. This difference of *chain extension* varies somewhat, but it always is less than an inch. Do not confuse chain extension with flap extension, because chain extension is linear while flap extension follows the camber of the wings for about 77 percent of the flap travel and then abruptly deflects downward.

In Figure 13a the difference of extension of the two detector chains and the two pairs of flap actuators is the same because both actuators on one flap have stopped at the same time. When only one actuator malfunctions as is shown in Figure 13b, the remaining actuators must travel approximately twice as far to produce the difference in chain extension required to actuate the asymmetry system. This distance is still less than two inches.

The wing flap asymmetry detector consists of a switch assembly and a sprocket. Two of these detectors are required for the asymmetry system, one mounted near the center of each flap well on the wing rear beam. Each detector unit sprocket is driven by a chain, one end of which is attached with a turnbuckle to the flap panel, while a cable lead on the other end of the chain is attached to one of the flap carriages. The routing of the chain is shown on Figure 14.

The two detectors are installed out of phase with respect to each other and are electrically connected in series so that at least one switch or contact in each of six circuits is open when flap movement is symmetrical. Should an asymmetrical flap condition develop, a circuit will be completed through the two detectors to the flap asymmetry electrical system, actuating the asymmetry shutoff valve, the two flap brakes, and the FLAP ASYM signal light.

Presently two types of asymmetry detectors may be found in the flap wells. The older units, made by Western Gear Corporation, utilize a 1:4 planetary gear system to drive a camshaft which actuates the detector's six limit switches. On these earlier units, the drive sprocket is a separate part of the asymmetry detector unit. Furthermore, there are left-hand (P/N 1098E82) and right-hand (P/N 1098E83) detectors which are *not* interchangeable.

Recently, detector units made by Bendix have been incorporated into production. These newer units have a rotary switch arrangement that vaguely resembles that of an automobile distributor. Rather than operating switches with a planetary gear-driven camshaft, this unit has a rotor that is driven directly by the shaft connecting to the sprocket. In addition, the sprocket is integral with the detector assembly. Like the earlier detectors, Bendix makes left-hand (P/N 3124365) and right-hand (P/N 3124365-1) units. The Bendix left-hand unit has an additional electrical receptacle for asymmetry circuitry test purposes. Again, left-hand and right-hand units are *not* interchangeable. However, Western Gear and Bendix left-hand units are interchangeable, as are the right-hand units.

In the future another Bendix asymmetry detector (P/N 3124365-101) of improved design will be incorporated into production. This unit will be similar to the earlier Bendix units, but it can be mounted in *either* flap well and can be used as a replacement for *any* left-hand *or* right-hand asymmetry detector previously installed on an Orion aircraft.

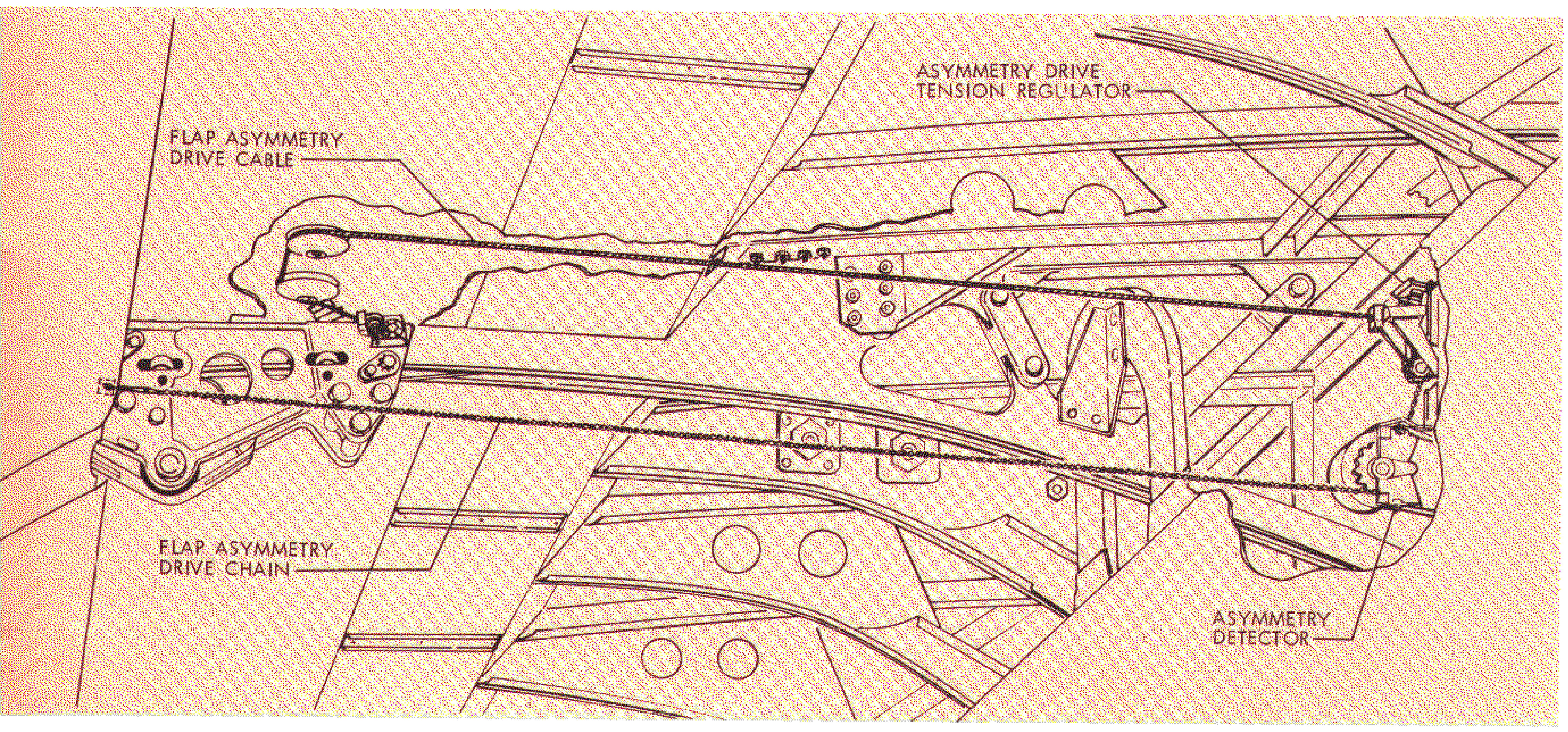


Figure 14
Routing of the Flap Asymmetry Detector Drive Chain and Cable Assembly

Periodic tests of the detector units are scheduled as part of the maintenance requirements of P-3 aircraft. Use of a switch test unit is necessary to perform the test procedures set down in the Maintenance Instruction Manual and the Maintenance Requirements Cards. Instructions for local manufacture of this flap asymmetry switch tester are also provided in the Maintenance Instruction Manual NAVWEPS 01-75PAA-2-2.

The wing flap brakes are solenoid operated multiple disc brakes. One brake is attached to the outboard drive shaft of the outboard flap actuator in each flap well. When an asymmetrical flap condition is sensed, a circuit is completed to each brake solenoid, actuating the brakes.

Each brake unit has two sets of brake discs. One set is coupled by a splined shaft to the outboard actuator and rotates when the flaps are extended or retracted. The other set of brake discs is retained by the brake unit housing. These stationary discs are sandwiched between the rotating discs. A pressure plate is spring-loaded toward the discs, but is retained by a ball-locking device. When the brake solenoid is energized it releases the ball-locking device, the pressure plate is forced against the two sets of discs by the spring, and the brake is applied.

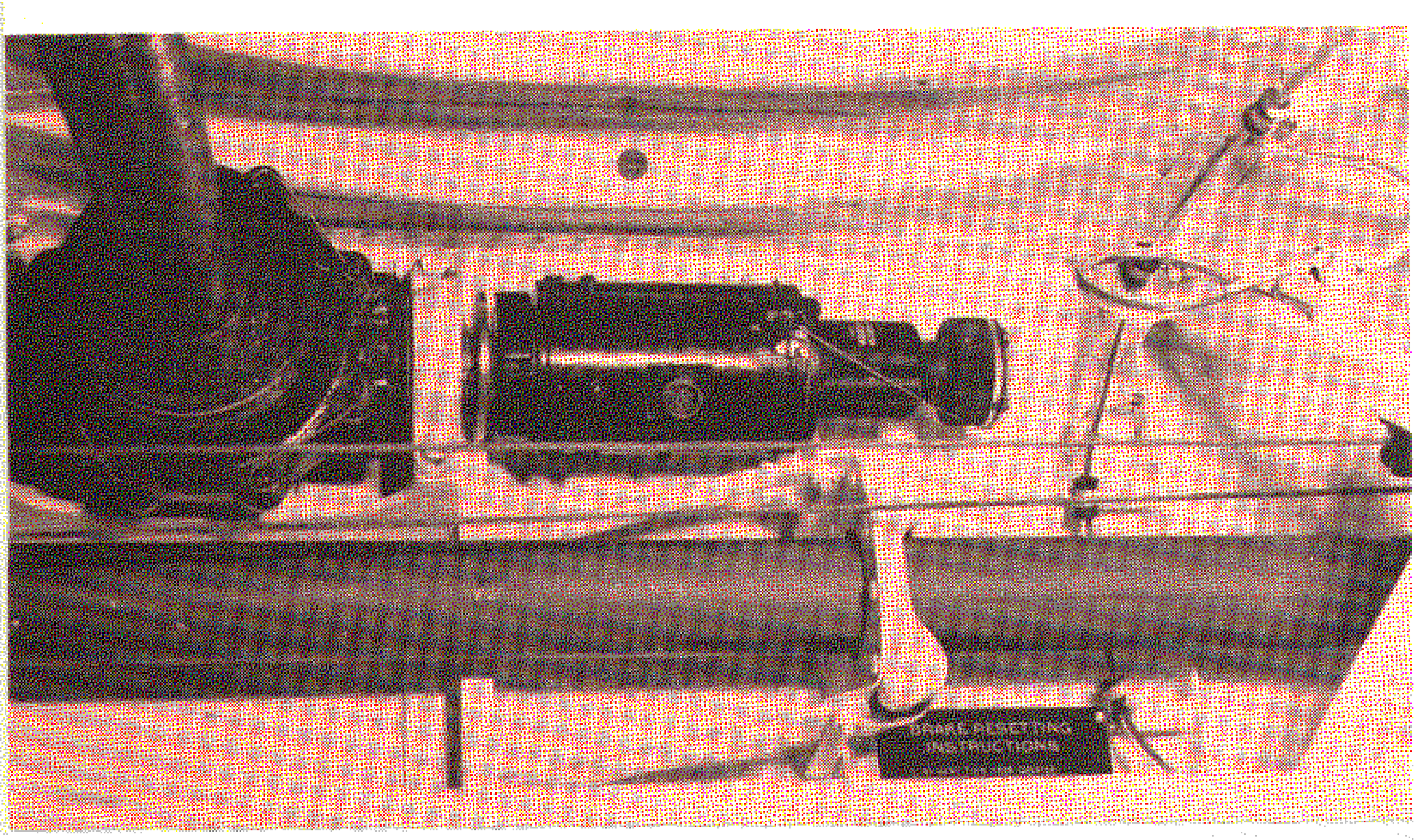


Figure 15 Wing Flap Brake Installation

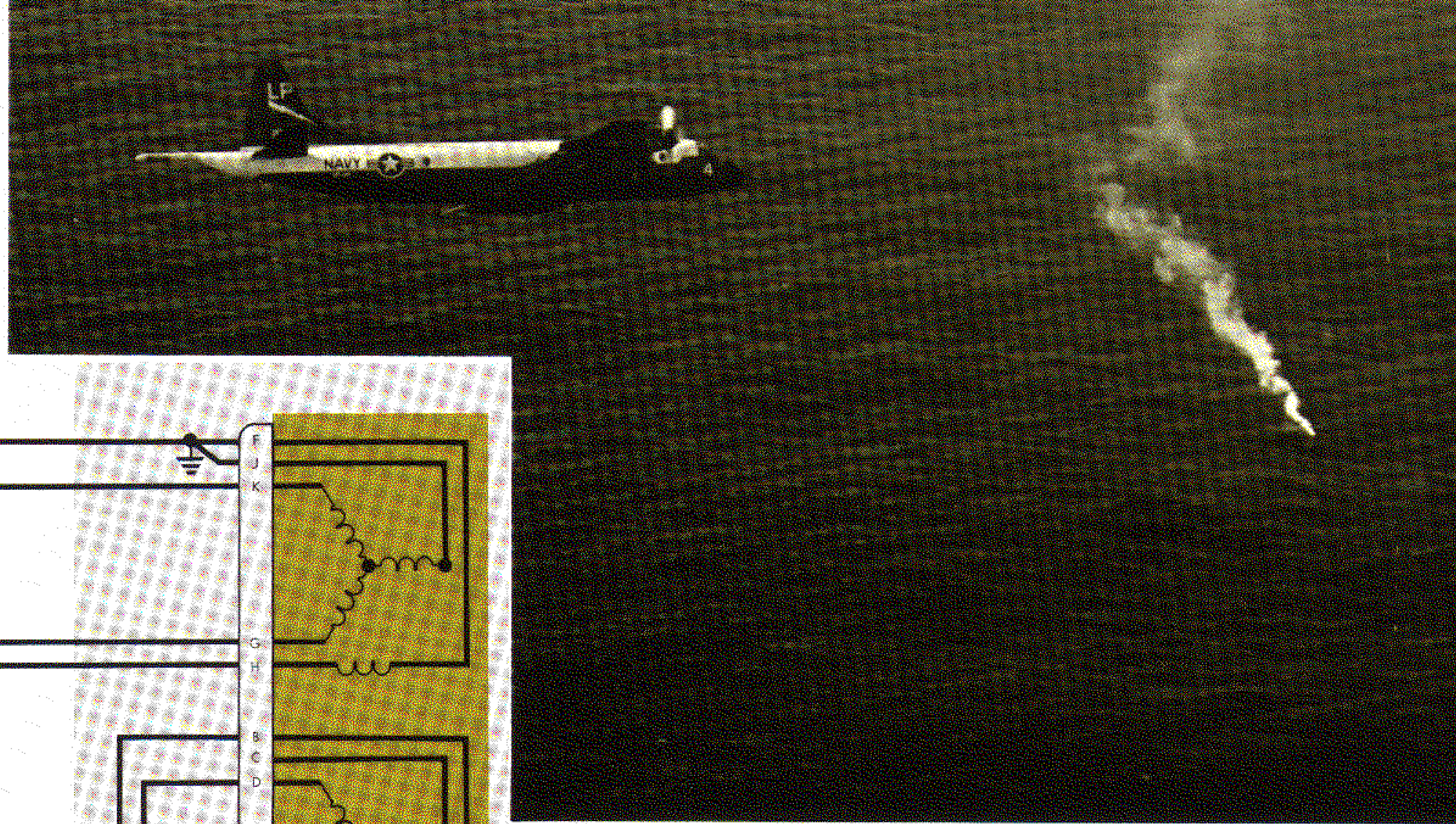
A transparent window is located in the end of each brake unit so that a quick visual ground check can be made to determine if the brakes have been applied. If a small red-tipped shaft protrudes from the end face of the brake unit, the brake is on. However, if the end of the shaft is flush with the end face of the unit, the brake is off. A diagram of a flap brake is included on the Flap System Master Diagram in the center of this magazine.

If the flap brakes have been applied, they must be reset manually. Note that this must be done in conjunction with the procedures discussed later in this article under "CLEARING ASYMMETRY TRIPS." However, as far as the brake unit itself is concerned, it is reset by cutting the lockwire retaining the knurled knob on the end of the brake, rotating the end counterclockwise until the red-tipped shaft is flush with the end face of the unit, and then backing off the knurled knob against spring pressure as far as it will go. The last $1\frac{1}{2}$ turns will be stiff. After the brakes have been reset, lockwire the brake knobs.

The wing flap asymmetry shutoff valve is a solenoid operated dual spool valve which will permit fluid from both No. 1 and No. 2 hydraulic systems to flow to the two flap motors when the flaps are operating normally. If an asymmetrical flap condition occurs, the shutoff valve solenoid is energized. This actuates the valve to the closed position and shuts off pressure to the flap motors. A spring loaded over-center device prevents the valve from opening unless it is manually reset.

The valve is reset by pushing a lever on one end of the valve inward. Pushing the lever rotates the over-center device back to "normal" and opens the valve. However, one must remember to reset the flap brakes before attempting to reset the shutoff valve, otherwise a circuit between the flap brakes and the shutoff valve solenoid will remain closed and the shutoff valve solenoid will remain energized. This means that the reset lever will pop right back out if you attempt to reset the shutoff valve while the brakes are applied and the flap asymmetry control circuit is energized. A diagram of this shutoff valve is on the Flap System Master Diagram.

When Lockheed's designers devised the circuit between the flap brakes and the shutoff valve it was not their intention to infuriate maintenance personnel with "that miserable little black knob that keeps popping back out." On the contrary, the purpose was to prevent the flap drive system from functioning after an asymmetry trip, as it has been demonstrated that under some circumstances the hydraulic motors can exert enough force to override the flap brakes. Efforts to circumvent the protection afforded by this circuitry might only result in a set of ruined brakes, but they could cause the flaps to move to a configuration that would have a pronounced adverse affect on the aircraft's flight characteristics. Thoughts to defeat the intent of this flap brake/shutoff valve circuit should be entertained only after considering the possible consequences.



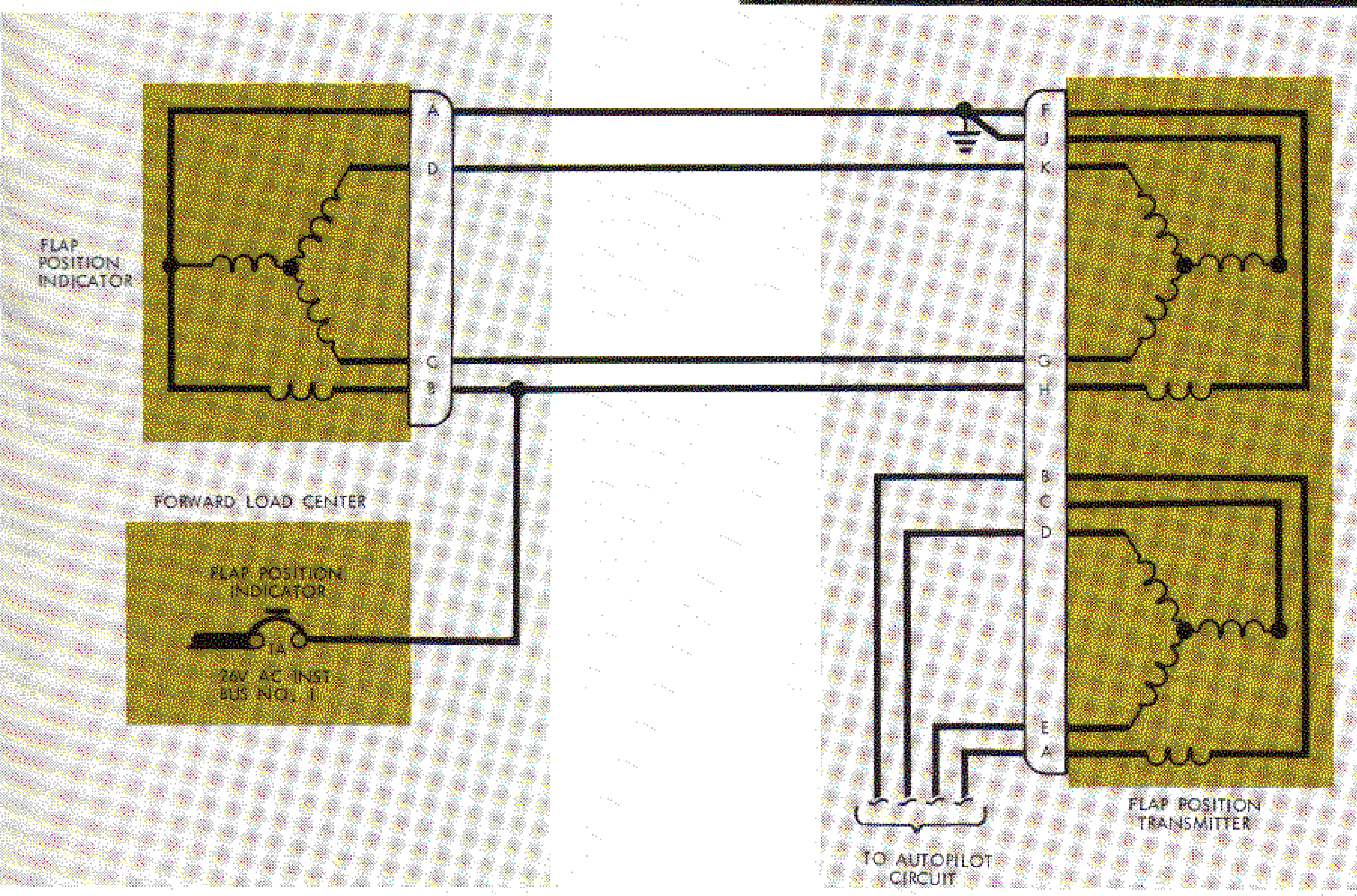


Figure 16
Schematic of Flap Position Indicator Circuit

WING FLAP ELECTRICAL SYSTEM

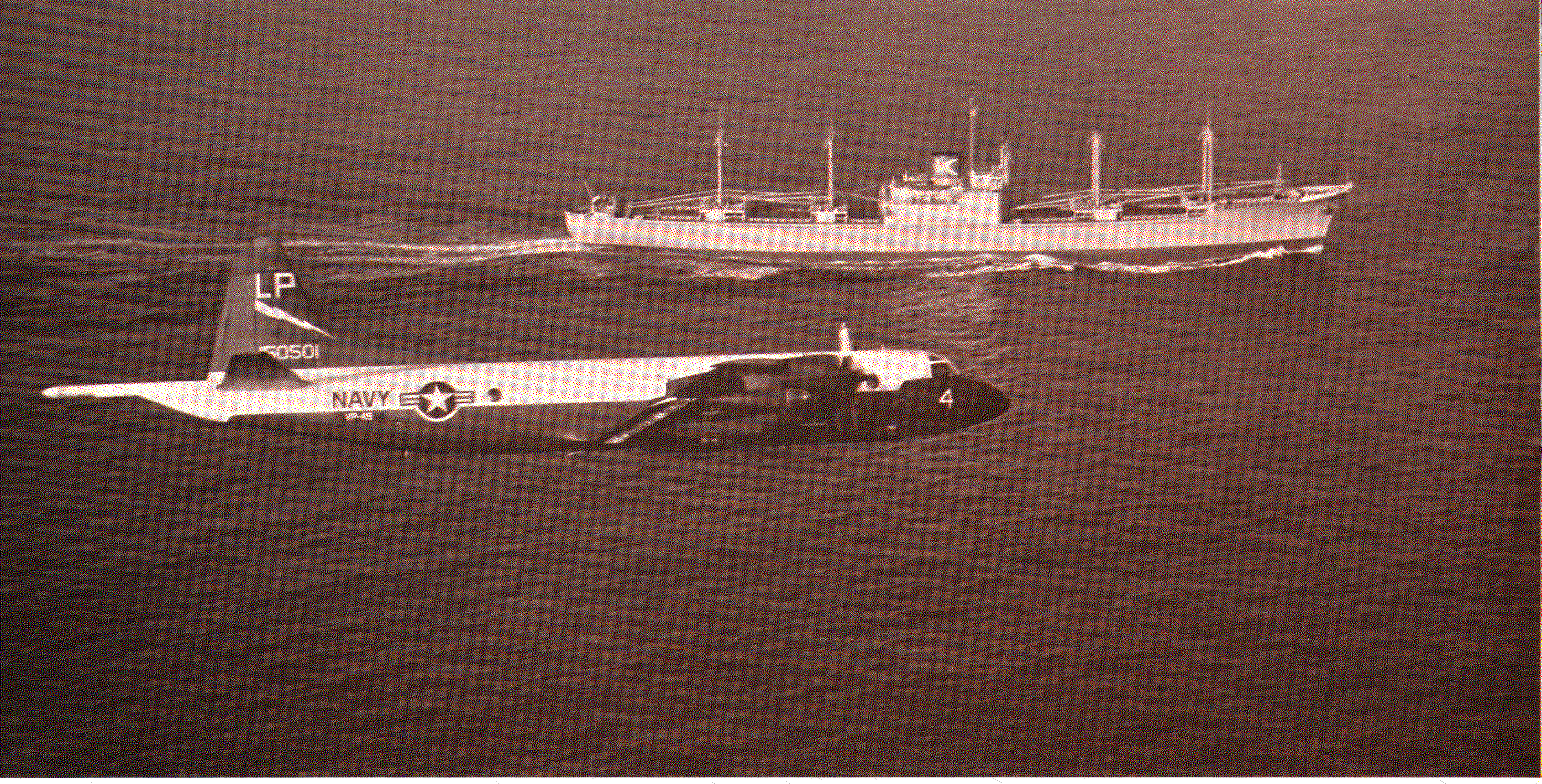
Up to this point the discussion has encompassed the general theory of operation of the wing flaps and the mechanical aspects of the flap drive and flap asymmetry system components, although supplementary material concerning the electrical nature of some of these components has been included for the sake of clarity.

Examination of the flap asymmetry system components will show that many of them are electromechanical devices, while a review of the flap drive system reveals that the only devices of this nature are the flap position transmitter and indicator. The flap drive system also has an electrical appendage to the rudder booster shutoff valve, but it has no affect on the function of the flap system circuitry.

FLAP POSITION The position of the wing flaps is indicated by an autosyn system. The transmitter is located in the hydraulic service center while the indicator is mounted on the co-pilot's instrument panel. System power comes from the 26-Volt Instrument AC Bus No. 1 in the forward load center. A 1-ampere fuse, labeled FLAP POS IND, is located on the forward load center panel, protecting the flap position indicator system circuitry. Another circuit runs from the flap position transmitter to the autopilot amplifier computer. This portion of the indicator circuitry is powered from the autopilot power supply and monitor. A schematic diagram of the circuitry is shown on Figure 16.

FLAP ASYMMETRY Components of the flap asymmetry system are installed in the wing flap wells, the hydraulic service center, the flight station, and the main cabin. The Flap System Master Diagram shows a schematic of the asymmetry electrical system about to be discussed.

The flap asymmetry system is powered from the 28-Volt Main DC Bus in the main load center through the 15-ampere L & R BK FLAP and 5-ampere LATCH RELEASE circuit breakers on the Main DC Bus circuit breaker panel. The 28-Volt Monitorable Essential DC Bus provides power in a rather devious manner to the flap asymmetry signal light in the flight station on the center instrument panel signal lights strip. Power from the dc bus goes through the 7.5-ampere SIGNAL LIGHTS CONT circuit breaker on the Monitorable Essential DC Bus circuit breaker panel, through the light control assembly, back to the Monitorable Essential DC Bus circuit breaker panel where it goes through the 5-ampere SIGNAL LIGHTS INST circuit breaker, to the FLAP ASYM signal light (which has dual lights).



If an asymmetry trip occurs, a circuit is completed from the 28-Volt Main DC Bus through the phased contacts of the two asymmetry detectors to ground. Completion of this circuit energizes the flap asymmetry latching relay, which in turn energizes the flap brake relay. (Both of these relays are on the flap asymmetry control test panel in the hydraulic service center.)

When the latching relay is energized, a circuit is completed from the Main DC Bus through the LATCH RELEASE circuit breaker to the asymmetry shutoff valve and energizes the valve's solenoid. Movement of the solenoid is transmitted to the valve spool through an over-center linkage, which places the valve in the closed position and keeps it there. Motion of this mechanical linkage also closes a switch in the flap asymmetry signal light circuit, completing the circuit to ground and causing the signal light to glow. The circuit will remain closed until the asymmetry shutoff valve is manually reset, at which time the switch is mechanically moved to the open position and the circuit is broken. Of course the signal light circuit can also be interrupted by pulling out either the SIGNAL LIGHTS CONT circuit breaker or the SIGNAL LIGHTS INST circuit breaker on the Monitorable Essential DC Bus panel in the flight station.

Meanwhile, the energized brake relay completes a circuit to the solenoid of each wing flap brake. Movement of the brake solenoid releases a ball-locking device, thereby releasing a spring loaded pressure plate which applies the brake. Both brakes are applied simultaneously.

When a brake is applied, movement of the spring loaded pressure plate actuates two limit switches that are part of the brake assembly. Actuation of the first of these switches interrupts the circuit to the brake solenoid. Actuation of the other switch completes a "back-up" circuit from the Main DC Bus through the LATCH RELEASE circuit breaker to the asymmetry shutoff valve to ensure that the valve solenoid will remain energized whenever either or both of the flap brakes are applied and electrical power is present. A conscious effort must be made to defeat the intent of this "back-up" circuit.

CLEARING ASYMMETRY TRIPS

An asymmetry trip is defined as actuation of the flap asymmetry system. Any one of a number of possible flap system component malfunctions can cause an asymmetry trip, but a trip may also be artificially induced for maintenance purposes by simply energizing the asymmetry system and then pulling downward on one of the detector drive chains. Nevertheless, once an asymmetry trip has occurred, regardless of the cause, the asymmetry system must be reset before the flaps can be safely operated.

There is always the possibility that the asymmetry system could be tripped inadvertently. This sort of thing can cause no end of perplexity to the mechanics called upon to cure the problem. The first portion of the instructions for clearing an artificial asymmetry trip may be performed to establish if the trip was inadvertently induced or if further maintenance action is required. This quick check can be performed without risk to man or machine because it is unnecessary to move the flaps manually or mechanically. Following the section on artificially induced asymmetry trips is the full treatment when the cause of an asymmetry trip is due to component malfunction.

CLEARING ARTIFICIALLY INDUCED ASYMMETRY TRIPS The first step in clearing an artificial trip is to provide electrical power to the asymmetry system circuitry. Next, open (pull out) the L & R BK FLAP circuit breaker on the Main DC Bus circuit breaker panel. Gain access to the hydraulic service center and reset the flap asymmetry latching relay by momentarily holding the reset switch to "RESET", and then:

Reset both brakes in accordance with the instructions in the Maintenance Instruction Manual (NAVWEPS 01-75PAA-2-2). The brakes are reset (released) if the red indicator pin viewed through the window on the end of the knurled reset knob is flush with the outer shaft. Close L & R BK FLAP circuit breaker. (If the brakes trip again at this point in the procedure, there is a malfunction in the flap drive or the asymmetry system. Reset the system as outlined under "Clearing Fault Induced Asymmetry Trips.")

Energize the signal lights circuitry in the flight station. The FLAP ASYM signal light on the signal light strip must be illuminated. Reset the asymmetry shutoff valve by depressing the valve lever. This action should turn off the FLAP ASYM signal light. Check the red indicator pins. If the brakes are released, safety wire the arming knobs of both brakes.

CLEARING FAULT INDUCED ASYMMETRY TRIPS Before any attempt is made to determine the cause of the asymmetry trip, open (pull out) the L & R BK FLAP and LATCH RELEASE circuit breakers. This removes electrical power from the asymmetry system.

Next the flap brakes must be reset. Refer to the Maintenance Instruction Manual (NAVWEPS 01-75PAA-2-2) when resetting the brakes. It is imperative that the brakes be released before any trouble-shooting is attempted, otherwise the brakes could be ruined if the flap drive is actuated.

Determine the cause of the asymmetry trip and take whatever corrective action is necessary. When reasonably certain that the cause of the asymmetry trip has been corrected, close (push in) the LATCH RELEASE circuit breaker. At this point, be certain that the Main DC Bus is energized. Momentarily hold the reset switch to the "RESET" position, and then close the L & R BK FLAP circuit breaker.

Manually drive the flaps at least two inches in both directions to ascertain if the flaps operate properly. This can be done by looping two or three turns of rope around one of the torque tubes, then rotating the torque tube system with the rope. In order to manually drive the flaps, the hydraulic power must be OFF and the flap position selector must be preset at some position past that shown by the indicator *in the direction that the flaps are to be moved.* If this is not done the flaps cannot be driven in the desired direction because the flap motors will be hydraulically locked. If the brakes trip again, something is still wrong with the flap drive or asymmetry system, and the preceding procedure must be repeated until the situation is rectified.

If all is well at this point, reset the asymmetry shutoff valve. As in the procedure for clearing an artificially induced asymmetry trip, this should extinguish the FLAP ASYM light on the signal lights panel in the flight station which has been glowing all this time.

Set the flap lever to the approximate position shown on the position indicator, energize *one* hydraulic pump, and carefully cycle the flaps. This operation requires one man in the flight station to manipulate the flap handle and two observers outside the aircraft—one by each wing flap. If anything of a suspicious or extraordinary nature should occur, the observers should immediately signal the man in the flight station to turn off the hydraulic pump.

As a final precautionary measure, check both flap brake indicators. If the brakes are engaged, repeat this reset procedure in its entirety. If the brakes are not engaged, safety wire the reset knobs and ground check the flaps through their full range of travel with full power. ▲ ▲

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