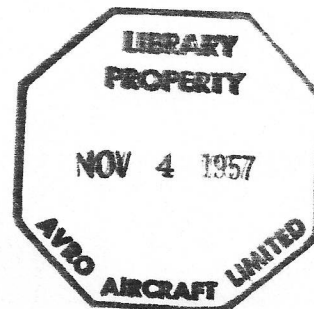




SECURITY CLASSIFICATION - SECRET

ARROW  
MAINTENANCE INSTRUCTIONS



DAMPER SYSTEM

70 MAINT 13/1

21 Oct, 57

Classification cancelled/changed to.....  
by authority of..... (date).....  
Signature..... Rank.....

Prepared:

*Johnson*  
For Maintenance and Reliability  
Section

Approved:

*B. N. Marshall*  
For Technical Design Department

Approved:

*[Signature]*  
For Equipment Design Department

Authorized:

*[Signature]*  
Project Designer

ENGINEERING DIVISION, AVRO AIRCRAFT LIMITED, MALTON, ONTARIO



SECRET

70/MAINT 13/1

### FOREWORD

This report has been prepared to provide information regarding description and maintenance of the Arrow Damper System. It is intended that the report shall serve as an indoctrination document for persons concerned with this system.

The information contained herein, reflects maintenance design objectives as of the date of publication. It must be recognized that the Damper System is presently in the development phase and that significant changes may occur before the system is delivered to the field. It is intended to maintain the report as an effective document by revising as the development program continues and as more information becomes available.

It should be noted that the Automatic Flight Control, Automatic Ground Control Interception and Automatic Ground Control Approach Sub-system will not be installed in the Arrow I aircraft, although the tie-in between the Damper System and the above mentioned sub-system is covered in this report.



SECRET

70/MAINT 13/1

TABLE OF CONTENTS

<u>Chapter</u>	<u>Para.</u>	<u>Subject</u>	<u>Page</u>
1		INTRODUCTION	1
2		DESCRIPTION	1
3		OPERATION	3
	3.1	Pitch Axis	3
	3.2	Roll Axis	12
	3.3	Yaw Axis	19
4		GROUND TEST EQUIPMENT	24
	4.1	Introduction	24
	4.2	Damper Test Set	25
	4.3	Damper Auxiliary Test Set	30
	4.4	Pitot - Static Test Set	32
	4.5	"G" Limiter Test Set	33
	4.6	Damper Test Stand	34
	4.7	Rate Table	36
5		FIRST LINE TESTING	37
	5.1	Test Equipment Required	37
	5.2	Preparation for Test	37
	5.3	Test Procedures	37
	5.4	Location of Faulty Components	47
6		SECOND LINE TESTING	62
	6.1	Damper Test Stand	62
	6.2	Rate Table	67
APPENDIX I		Damper and Associated Equipment List	70



SECRET

70/MAINT 13/1

LIST OF ILLUSTRATIONS

- FIGURE 1 Damper and Associated Equipment Location
- FIGURE 2 MH-64 Damper, Pitch Axis, Pre-engage, Gear Up or Down
- FIGURE 3 MH-64 Damper, Pitch Axis, Engage, Gear Down
- FIGURE 4 MH-64 Damper, Pitch Axis, Engage, Gear Up
- FIGURE 5 MH-64 Damper, Pitch Axis, (complete) Shown with Relay in Engage and Gear Up
- FIGURE 6 MH-64 Damper, Roll Axis, Pre-engage, Gear Up or Down
- FIGURE 7 MH-64 Damper, Roll Axis, Engage, Gear Down
- FIGURE 8 MH-64 Damper, Roll Axis, Engage, Gear Up
- FIGURE 9 MH-64 Damper, Roll Axis, (complete) Shown with Relay In Engage and Gear Up
- FIGURE 10 MH-64 Damper, Yaw Axis
- FIGURE 11 UG 6004A-1 Damper Test Set
- FIGURE 12 UG 6005A-1 Damper Auxiliary Test Set
- FIGURE 13 MB-1 Pitot-Static Test Set
- FIGURE 14 UG 6003A-1 Damper Test Stand
- FIGURE 15 UG 6002A-1 Rate Table
- FIGURE 16 Connection of Test Equipment to Aircraft



## 1. INTRODUCTION

- 1.1 Movement of the aircraft's ailerons, elevators and rudder is effected by hydraulic components which are normally controlled by electrical means. There is no provision for direct mechanical control. In the interests of safety, two independent flying control hydraulic systems are fitted.
- 1.2 There are three modes of control, the normal mode, the automatic flight mode, and the emergency mode.
- 1.3 In the normal mode, a damping system automatically stabilizes the aircraft in all three axes, and also co-ordinates rudder movement with movement of the ailerons and elevators. Control of the ailerons and elevators in this mode is by an electrical force transducer fitted in the control column.
- 1.4 In the automatic flight mode, the damping system is operative in the normal mode, but aileron and elevator position is controlled by an Automatic Flight Control Sub-system (AFCS). The AFCS allows the aircraft to be controlled from the ground for Automatic Ground Control Interception (AGCI) or for Automatic Ground Control Approach (AGGA). It also provides certain pilot assist functions by holding attitude, any set course and altitude or it may hold a set Mach number by varying the aircraft's pitch attitude. The AFCS also provides for automatic navigation by controlling the aircraft according to information fed into a dead reckoning computer by the navigator.
- 1.5 In the emergency mode, the hydraulic components for the ailerons and elevators are controlled mechanically. Yaw stabilization and rudder co-ordination are maintained by an emergency yaw damping system.
- 1.6 Pilot "feel" at the control column is provided by the damping system in the normal mode, and by mechanical means in the emergency mode.
- 1.7 A four-way push button on the control column allows for aileron and elevator trim. There are no trimmer tabs, trim being achieved by altering the position of the entire control surfaces. To reduce elevator trim drag at high altitudes, provision is made for an automatic up deflection of both ailerons.
- 1.8 If certain flight limitations are exceeded, the system automatically changes over to the emergency mode.

## 2. DESCRIPTION

- 2.1 Four distinct channels comprise the damping system; the pitch channel, which controls the elevators; the roll channel, which controls the ailerons; and the normal and emergency yaw channels, which control the rudder.



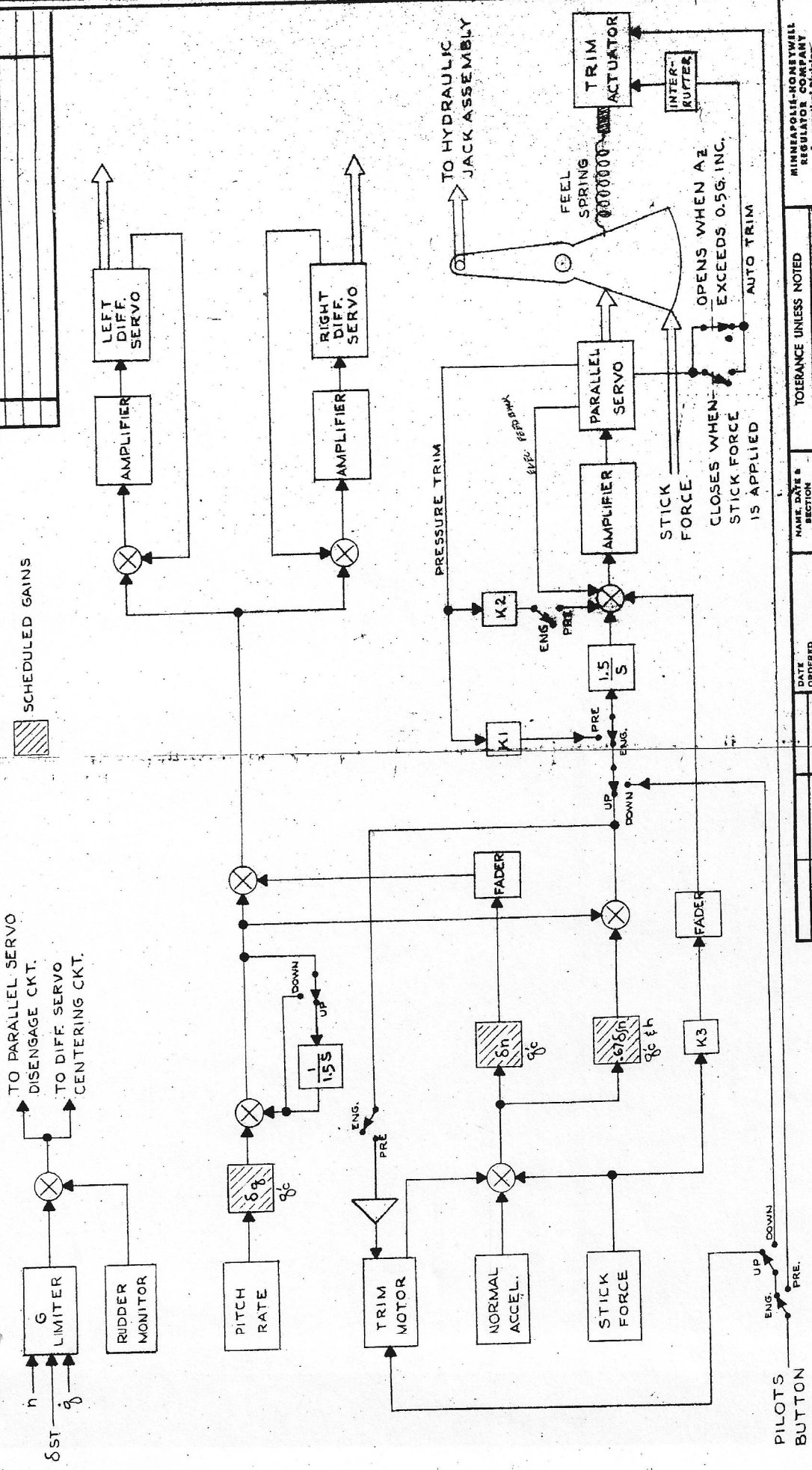
SECRET

70/MAINT 13/1

- 2.2 The switching controls for the damper system are located on a function selector panel fitted in the front cockpit LH console, and on the control column. Mounted on the function selector control panel are a POWER ON-OFF switch protected by a guard, an ENGAGE push switch for the normal mode and an EMERGENCY push-switch for engaging the emergency mode. Note that when the POWER ON-OFF switch is selected on, power is supplied to but does not engage the damper system and the AFCS. In addition, the normal mode of operation must be selected before the emergency mode of operation can be selected. Two push-switches are fitted in the control column handgrip. One switch, when operated, reverts the damper system to the emergency mode of operation, and the other switch when operated, disengages the AFCS but leaves the damper engaged. Three indicator lights fitted on the master warning system panel indicate, respectively, roll and/or pitch axis disengaged, emergency yaw damping system operative and all damping inoperative.

REV.	REVISIONS	DATE
A	ADD INTERRUPTER	7-23-52

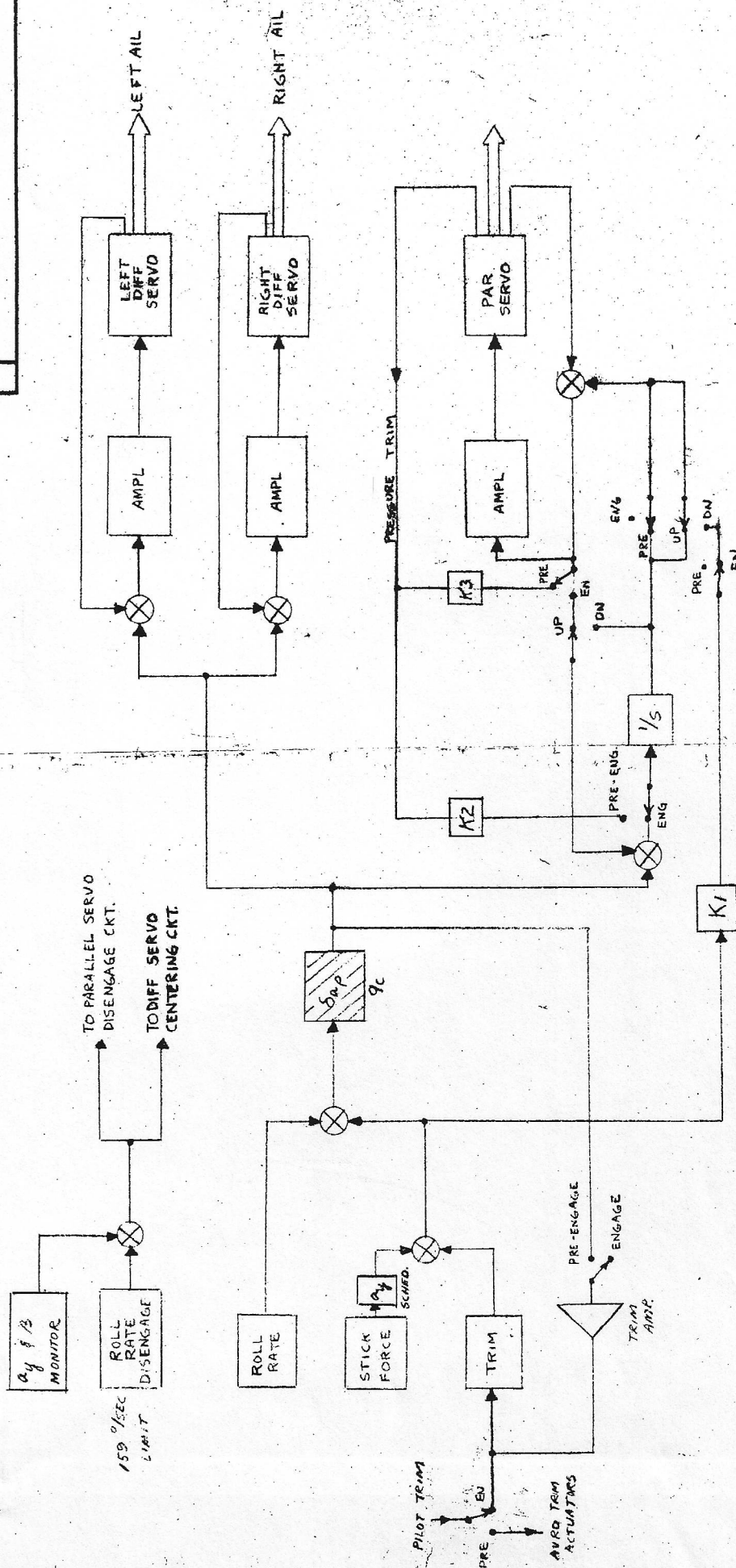
SCHEDULED GAINS



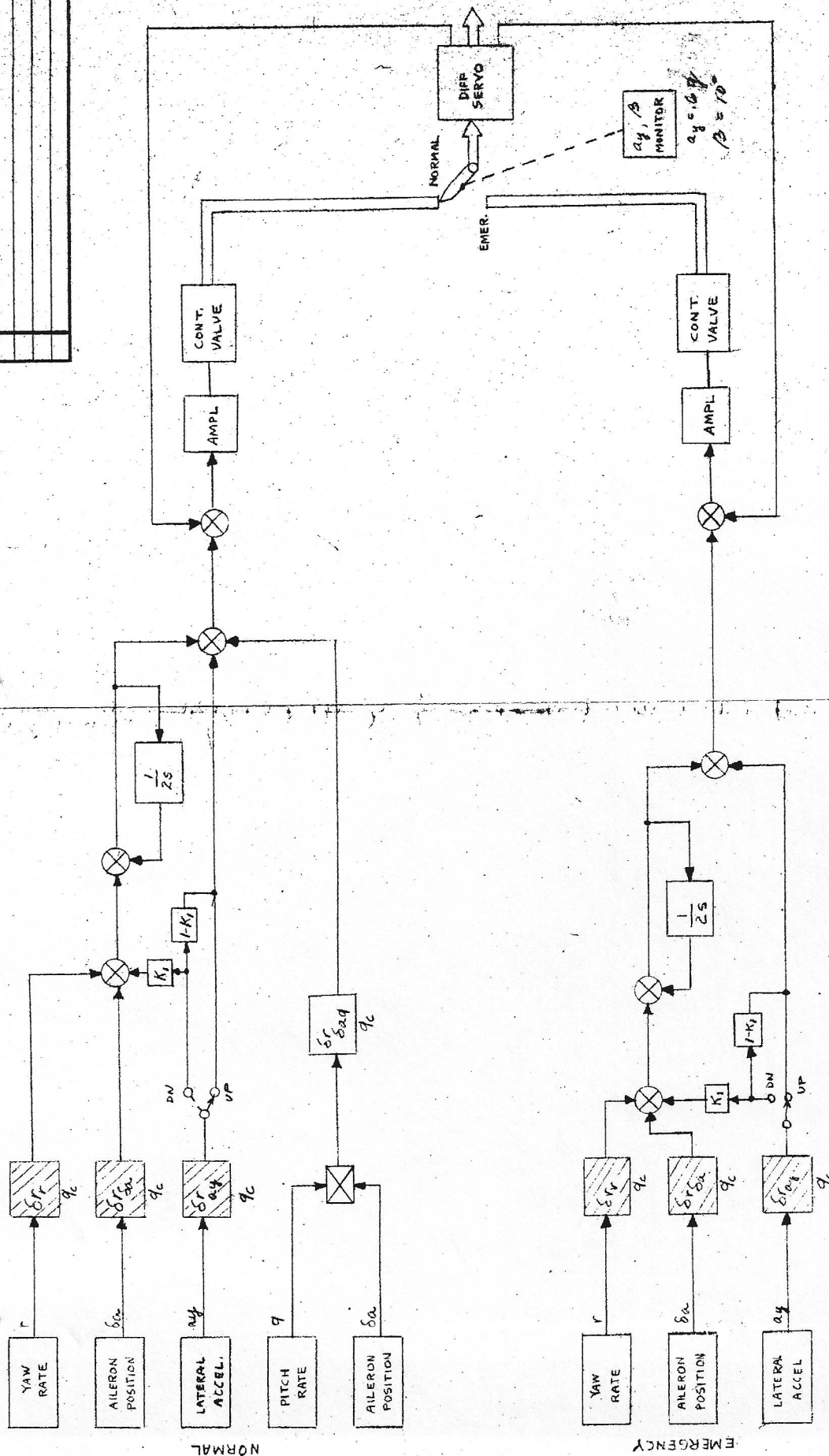
DATE ORDERED	NAME, DATE & SECTION	TOLERANCE UNLESS NOTED	MINNEAPOLIS-HONEYWELL REGULATOR COMPANY Regulator Division Minneapolis, Minnesota
QTY. REQ.	22 JAN 1957	ONE PLACE $\pm .01$ TWO PLACE $\pm .001$ THREE PLACE $\pm .0001$	AD SK 62527
TELEPHONE EXTENSION		90° FORMED $\pm .1$ ALL OTHERS $\pm .2$	DEVELOPMENT SKETCH NUMBER
REF. SPEC.			
FINISH SPEC.			
M-H MAT'L SPEC.			
MAT'L			
TOOL REF.			
REFERENCE			
EXTENSION			
FINISH SPEC.			
M-H MAT'L SPEC.			
MAT'L			
TOOL REF.			
REFERENCE			
EXTENSION			
FINISH SPEC.			
M-H MAT'L SPEC.			
MAT'L			

AD SK 62527

BLOCK DIAGRAM  
DAMPER, PITCH AXIS  
CF 105



MINNEAPOLIS-HONE		REGULATOR COMP		TOLERANCE UNLESS NOTED		NAME, DATE & SECTION	
Aeronautical Divid		Aeronautical Divid		ONE PLACE (0) ±0.05 10° FORMED ±1°		1/15/57	
Minneapolis, Minn		Minneapolis, Minn		TWO PLACE (00) ±0.10 10° ALL OTHERS ±1°		1/21/57	
AD SK625		BLOCK DIAGRAM		DAMPER, ROLL AXIS		CF 105	
DEVELOPMENT SKETCH							
DATE ORDERED		QTY. REQD.		TELEPHONE EXTENSION		FINISH SPEC.	
M-H MAT'L SPEC.		TOOL REF.		REFERENCE			
NEXT ASBY.		M-H MAT'L SPEC.					
MAT'L							

[illegible]

MINNEAPOLIS-MONETWELL REGULATOR COMPANY Ammendale, Minnesota Minneapolis, Minnesota		AD \$K-62528		DEVELOPMENT SKETCH NUMBER	
TOLERANCE UNLESS NOTED		BLOCK DIAGRAM DAMPER, YAW AXIS C/F 105			
ONE PLACE (0) ± .001 TWO PLACES (00) ± .010 THREE PLACES (000) ± .005 ALL OTHERS ± .01"		90° FORMED ± .1"			
NAME, DATE & SECTION		1/15/57			
DATE ORDERED		1/12/57			
QTY.					
RECD.					
TELEPHONE					
EXTENSION					
REFERENCE					
TOOL REF.					
NET ASBY.					
MATERIAL		M-M MAT'L SPEC.		FINISH SPEC.	
		( )		( )	

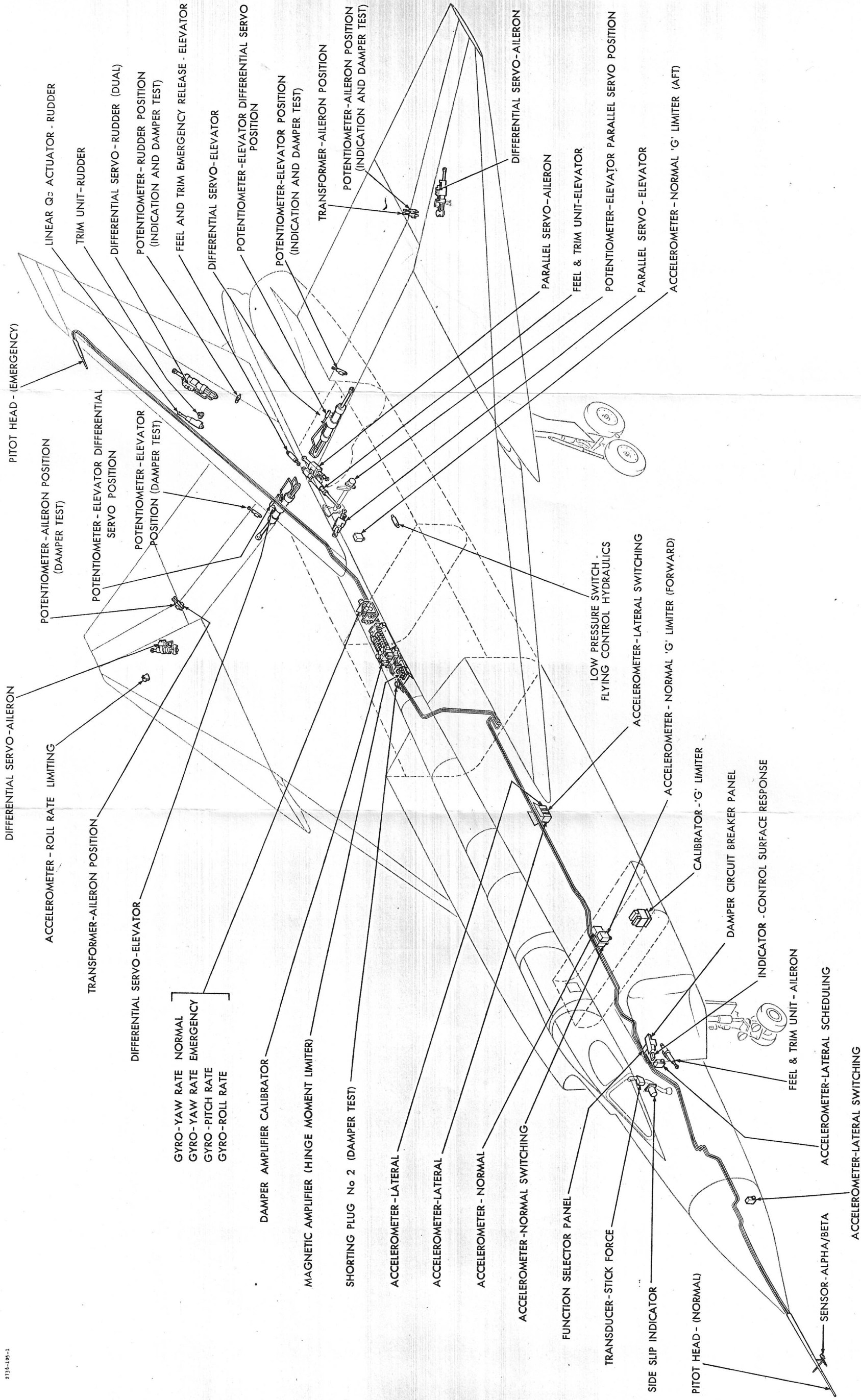


FIG. 1 DAMPER AND ASSOCIATED EQUIPMENT LOCATION



#### 4.3 UG 6005A-1 DAMPER AUXILIARY TEST SET

##### 4.3.1 Description

4.3.1.1 The UG 6005A-1 Damper Auxiliary Test Set must be used with the UG 6004A-1 Damper Test Set to isolate faulty Damper components. The Auxiliary Test Set also permits the measurement of the null voltages from the aircraft gyros and accelerometers, and currents in the servo control valves. It contains circuits allowing manually adjustable voltages other than those pre-selected by the UG 6004A-1 Damper Test Set to be applied to the Damper bridge circuits, and to the Damper scheduler units.

4.3.1.2 The UG 6005A-1 Damper Auxiliary Test Set will be of the portable "flyway" type and capable of being carried by one man. It will have the approximate dimensions:

Length	- 20 inches
Width	- 18 inches
Height	- 8 inches
Weight	- 40 lbs.

##### 4.3.2 Operation

The operation of the UG 6005A-1 Damper Auxiliary Test Set will be explained with reference to Figure 12.

4.3.2.1 Fault isolation in a Damper system is accomplished by using the VTVM (Vacuum Tube Voltmeter) and the SERVO CONTROL CURRENT indicators. When a "no-go" indication is obtained with the UG 6004A-1 Damper Test Set the UG 6005A-1 Damper Auxiliary Test Set must be used. This unit is connected to the UG 6004A-1 Damper Test Set and the portion of the test that produced the faulty output repeated. Faults in the Damper system can be isolated to either the Damper Amplifier Calibrator or the external circuitry by observing the deflection of the SERVO CONTROL CURRENT indicators. No indicator deflection indicates no output from the Damper Amplifier Calibrator and that this unit is faulty. If a deflection on SERVO CONTROL CURRENT indicators is observed that does not reduce to zero as the surface deflects, then the fault in the system is in the servo feed-back transformer, the surface position potentiometer, the inter-connecting cables, or in the hydraulic themselves.



SECRET

70/MAINT 13/1

4.3.2.2 Operation of other controls and indicators on the UG 6005A-1 Damper Auxiliary Test Set are as follows:

- (a) VTVM (Vacuum Tube Voltmeter) - Where it is necessary to measure voltages at various points in the Damper system the VTVM is used. Test points are available on the Damper Amplifier Calibrator chassis and these provide access to most of the Damper gain setting and scheduling potentiometers. Test points that are not accessible on the Damper Amplifier Calibrator are available at the pin jacks on the front of the Auxiliary Test Set.
- (b) VTVM RANGE Switch - This switch is the range selector switch normally associated with a multi-range meter.
- (c) VTVM INPUT Switch - This switch connects the VTVM to each of the sensors in turn and automatically selects the correct range on the VTVM for measuring the null voltages from the various sensors. The additional positions on the VTVM INPUT switch permits the input voltage to the "q c" schedulers to be measured and the input to the VTVM to be switched to a pair of test leads.
- (d) INPUT ADJUST Control - If it is desired to apply some inputs other than the values pre-selected on the UG 6004A-1 Damper Test Set the EXTERNAL/INTERNAL switch located on the Damper Test Set should be selected to the EXTERNAL position. This transfers control of the input signals and the scheduler inputs to the Auxiliary Test Set. The input signal may then be varied by rotating the INPUT ADJUST control until the correct value of input signal is read on the VTVM.
- (e) "q c" ADJUST PSF Selector - Any desired value of "q c" signal may be obtained by selecting the "q c" ADJUST PSF selector to the desired value. The correspondence between the position of the "q c" ADJUST PSF selector and the values of "q c" will be obtained from charts furnished with the equipment.

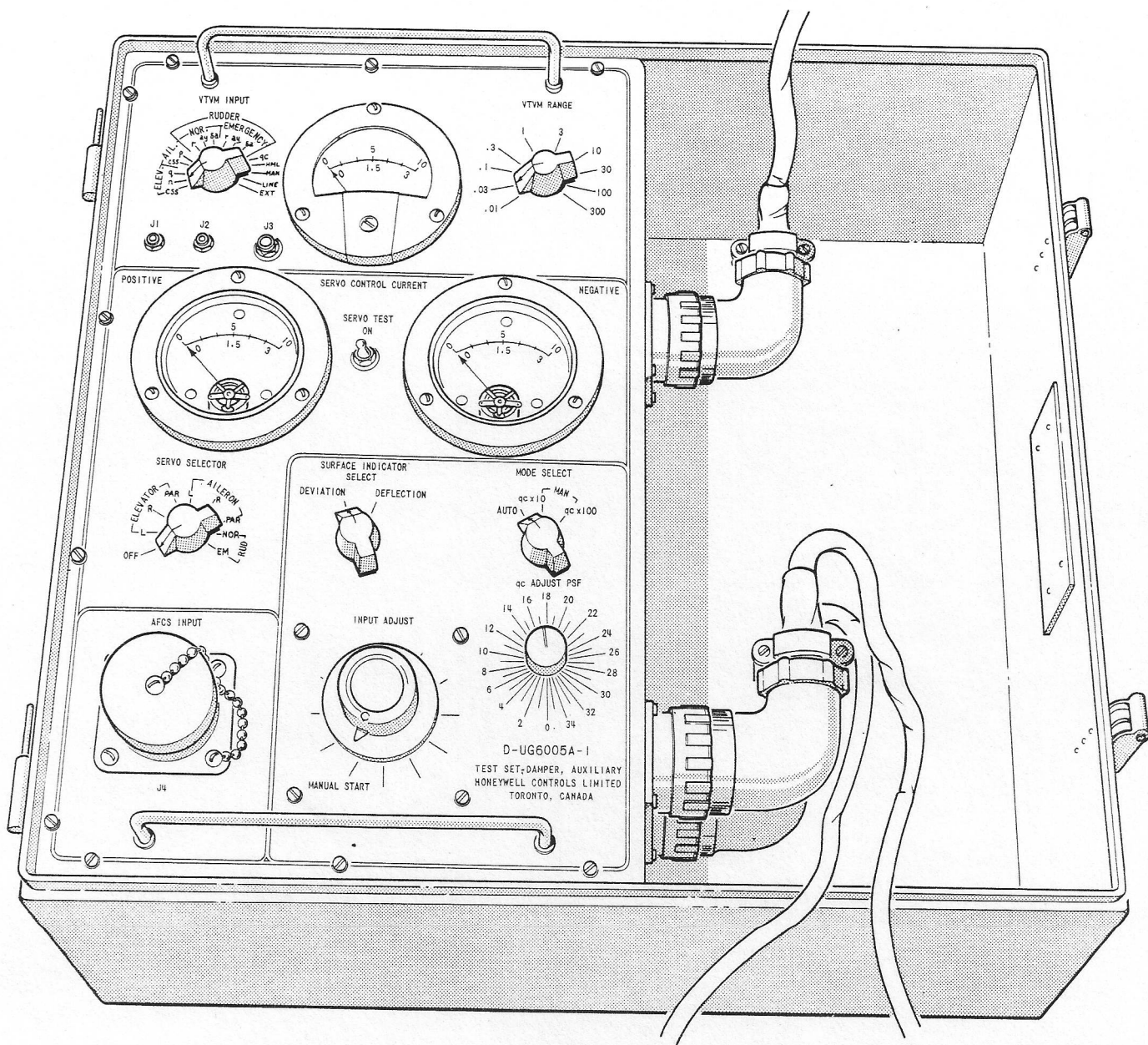
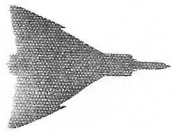


FIG. 12 UG 6005A-1 DAMPER AUXILIARY TEST SET



SECRET

70/MAINT 13/1

#### 4.4 MB-1 PITOT - STATIC TEST SET

##### 4.4.1 Description (Reference Figure 13)

4.4.1.1 The MB-1 Pitot-Static Test Set will be used to test the normal and emergency pitot-static systems.

4.4.1.2 The Test Set consists of the following equipment:

- (a) 1 hand operated vacuum pump
- (b) 1 hand operated pressure pump
- (c) 5 needle-type control valves
- (d) 1 vacuum gauge
- (e) 1 0-to 80,000 ft. altimeter
- (f) 1 machmeter (to mach. 2.5)
- (g) 1 thermometer
- (h) 1 circular slide rule type computer.

4.4.1.3 The Test Set is a portable unit enclosed in a metal carrying case which has the following dimensions:

Length	- 18 inches
Width	- 10.5 inches
Height	- 6 inches
Weight	- 23 lbs.

2805-105-1

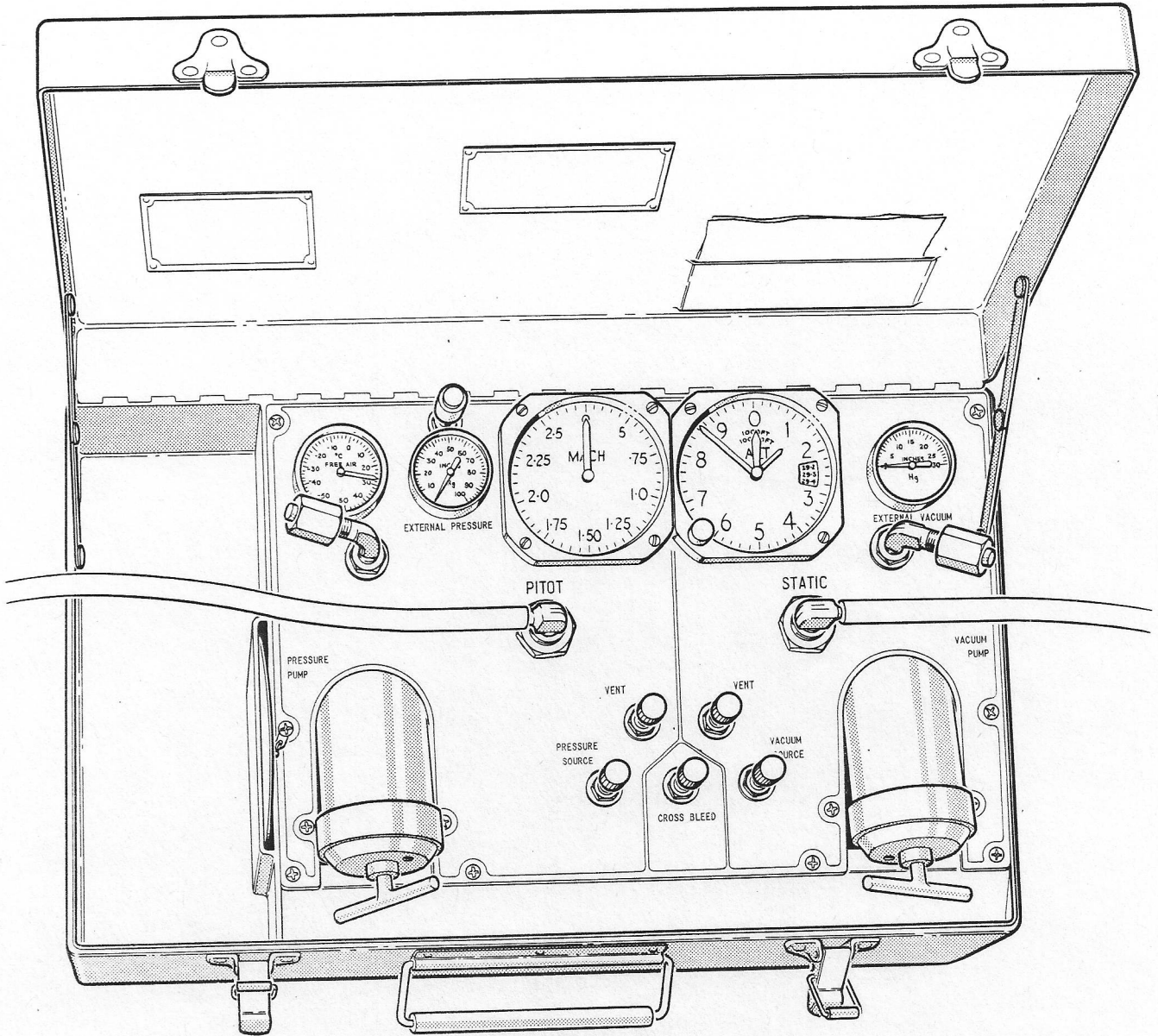


FIG. 13 MB-1 PITOT STATIC TEST SET



SECRET

70/MAINT 13/1

4.5 UG 6006A-1 "G" LIMITER TEST SET

4.5.1 Description

4.5.1.1 The UG 6006A-1 "G" Limiter Test Set will permit an independent check to be made of the "G" Limiter calibration.

4.5.1.2 The "G" Limiter Test Set is a self-contained unit and will be stored in the UG 6004A-1 Damper Test Set carrying case, it will have the following dimensions:

Length	- 5 inches
Width	- 4 inches
Height	- 6 inches
Weight	- 3 lbs.

4.5.2 Operation

4.5.2.1 It will be necessary to disconnect the accelerometers and stick force signals from the "G" Limiter Calibrator to test the "G" Limiter.

4.5.2.2 Signals simulating the outputs of the accelerometers will be applied to the "G" Limiter calibrator. A step input of pre-determined amplitude will be fed into the stick input. This signal when high-passed in the "G" Limiter Calibrator will apply a pulse to the "G" Limiter bridge causing the disconnect relay to operate .

4.5.2.3 Additional tests will apply simulated accelerometer signals to the "G" Limiter bridge to cause the disconnect relays to operate. Both the normal and emergency limiters will be checked for positive and negative "G"'s. Panel lights on the "G" Limiter Test Set will indicate proper operation of the "G" Limiter.



SECRET

70/MAINT 13/1

#### 4.6 UG 6003A-1 DAMPER TEST STAND

##### 4.6.1 Description (Reference Figure 14)

- 4.6.1.1 The UG 6003A-1 Damper Test Stand is a combination bench and transit case. Damper components are mounted on brackets which form part of the stand and are electrically interconnected by means of cables provided with the Test Stand.
- 4.6.1.2 Space is provided to mount the UG 6004A-1 Damper Test Set, and the UG 6005A-1 Damper Auxiliary Test Set on a shelf above the Damper components. Space is also provided to mount the MB-1 Pitot Static Test Set.
- 4.6.1.3 The UG 6003A-1 Damper Test Stand is of the "fly-away" type. The overall stand dimensions and weights without Damper components are approximately as follows:

Closed for transportation

Length	- 48 inches
Width	- 34 inches
Height	- 36 inches
Weight	- 200 lbs.

Open

Length	- 77 inches
Width	- 34 inches
Height	- 60 inches
Weight	- 200 lbs.

- 4.6.1.4 The power required to operate the Test Stand will be 27.5 volts d-c with an input current of 10 amps and 115 volts, three phase, 400 cps at 5 amps.

##### 4.6.2 Operation

- 4.6.2.1 The Test Stand will be used for calibrating components, confirming faulty components and pre-installation tests of a complete Damper System. It will allow gains to be adjusted, faulty components to be isolated, and the cause of the fault determined.
- 4.6.2.2 Manually adjustable feed back potentiometers are provided to replace the inductive pick-off connected to the servo unit. This will prevent saturation of the servo amplifier. In practice, a step input will be applied to the Damper System and the feedback potentiometer adjusted for minimum deflection of the SERVO CONTROL CURRENT indicators which are located on the UG 6005A-1 Auxiliary Test Set. A surface position potentiometer ganged to the feed back



SECRET

70/MAINT 13/1

4.6.2.2 (continued)

potentiometer will provide the necessary voltage for operating the SURFACE INDICATOR on the UG 6004A-1 Damper Test Set.



2807-105-1

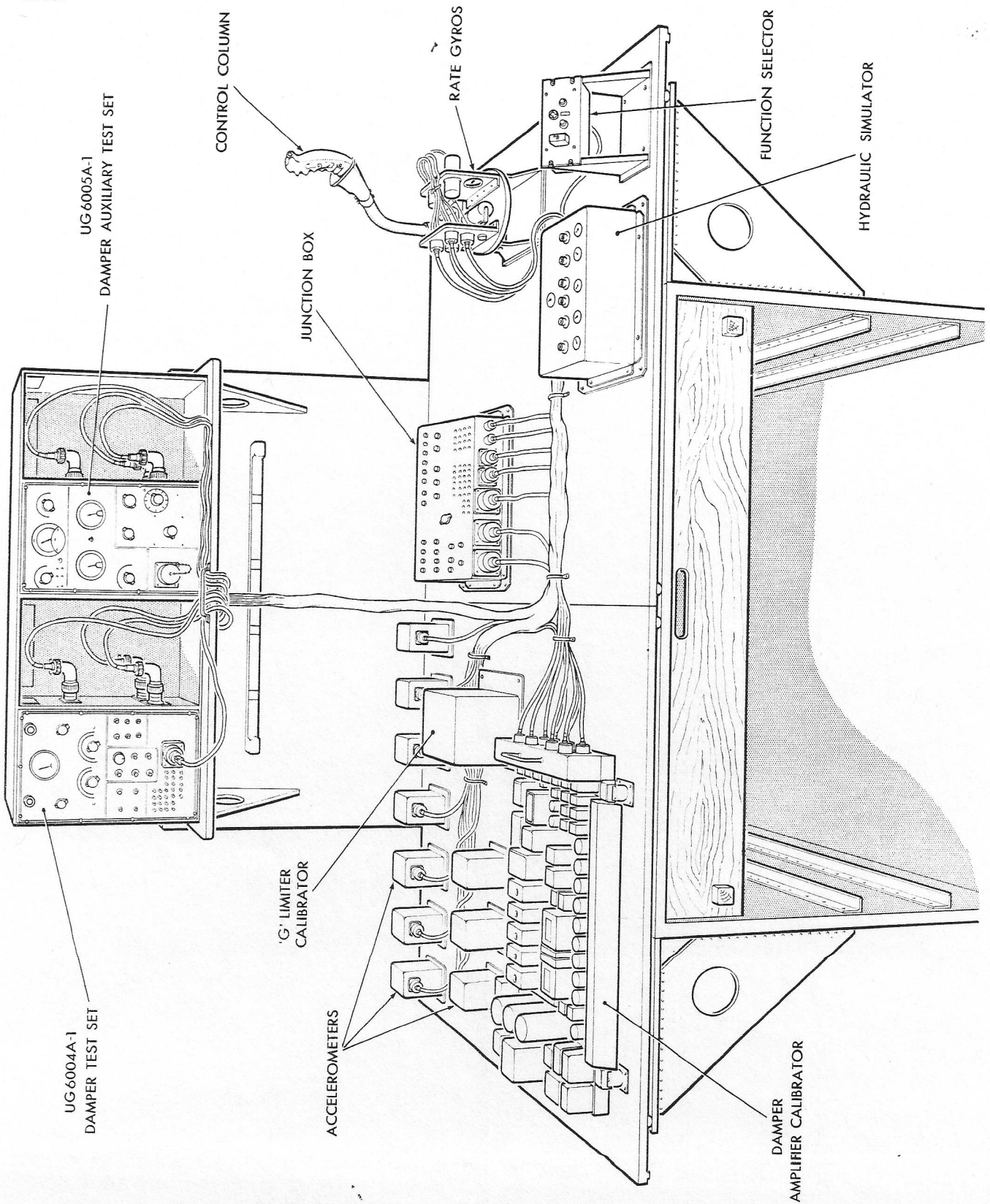


FIG. 14 UG 6003A-1 DAMPER TEST STAND



#### 4.7 UG 6002A-1 RATE TABLE

##### 4.7.1 Description (Reference Figure 15)

- 4.7.1.1 The UG 6002A-1 Rate Table is a Genisco Model 181 Rate Table mounted with an operating console in an air-transportable case that also serves as a stand.
- 4.7.1.2 The operating console contains all the switches and meters necessary to perform quantitative tests on the rate gyros and accelerometers. The gyro tests include linearity, sensitivity and maximum turning rate as well as the measurement of spin motor currents. The accelerometers can be tested for sensitivity, linearity and range. Those accelerometers that perform switching operations can be tested to ensure that their operation is within the allowable limits of performance. Provision is made to check the continuity of the heaters in those gyros and accelerometers so equipped.

- 4.7.1.3 The Rate Table approximate dimensions and weight are as follows:

Closed for transportation:

Length	- 48 inches
Width	- 48 inches
Height	- 36 inches
Weight	- 400 lbs.

Open:

Length	- 48 inches
Width	- 48 inches
Height	- 56 inches
Weight	- 400 lbs.

##### 4.7.2 Operation (Reference Figure 15)

- 4.7.2.1 The accelerometers can be tested by comparing their linearities. This can be done by mounting two accelerometers on the rotating beam and connecting them in such a manner that their outputs buck each other. A meter is provided to measure the difference in the outputs and if the outputs are within some predetermined levels the accelerometers are considered serviceable.
- 4.7.2.2 Those accelerometers that operate a switch at some preset acceleration can be tested by rotating them at a speed such that accelerations just above and below these limits are obtained. The operation, or non operation of the acceleration limit switch will be an indication of the serviceability of the accelerometer.

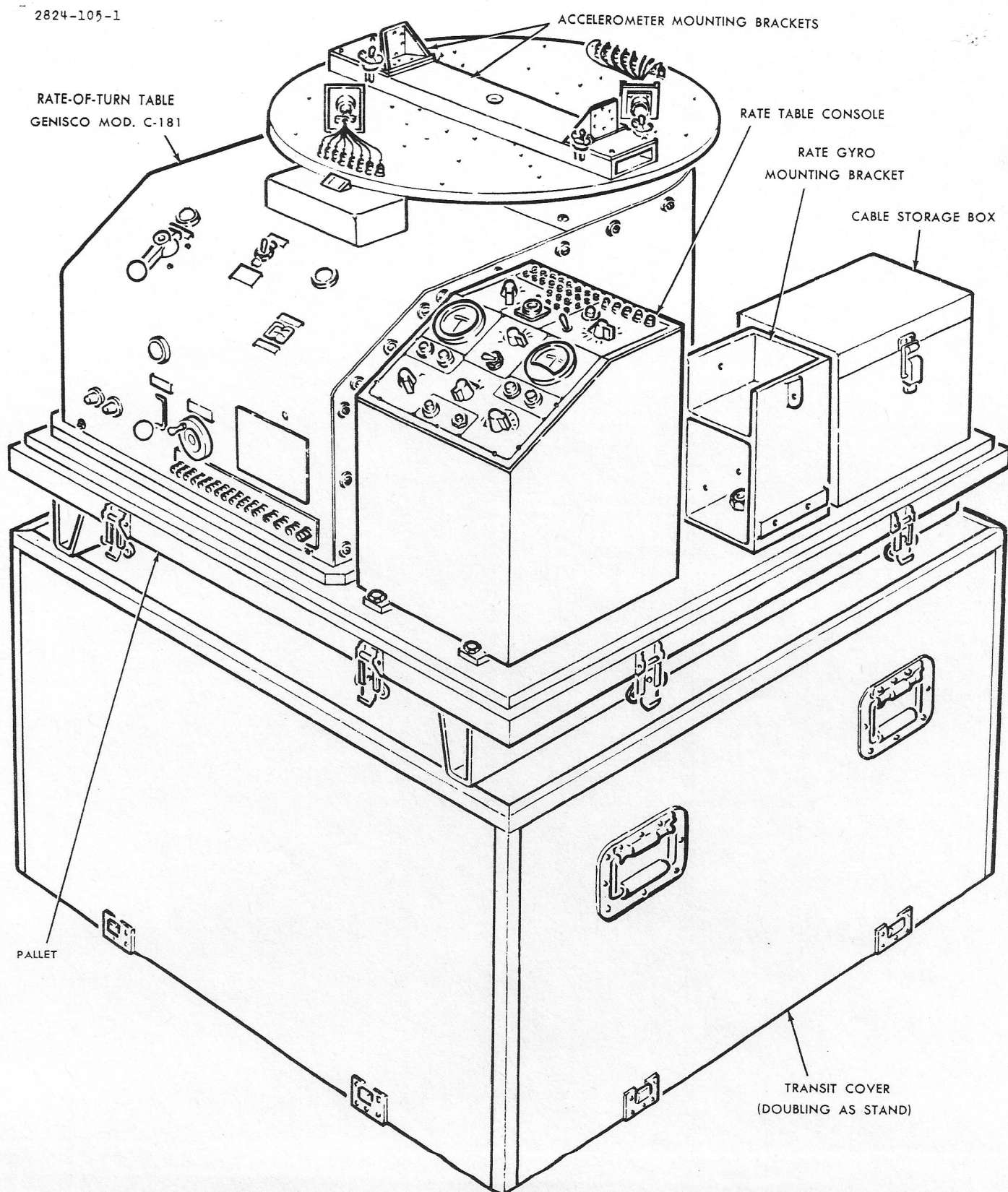
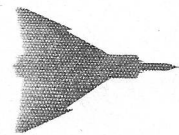


FIG. 15 D-UG6002A-1 RATE TABLE



SECRET

70/MAINT 13/1

## 5. FIRST LINE TESTING

### 5.1 Test Equipment Required

- (a) Hydraulic Test Machine Trailer
- (b) A-C Ground Power Unit
- (c) UG 6004A-1 Damper Test Set
- (d) UG 6005A-1 Damper Auxiliary Test Set
- (e) MB-1 Pitot - Static Test Set
- (d) UG 6006A-1 "G" Limiter Test Set

### 5.2 Preparation for Test

- 5.2.1 Rotate all switches on the UG 6004A-1 Damper Test Set to the left, turn all power switches OFF and centre all controls. Turn the EXTERNAL-INTERNAL switch to INTERNAL. This readies the UG 6004A-1 Test Set for checking the Damper.
- 5.2.2 With reference to Figure 15 connect the UG 6004A-1 Damper Test Set to the aircraft as follows:
  - (a) Remove connector R1087/5 from the Damper Amplifier Calibrator and connect in its place P29 from the Damper Test Set.
  - (b) Remove connector R1087/8 from the Damper Amplifier Calibrator and connect in its place P30 from the Damper Test Set.
  - (c) Remove the Damper Test Shorting Plug No. 2 and connect in its place P31 from the Damper Test Set.

This connects the UG 6004A-1 Damper Test Set to the Damper and surface position potentiometers permitting "go-no-go" checks to be made on the Damper Amplifier Calibrator, hydraulic system and control surface linkage.

- 5.2.3 Connect the A-C Ground Power Supply Unit and Hydraulic Test Machine Trailer to the aircraft.

### 5.3 Test Procedure

- 5.3.1 Select the MASTER ELECTRIC switch, located in the pilot's cockpit to the ON position.
- 5.3.2 Select the POWER switch, located on the Damper Function Selector Panel in the pilot's cockpit to the ON position.
- 5.3.3 Carry out the following on the Damper Test Set.
  - (a) Select the A-C and D-C POWER switches to the ON position and check that the POWER ON lights are illuminated.

2903-105-1

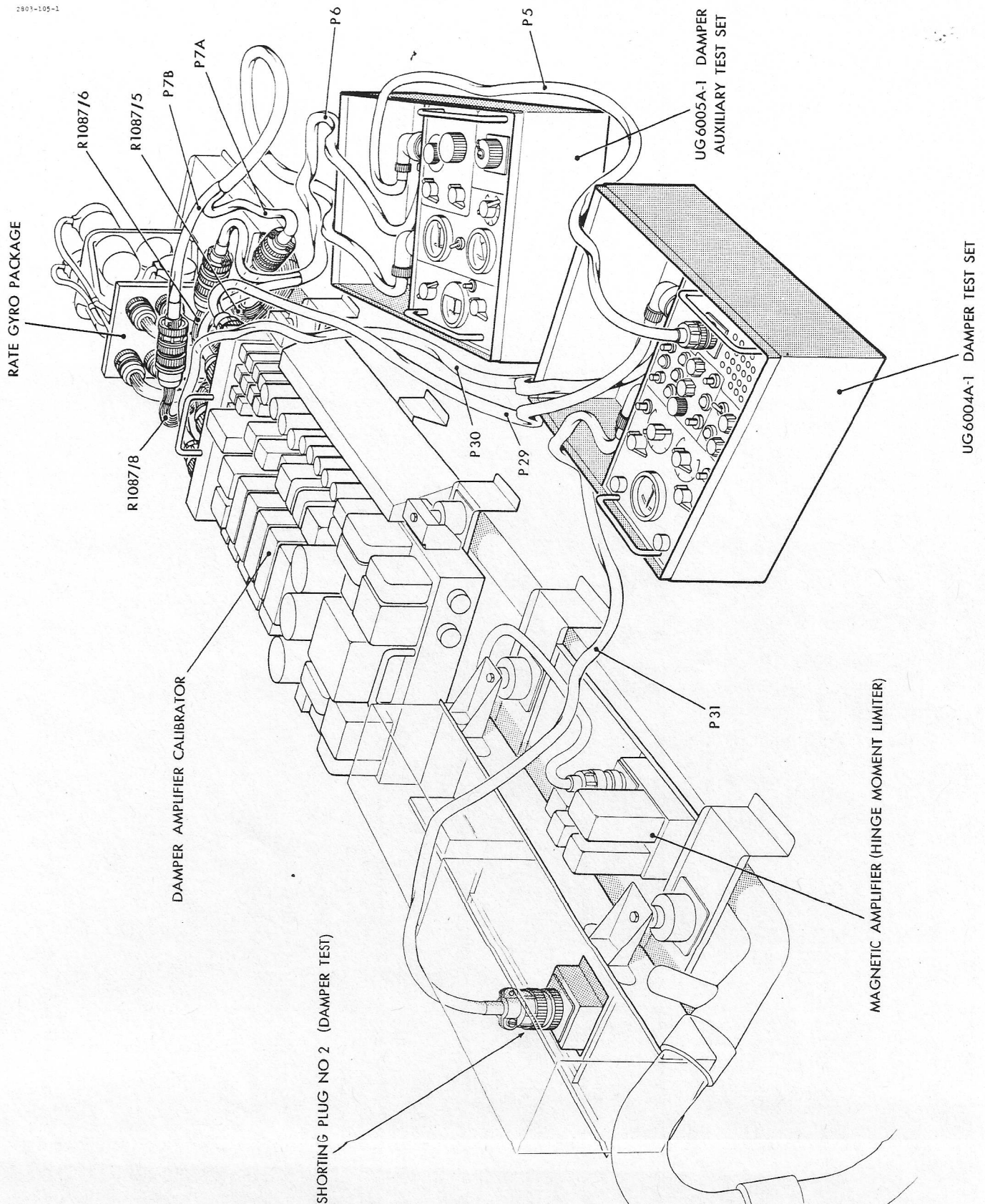


FIG. 16 CONNECTING TEST EQUIPMENT TO AIRCRAFT



SECRET

70/MAINT 13/1

- (b) Press the D-C PRESS TO ADJUST push-switch and adjust the D-C ADJUST control until the pointer of the SURFACE INDICATOR is at the D-C VOLTAGE ADJUST position.
- (c) Engage the Damper by pressing the DAMPER ENGAGE push-switch located on the Damper Test Set.
- (d) Ensure that TEST SELECTOR A is selected to the first "SL" position. With the Damper Test Set as above a zero signal is applied to the pitch axis bridge which should result in zero surface deflection producing a zero reading on the SURFACE INDICATOR. Should the control surface not be streamlined a non zero reading will be read on the SURFACE INDICATOR. This indicates residual signal in the damper bridge, faulty mechanical linkage or a faulty servo control valve operation. If the surface is only slightly off the streamline position it is quite likely that the trouble lies in faulty mechanical linkage and the procedure in sub para 5.3.4 should be followed.

5.3.4 If the SURFACE INDICATOR does not read zero adjust the ZERO LEFT TRIM control unit it does. The control index should not need to be rotated more than  $\text{---}^\circ$  in order to zero the SURFACE INDICATOR.

5.3.5 Select the ELEVATOR/AILERON switch to the "R" position and adjust the ZERO RIGHT TRIM control until the SURFACE INDICATOR reads zero. Select the ELEVATOR/AILERON switch to the "L" position. This test ensures that both the left and right elevators are in the streamline position or that the streamlining has been corrected for electrically in the test set.

NOTE:- All tests but one on the pitch axis damper will be performed by energizing the differential servos only. In addition, the tests are performed on the "gear up" configuration so that the fader potentiometer to the differential servo bridge is at its full gain end, and the parallel servo fader potentiometer is at its zero gain end. Furthermore, the output of the integrator in the parallel servo circuit is fed-back to the input of the integrator forming a high pass circuit to prevent the integrator from drifting. These precautions prevent the tests on the differential servos from being confused by such factors as improper operation of the integrator and altitude scheduler or by integrator drift. The deflection of the control surface for all tests on the differential servos will be approximately five degrees. The operation of the integrator and parallel servo will be tested at the "PD" position of the TEST SELECTOR A and the fader circuits will be tested at the PITCH GEAR DOWN position of the TEST SELECTOR B.



- 5.3.6 Select the TEST SELECTOR A to the "CSS" position. A signal voltage simulating that from the stick force transducer is injected into the pitch axis bridge causing the control surface to deflect. A second voltage is simultaneously applied to the D-DG 33A unit causing it to run to some predetermined position, automatically adjusting the gain of the Damper circuit. The combination of input voltage, manual gain, and automatic gain determines the control surface deflection. The signal voltage and scheduling voltage are set to produce a deflection of approximately  $5^{\circ}$ .
- 5.3.7 A potentiometer attached to the control surface produces an output voltage proportional to the surface deflection and this voltage is compared with a fixed voltage in the Test Set and displayed on the SURFACE INDICATOR. If the difference between these two voltages is within tolerance the needle of the SURFACE INDICATOR will deflect within the GOOD portion of the scale.
- 5.3.8 Select the ELEVATOR/AILERON switch to the "R" position, the SURFACE INDICATOR should read GOOD. Return the ELEVATOR/AILERON switch to the "L" position. This checks that the motion of the left elevator is equal to that of the right elevator.
- 5.3.9 Select the DIRECTION switch from the "+" position to the "-" position. This causes the elevators to deflect in the opposite (down) direction. A GOOD reading should be obtained on the SURFACE INDICATOR indicating that the motion of the control surface is symmetrical. Return the DIRECTION switch to the "+" position.
- 5.3.10 Select the TEST SELECTOR A to the "n" position. The SURFACE INDICATOR should read GOOD. It should be noted that it is no longer necessary to rotate the ELEVATOR/AILERON switch or the DIRECTION switch to check that the symmetry of the elevator deflection is correct since this symmetry has already been established on the "CSS" position of the TEST SELECTOR A.
- 5.3.11 Select the TEST SELECTOR A to the "q" position. A GOOD indication on the SURFACE INDICATOR should be obtained.
- 5.3.12 Select the TEST SELECTOR A to the "q h" position and press the HP-INTEGRATOR push-switch. When the TEST SELECTOR A is first selected to the "q h" position, the SURFACE INDICATOR will deflect off the scale but will gradually come back to the GOOD portion of the scale within \_\_\_\_\_ seconds after the HP-INTEGRATOR push-switch is pressed. A GOOD reading will indicate that the high pass portion of the pitch rate circuit is operating properly. During all the previous tests (except 5.3.11 above) the high pass unit has been connected to the Damper bridge in such a manner that no signal will reach the parallel servo amplifier.



SECRET

70/MAINT 13/1

5.3.12 (continued)

When the TEST SELECTOR A is selected to the "q h" position a signal simulating pitch rate is applied to the bridge causing the elevators to deflect, (the high pass unit is grounded to prevent drift) and the SURFACE INDICATOR to deflect off the scale. When the HP-INTEGRATOR switch is pressed the ground is removed and the high pass unit is connected to the bridge for \_\_\_\_\_ seconds causing the high pass unit to operate and "washing out" a portion of the input signal, thereby reducing the amount of elevator deflection. If the operation of the high pass circuit is correct, the needle of the SURFACE INDICATOR will return to the GOOD portion of the scale. This test actually checks the time constant of the high pass unit.

- 5.3.13 Select the TEST SELECTOR A to the "PD" position. The SURFACE INDICATOR should read approximately  $5^{\circ}$ . Hold down the PITCH DISENGAGE push-switch. The SURFACE INDICATOR reading should now decrease to zero. If the SURFACE INDICATOR does not return to zero but remains fixed, a faulty differential servo is indicated. If the surface deflection increases, the parallel servo is not disengaged. When a faulty differential servo is indicated it will be necessary to repeat step 5.3.13 but with the ELEVATOR/AILERON switch in the "R" position to determine if the fault is common to both differential servos.

NOTEs- Re-engage the Damper by pressing the ENGAGE push-switch.  
Return the ELEVATOR/AILERON switch to the "L" position.

- 5.3.14 Select the TEST SELECTOR A to the "SL" position and check that the SURFACE INDICATOR is at zero deviation for both left and right elevators. This test ensures the proper streamlining of the control surface before checking the pitch axis integrator.
- 5.3.15 Select the TEST SELECTOR A to the "INTEG" position and press the HP-INTEGRATOR push-switch. The SURFACE INDICATOR needle will first go off the scale but should return within the GOOD portion within \_\_\_\_\_ second if the integrator is operating properly. This test checks both the operation of the integrator and of the parallel servo, for in this case no signal is applied to the differential servo; the control surface motion being carried by the parallel servo. The integrator is tested by applying a signal of known amplitude and duration when the HP-INTEGRATOR push switch is pressed, causing the unit to run and produce a pre-determined known surface deflection.
- 5.3.16 Select the TEST SELECTOR A to the AILERON "SL" position and check that the left and right ailerons are streamlined by means of the ELEVATOR/AILERON switch as described in step 5.3.7 for the elevator. Return the ELEVATOR/AILERON switch to the "L" position. Select the TEST SELECTOR A to the "CSS" position and ensure the SURFACE INDICATOR deflects within the GOOD portion of the scale.



SECRET

70/MAINT 13/1

- 5.3.17 Select the DIRECTION switch to the " - " position and the ELEVATOR/AILERON switch to the "R" position. A GOOD reading should be obtained on the SURFACE INDICATOR indicating that control surface motion is symmetrical. Test 5.3.16 and 5.3.17 are necessary to ensure proper operation of both the left and right aileron servo systems as each is separately powered.
- 5.3.18 Select the TEST SELECTOR A to the "P" position and ensure that the deflection is GOOD. It is no longer necessary to rotate the DIRECTION switch and the ELEVATOR/AILERON switch to ensure that aileron position is symmetrical since this has already been checked in 5.3.16 and 5.3.17 and only those portions of the bridge that are common to both surfaces are now being tested.
- 5.3.19 Select the TEST SELECTOR A to the "RD" position. The SURFACE INDICATOR should read approximately 5°. Press the ROLL DISENGAGE push-switch to test the proper operation of the differential servo disengage relay. If the relay is operating properly the differential servo should become disconnected and return to a streamline position due to the satisfactory operation of the centering spring in the servo unit.
- 5.3.20 Select the TEST SELECTOR A to the "SL" position. This removes all signal inputs to the roll axis bridge and ensures that there are no spurious signals being applied to the servo amplifier. It is necessary to ensure streamlining at this point preparatory to checking the integrator.
- 5.3.21 Select the TEST SELECTOR A to the "INTEG" position. The SURFACE INDICATOR should deflect off scale as a voltage applied to the SURFACE INDICATOR representing the final deflection will not be reached until \_\_\_\_\_ seconds after the HP-INTEGRATOR push-switch is pressed. If the integrator is operating satisfactorily the control surface should slowly return to its predetermined position which will be indicated by a GOOD indication on the SURFACE INDICATOR.
- 5.3.22 Select the TEST SELECTOR A to the "TO B" position. This automatically transfers all functions from the TEST SELECTOR A to the TEST SELECTOR B. If the Test Set was originally set up properly the TEST SELECTOR B should be at its first "SL" position. Check that the streamlining is correct by ensuring that the SURFACE INDICATOR reads zero. If not, rotate the ZERO LEFT TRIM control until it does.
- 5.3.23 Select the TEST SELECTOR B to the "q δ a" position. In this position the produce term consisting of an aileron position and pitch rate is checked. This is done by deflecting the aileron a pre-determined amount and applying a test signal corresponding to pitch rate to the aileron position potentiometer.



## 5.3.23 - (continued)

The resulting signal applied to the bridge is therefore a combination of pitch rate and aileron position and the SURFACE INDICATOR should read GOOD. If a "bad" reading is obtained it is most likely due to a fault in the yaw axis bridge or the aileron position potentiometer as both pitch rate and aileron position have been previously tested.

5.3.24 Select the DIRECTION switch to the " - " position. This should cause the rudder to deflect in the opposite direction, and symmetrical operation of the rudder will be indicated by a GOOD reading on the SURFACE INDICATOR. This test need not be repeated for all subsequent tests as the rudder axis will be on portions common to the servo amplifier, and if the amplifier and control surface linkage is operating properly in both directions for one test it will obviously do the same for all.

5.3.25 Select the TEST SELECTOR B successively to the RUDDER NORMAL "r", "ay", "sa" and "HP" positions and observe that GOOD readings are obtained on the SURFACE INDICATOR.

5.3.26 Connect the Pitot-Static Test Set to the pitot head mounted on the fin of the aircraft.

5.3.27 Select the TEST SELECTOR B successively to the RUDDER EMERGENCY "SL", "r", "ay", "sa" and "HP" positions and with a differential pressure applied by the Pitot-Static Test Set as outlined in Table I for each test position, observe that GOOD readings are obtained on the SURFACE INDICATOR.

TABLE 1

Position of Test Selector B	q c	Altitudes	Mach. No.
Rudder Emerg. "SL"			
Rudder Emerg. "r"			
Rudder Emerg. "ay"			
Rudder Emerg. "sa"			
Rudder Emerg. "HP"			

5.3.28 Select the TEST SELECTOR B to the PITCH GEAR DOWN position and engage the Damper by pressing the ENGAGE push-switch. The pointer of the SURFACE INDICATOR should deflect off the scale and gradually return to the GOOD portion of the scale.



## 5.3.28 (continued)

The fact that the pointer returns slowly to GOOD indicates that the faders in the pitch axis are operating. When the TEST SELECTOR B is selected to the PITCH GEAR DOWN position, a signal is applied to the "CSS" input of the Damper Amplifier Calibrator. The mode of operation is switched to "Landing gear down" and satisfactory operation of the fader motor should be indicated by the SURFACE INDICATOR pointer deflecting to the red or "bad" portion of the scale and gradually returning to the GOOD portion. The speed of return is associated with the speed of the fader.

- 5.3.29 Select the TEST SELECTOR B to the ROLL GEAR DOWN position. A good reading should be obtained on the SURFACE INDICATOR indicating proper operation of the differential and parallel servos.
- 5.3.30 Connect the Pitot-Static Test Set to the pitot head mounted on the nose boom of the aircraft and apply a differential pressure of \_\_\_\_\_ to the normal pitot-static system.
- 5.3.31 Select the TEST SELECTOR B to the "q c NORMAL" position. A previously selected input is applied to the Damper bridge and the proper bucking voltage applied. The "q c" scheduler runs and if its operation is satisfactory it will stop at such position that the deviation on the SURFACE INDICATOR will be zero or GOOD. Therefore, a GOOD indication on the SURFACE INDICATOR means that the normal Damper mode "q c" transducer is serviceable and within tolerance.
- 5.3.32 Connect the Pitot-Static Test Set to the pitot head mounted on the fin of the aircraft.
- 5.3.33 Select the TEST SELECTOR B to the "ALT" position. Using the Pitot-Static Test Set apply a pressure corresponding to \_\_\_\_\_ feet of altitude to the pitot-static system. If a differential pressure of \_\_\_\_\_ lbs. is applied to the pitot-static system as well, the "q c" scheduler will run, and if its operation is satisfactory it will stop at such a position that the deviation on the SURFACE INDICATOR will be zero or GOOD. Therefore a GOOD indication on the SURFACE INDICATOR means that the altitude scheduler transducer is serviceable as the "q c" scheduler was previously tested.

NOTE

If good readings are obtained on each of the above steps the aircraft Damper System including the Damper Amplifier Calibrator, the servo amplifiers and the control surface linkage will be serviceable. Should a "bad" reading be obtained on any one of the above it is likely that there is an error in the calibration of one input circuit.



SECRET

70/MAINT 13/1

Note (continued)

If the deflection is off scale it is possible that one of the gain controls or scheduling potentiometers in the Damper Amplifier Calibrator is "open". The position of the TEST SELECTOR A and B will locate the faulty circuit. Should the deflection be only slightly out of the GOOD region it may be possible to adjust the offending potentiometer on the Amplifier Calibrator, (care should be taken that it is a gain potentiometer and not a "q c" potentiometer at fault. Faults in any of the other portions of the Damper System will normally be characterized by a series of "no-go" indications and the use of the UG 6005A-1 Damper Auxiliary Test Set will be required in order to isolate the faulty component. The operation of the sensors is tested with the aid of the VTVM which is part of the UG 6005A-1 Damper Auxiliary Test Set. The procedure is as follows:

- 5.3.34 With reference to Figure 16 connect the UG 6005A-1 Damper Auxiliary Test Set to the UG 6004A-1 Damper Test Set and the aircraft in the following manner:
- (a) Connect cable P5 from the Damper Auxiliary Test Set to J28 on the Damper Test Set.
  - (b) Connect cable P7A from the Damper Auxiliary Test Set to connector R1087/5 that was removed from the Damper Amplifier Calibrator.
  - (c) Connect cable P7B from the Damper Auxiliary Test Set to connector R1087/8 that was removed from the Damper Amplifier Calibrator.
  - (d) Remove connector R1087/6 from the Damper Amplifier Calibrator and connect in its place cable P6 from the Damper Auxiliary Test Set.
- 5.3.35 Turn the VTVM located on the Damper Auxiliary Test Set "on" by selecting the INTERNAL-EXTERNAL switch on the UG 6004A-1 Damper Test Set, to the EXTERNAL position.
- 5.3.36 Select the VTVM INPUT switch on the Auxiliary Test Set to measure voltages from the sensors indicated. All the readings should be below \_\_\_\_\_ volts but not zero with the exception of the "CSS" and "δ a" positions. The readings on the "CSS" and "δ a" positions will depend on force applied to the control column handgrip and on the aileron surface position respectively. A further check on the aileron position potentiometer is obtained by selecting the DIRECTION switch on the Damper Test Set to the "-" position, causing the aileron to deflect in the opposite direction. The VTVM reading on the Auxiliary Test Set will drop to zero and rise to the same value as for the "+" position. "CSS" can be checked qualitatively from the pilot's cockpit by applying a force on the control column handgrip and observing the



## 5.3.36 (continued)

deflection of the VTVM. If a quantitative check of the stick force is required it will be necessary to use a spring balance to apply a measured force on the control column handgrip and to observe the deflection of the VTVM.

- 5.3.37 The operation of the air data transducers may be further checked by applying "q c" signals to the pitot-static tube mounted on the fin of the aircraft and measuring the voltage output from the "q c" transducer. Table 2, lists values of pressures and the corresponding VTVM readings.

TABLE 2

ALTITUDE	MACH NO.	q c	VTVM READINGS

- 5.3.38 Select the VTVM INPUT switch to the "HML" position and apply a differential pressure of \_\_\_\_\_ lbs to the pitot-static head mounted on the fin of the aircraft. A reading of \_\_\_\_\_ volts should be read on the VTVM.
- 5.3.39 Surface deflection other than those preselected on the Damper Test Set may be obtained by using the MODE SELECT switch on the Auxiliary Test Set. When this switch is selected to the MANUAL position, manually adjustable voltages can be applied to each of the inputs selected by the TEST SELECTORS A and B on the Damper Test Set as required. These input voltages are adjusted by means of the INPUT ADJUST CONTROL on the Auxiliary Test Set. Values of "q c" for the normal axis scheduler can be adjusted by means of the "q c" ADJUST control on the Auxiliary Test Set. Where manual voltages are applied the Damper System it is generally desirable to measure control surface deflection rather than deviation. Deflection can be measured by selecting the DEVIATION/DEFLECTION switch on the Auxiliary Test Set to the DEFLECTION position. This will enable the control surface deflection to be measured directly on the SURFACE INDICATOR located on the Damper Test Set. (Note that the deviation and deflection readings are accurate only when the surfaces have been previously streamlined).



SECRET

70/MAINT 13/1

NOTE

In order to prevent excessive signals being applied to the Damper bridge when the MODE SELECT switch on the Auxiliary Test Set is selected to the MANUAL position it is necessary to select the INPUT ADJUST control on the Auxiliary Test Set to the MANUAL START position before a signal is applied. When the INPUT ADJUST control is selected to the MANUAL START position a relay is closed which allows this "manual adjust" signal to be applied to the Damper bridge. This is a safety feature to protect personnel working either in the pilot's cockpit, or around the control surfaces, from receiving blows from the control column or the control surface, should the test technician accidentally switch the MODE SELECT switch to the MANUAL position when the INPUT ADJUST control is set for a large signal.

- 5.3.40 Select the VTVM INPUT switch on the Auxiliary Test Set to the LINE position to read the value of the 400 cycle input voltages to the Damper.
- 5.3.41 When the VTVM INPUT switch on the Auxiliary Test Set is selected to the EXTERNAL position the input to the VTVM on the Auxiliary Test Set is connected to the VTVM INPUT jacks (J1, J2, & J3) located immediately below the VTVM INPUT switch. The equipment can then be used as a conventional VTVM for measuring voltages at various points in the Damper circuit. The voltage range of the VTVM can be selected by means of the VTVM RANGE switch located on the Auxiliary Test Set.



#### 5.4 Location of Faulty Components

The procedure to be followed in the event of a "no-go" reading on any one of the First Line tests is as follows in order of switch positions.

##### Pitch Axis (Elevators)

##### 5.4.1 SL (Streamline)

Failure to streamline within specified rotation of the TRIM control ( $\pm$  \_\_\_\_\_ %) may be caused by a malfunction of one or more of the following:

- (a) Left or right elevator differential servo.
- (b) Elevator parallel servo.
- (c) A signal in the elevator differential or parallel servo bridge
- (d) Elevator differential servo amplifier.
- (e) Elevator parallel servo amplifier.
- (f) Elevator differential servo feed-back or the elevator parallel servo feed-back.
- (g) Elevator position potentiometers.

Checks should be made in the following order.

5.4.1.1 Select the ELEVATOR/AILERON switch on the Damper Test Set to the "L" and "R" positions. If both readings are out of tolerance check the differential servo bridge and the parallel servo bridge for a signal, check the parallel servo, the parallel servo amplifier and the parallel servo feed-back. If the reading for the right differential is GOOD and the left one is at fault check the left differential servo, the left surface position potentiometers, the left differential servo feed-back and the left differential servo amplifier.

5.4.1.2 The following applies when the left reading is at fault.

- (a) To check the surface position potentiometers disengage the Damper by pressing the "P D" push-switch on the Damper Test Set. This centres the differential servo and the SURFACE INDICATOR on the Damper Test Set should readily be made to read zero by the use of the ZERO LEFT TRIM control on the Damper Test Set if the surface potentiometer is good. If the SURFACE INDICATOR cannot be made to read zero then the potentiometer is faulty or misadjusted.



- (b) The positional feed-back can be checked by connecting test leads from J1 and J2 of the Auxiliary Test Set to J27 and J28 of the Damper Amplifier Calibrator and taking a reading on the VTVM on the Auxiliary test Set. This reading should be below \_\_\_\_\_ volts, otherwise the postional feed-back is faulty.
- (c) Check the differential servo amplifier by selecting the SERVO SELECTOR switch on Auxiliary TestSet to the ELEVATOR L position and connecting test leads from J1 and J2 of the Auxiliary Test Set to J27 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read zero and the SERVO CONTROL meters on the same Test Set should read within \_\_\_\_\_ milliamps and less than \_\_\_\_\_ milliamps otherwise the differential servo amplifier is faulty.
- (d) If the surface potentiometer, the positional feed-back and the servo amplifier are satisfactory then it is likely that the differential servo is faulty. A further check on the differential servo is to engage the Damper by pressing the DAMPER ENGAGE push-switch on the Damper Test Set and since the positional feed-back, the surface potentiometer, and the servo amplifier are good, a residual signal will appear at the input to the amplifier when the servo has stopped. This will give an unbalance current into the servo control valve which will neutralize any unequal pressure built up in the faulty servo valve.

5.4.1.3 The following applies when both reachings give a "no-go" indication.

- (a) A residual signal in the bridge can be checked by connecting test leads from J1 and J2 of the Auxiliary Test Set to J28 and J80 on the Damper Amplifier Calibrator for the differential servos, and J35 and J8 for the parallel servo. The reading obtained on the VTVM on the Auxiliary Test Set should be less than \_\_\_\_\_ volts otherwise the integrator may be faulty.



SECRET

70/MAINT 13/1

5.4.1.4 If there is a residual signal in the differential servo bridge proceed as follows:

- (a) Connect test leads from J1 and J2 on the Auxiliary Test Set to J31 and J32 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set will indicate any residual signal from the bridge amplifier. If no signal is present from the bridge amplifier move the test leads from J31 and J32 on the Amplifier Calibrator to J62 and J65 of the same unit. If a signal is present, there is a residual trim signal in the bridge and it is quite likely that the trim switching amplifier, trim motor or trim circuitry is faulty.
- (b) Move the test leads from J62 and J65 of the Amplifier Calibrator to J32 and J80 of the same unit. Any signal here is due to either faulty high pass or amplifier. To eliminate high pass move the test leads to J32 and J70 of the Amplifier Calibrator and obtain a reading less than \_\_\_\_\_ volts on the VTVM on the Auxiliary Test Set if high pass is working properly.

5.4.1.5 The parallel servo positional feedback can be checked as follows:

- (a) Select the TEST SELECTOR A on the Damper Test Set to the "TO B" position and the TEST SELECTOR B of the same Test Set to the PITCH GEAR DOWN position.
- (b) Select on the Auxiliary Test Set the MODE SELECT switch to the MANUAL position, the SURFACE INDICATOR SELECT switch to the DEFLECTION position and adjust the INPUT ADJUST control until the SURFACE INDICATOR on the Damper Test Set read zero.
- (c) Measure the voltage across the servo feedback by connecting test leads from J1 and J2 of the Auxiliary Test Set to J34 and J35 of the Damper Amplifier Calibrator and taking a reading on the VTVM on the Auxiliary Test Set. If the voltage is not less than \_\_\_\_\_ volts the positional feedback is faulty.



SECRET

70/MAINT 13/1

5.4.2 CSS (Control Stick Steering)

- 5.4.2.1 A "no-go" indication on "CSS" may be the result of a faulty gain adjustment or an open bridge. The magnitude of error will be indicated by the SURFACE INDICATOR on the Damper Test Set. If it is off scale there is probably an open circuit in the bridge and if in the "no-go" portion a gain adjustment is indicated, check as follows:
- (a) Select the TEST SELECTOR A on the Damper Test Set to the "n" position and if the SURFACE INDICATOR on the Damper Test Set reads GOOD a manual gain adjustment is probably necessary.
  - (b) Select the TEST SELECTOR A on the Damper Test Set to the "CSS" position, connect test leads from J1 and J2 on the Auxiliary Test Set to J66 and J67 on the Damper Amplifier Calibrator and adjust until the VTVM on the Auxiliary Test Set reads \_\_\_\_\_ volts.
  - (c) If a "no-go" reading is obtained with the TEST SELECTOR A selected to the "n" position, select it to the "q" position and if this reading is "no-go" also, the "q c" scheduler is probably faulty.
  - (d) If a GOOD reading is obtained with the TEST SELECTOR A in the "q" position the stick force transducer and normal acceleration bridge amplifier is probably faulty.
  - (e) Select the TEST SELECTOR A on the Damper Test Set to the "CSS" position, connect test leads from J1 and J2 on the Auxiliary Test Set to J31 and J32 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set will read \_\_\_\_\_ volts if the amplifier is good.
  - (f) Move the test leads from J31 and J32 on the Amplifier Calibrator to J28 and J32 on the same unit. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts if the "q c" scheduling potentiometer setting is correct.
  - (g) A "no-go" reading with the TEST SELECTOR A on the Damper Test Set in the "q", "n" and "CSS" positions may indicate that there is an incorrect adjustment of the differential ratio potentiometer.



SECRET

70/MAINT 13/1

### 5.4.3 n (Normal Acceleration)

5.4.3.1 Since the "CSS" position is satisfactory, the bridge amplifier and the scheduler are assumed satisfactory, this leaves only the manual adjustment on "n" to be checked as follows:

- (a) Select the TEST SELECTOR A on the Damper Test Set to the "n" position and connect test leads from J1 and J2 on the Auxiliary Test Set to J62 and J67 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.

### 5.4.4 q (Pitch Rate)

5.4.4.1 With the TEST SELECTOR A on the Damper Test Set selected to the "q" position take readings on the VTVM of the Auxiliary Test Set with test leads connected to J1 and J2 on the Auxiliary Test Set and to the following on the Damper Amplifier Calibrator.

- (a) J69 and J80 the VTVM should read \_\_\_\_\_ volts if the amplifier is satisfactory.
- (b) J70 and J80 the VTVM should read \_\_\_\_\_ volts if the amplifier and the "q c" scheduling are satisfactory.
- (c) J32 and J70 the VTVM should read zero if the high-pass is working satisfactory.
- (d) J28 and J80 should read the same as J32 and J80 otherwise there is some residual signal from the "CSS" and "n" bridge amplifier into the bridge which appears across the fader potentiometer and adds to the pitch rate signal.

### 5.4.5 q h (High Pass)

5.4.5.1 Streamline the surface again by pressing the SL push-switch on the Damper Test Set.

5.4.5.2 Connect test leads from J1 and J2 on the Auxiliary Test Set to J32 and J80 on the Damper Amplifier Calibrator.

5.4.5.3 Press the HP-INTEG. push-switch on the Damper Test Set and watch the voltage indicated on the VTVM of the Auxiliary Test Set decrease from \_\_\_\_\_ volts to between \_\_\_\_\_ and \_\_\_\_\_ volts if the high pass is operating satisfactory.



## 5.4.5.3 (continued)

A reading above or below this value indicates that a timing adjustment is needed. If there is no action at all, the high pass circuit is faulty.

5.4.6 P D (Pitch Disengage)

5.4.6.1 If the SURFACE INDICATOR on the Damper Test Set reads 5° after disengagement the differential servo has not re-centred. Select to the right differential servo by selecting the ELEVATOR/AILERON switch on the Damper Test Set to the "R" position and check it. If the reading indicated by the SURFACE INDICATOR continues to rise the parallel servo has not released which indicates a faulty parallel servo disengage unit.

5.4.7 INTEG (Integrator)

5.4.7.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J63 and J80 on the Damper Amplifier Calibrator.

5.4.7.2 Streamline the surface by pressing the "SL" push-switch on the Damper Test Set.

5.4.7.3 Press the HP-INTEG push-switch on the Damper Test Set and watch the VTVM on the Auxiliary Test Set increase from zero to between \_\_\_\_\_ and \_\_\_\_\_ volts if the integrator timing is satisfactory.

Roll Axis (Aileron)5.4.8 SL (Streamline)

Failure to streamline within the specified rotation of the TRIM control ( $\pm$  %) may be caused by a malfunction of one or more of the following:

- (a) Left or right aileron differential servo
- (b) Aileron parallel servo
- (c) A signal in the aileron differential on parallel servo bridge.
- (d) Aileron parallel servo amplifier.
- (e) Aileron differential servo feed-back of the aileron parallel or servo feed-back.
- (g) Aileron position potentiometers.

Checks should be made in the following order:

5.4.8.1 Select the ELEVATOR/AILERON switch on the Damper Test Set to the "L" and "R" positions. If both readings are out of tolerance check the differential servo bridge and the parallel servo bridge for a signal,



## 5.4.5.3 (continued)

A reading above or below this value indicates that a timing adjustment is needed. If there is no action at all, the high pass circuit is faulty.

5.4.6 P D (Pitch Disengage)

5.4.6.1 If the SURFACE INDICATOR on the Damper Test Set reads 5° after disengagement the differential servo has not re-centred. Select to the right differential servo by selecting the ELEVATOR/AILERON switch on the Damper Test Set to the "R" position and check it. If the reading indicated by the SURFACE INDICATOR continues to rise the parallel servo has not released which indicates a faulty parallel servo disengage unit.

5.4.7 INTEG (Integrator)

- 5.4.7.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J63 and J80 on the Damper Amplifier Calibrator.
- 5.4.7.2 Streamline the surface by pressing the "SL" push-switch on the Damper Test Set.
- 5.4.7.3 Press the HP-INTEG push-switch on the Damper Test Set and watch the VTVM on the Auxiliary Test Set increase from zero to between \_\_\_\_\_ and \_\_\_\_\_ volts if the integrator timing is satisfactory.

Roll Axis (Aileron)5.4.8 SL (Streamline)

Failure to streamline within the specified rotation of the TRIM control ( $\pm$  %) may be caused by a malfunction of one or more of the following:

- (a) Left or right aileron differential servo
- (b) Aileron parallel servo
- (c) A signal in the aileron differential on parallel servo bridge.
- (d) Aileron parallel servo amplifier.
- (e) Aileron differential servo feed-back of the aileron parallel or servo feed-back.
- (g) Aileron position potentiometers.

Checks should be made in the following order:

- 5.4.8.1 Select the ELEVATOR/AILERON switch on the Damper Test Set to the "L" and "R" positions. If both readings are out of tolerance check the differential servo bridge and the parallel servo bridge for a signal,



SECRET

70/MAINT 13/1

(d) (continued)

valve which will neutralize any unequal pressure built up in the faulty servo valve.

5.4.8.3 The following applies when both readings give a "no-go" indication.

- (a) A residual signal in the bridge can be checked by connecting test leads from J1 and J2 on the Auxiliary Test Set to J20 and J80 on the Damper Amplifier Calibrator for the differential servo, and J59 and J80 for the parallel servo. The reading obtained on the VTVM on the Auxiliary Test Set should be less than \_\_\_\_\_ volts.

5.4.8.4 If there is a residual signal in the differential servo bridge proceed as follows:

- (a) Connect test leads from J1 and J2 on the Auxiliary Test Set to J56 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set will indicate any residual signal. If no signal is present move the test leads from J56 and J80 on the Amplifier Calibrator to J25 and J55 of the same unit. A signal here indicates there is trim voltage in the bridge and therefore a faulty trim circuit.
- (b) Move the test leads from J25 and J55 on the Amplifier Calibrator to J57 and J80 of the same unit. Any signal here indicates a faulty Roll Bridge Amplifier.

5.4.8.5 The parallel servo positional feed-back can be checked as follows:

- (a) Select the TEST SELECTOR A on the Damper Test Set to the "TO B" position and the TEST SELECTOR B on the Test Set to the ROLL GEAR DOWN position.
- (b) Select on the Auxiliary Test Set the MODE SELECT switch to the MANUAL position, the SURFACE INDICATOR SELECT switch to the DEFLECTION position and adjust the INPUT ADJUST control until the SURFACE INDICATOR on the Damper Test Set reads zero.



SECRET

70/MAINT 13/1

- (c) Measure the voltage across the servo feed-back by connecting test leads from J1 and J2 on the Auxiliary Test Set to J58 and J59 on the Damper Amplifier Calibrator and taking a reading on the VTVM on the Auxiliary Test Set. If the voltage is not less than \_\_\_\_\_ volts the positional feed-back is faulty.

#### 5.4.9 CSS (Control Stick Steering)

- 5.4.9.1 A "no-go" indication on "CSS" may be the result of a faulty amplifier or ratio adjustment. The magnitude of error will be indicated by the SURFACE INDICATOR on the Damper Test Set. If it is off scale there is probably an open circuit in the bridge and if in the "no-go" portion a gain adjustment is indicated, check as follows:
  - (a) Select the TEST SELECTOR A on the Damper Test Set to the "P" position and if the SURFACE INDICATOR on the Damper Test Set reads GOOD a manual adjustment or a "q c" adjustment is required.
  - (b) Connect test leads from J1 and J2 on the Auxiliary Test Set to J24 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts if the manual adjustment is good.
  - (c) Move the test lead from J25 on the Amplifier Calibrator to J23 on the same unit. The VTVM should read \_\_\_\_\_ volts if the manual and the "q c" setting is good.
  - (d) Move the test leads to J57 and J80 on the Amplifier Calibrator. The VTVM should read \_\_\_\_\_ volts if the bridge amplifier is satisfactory.

#### 5.4.10 P (Roll Rate)

- 5.4.10.1 If the "CSS" test was satisfactory the bridge ratio adjustment and bridge amplifier are satisfactory. Check the manual adjustment as follows:
  - (a) Connect test leads from J1 and J2 on the Auxiliary Test Set to J22 and J23 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts if the manual adjustment is correct.



- (b) Move the test leads from J22 and J23 on the Amplifier Calibrator to J23 and J56 of the same unit. The VTVM should read \_\_\_\_ volts if the "q c" is correct.

5.4.11 RD (Roll Disengage)

- 5.4.11.1- If the SURFACE INDICATOR on the Damper Test Set reads  $5^{\circ}$  after disengagement, the differential servo has not re-centred. Select to the right differential servo by selecting the ELEVATOR/AILERON switch on the Damper Test Set to the "R" position and check it. If the reading indicated by the SURFACE INDICATOR continues to rise the parallel servo has not released which indicates a faulty parallel servo disengage unit.

5.4.12 INTEG. (Integrator)

- 5.4.12.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J59 and J80 on the Damper Amplifier Calibrator.
- 5.4.12.2 Streamline the surface by pressing the SL push-switch on the Damper Test Set.
- 5.4.12.3 Press the HP-INTEG push-switch on the Damper Test Set and watch the VTVM on the Auxiliary Test Set increase from zero to between \_\_\_\_ volts and \_\_\_\_ volts if the integrator timing is satisfactory.

Normal Rudder Axis

5.4.13 SL (Streamline)

- 5.4.13.1 Carry out the following checks.
- (a) Check for zero bridge voltage by connecting test leads from J1 and J2 on the Auxiliary Test Set to J11 and J80 on the Damper Auxiliary Calibrator. The VTVM on the Auxiliary Test Set should read zero.
- (b) If the bridge voltage is not zero, move the test leads to J15 and J16 on the Amplifier Calibrator to check the high pass output. The VTVM on the Auxiliary Test Set should read zero.
- (c) If the bridge voltage is zero, select the Damper POWER. ON-OFF switch in the pilot's cockpit to first the OFF then the ON position to disengage the Damper. If the SURFACE INDICATOR on the Damper Test Set does not read zero the surface potentiometer is misadjusted.



SECRET

70/MAINT 13/1

- (d) If the surface potentiometer output is zero move the test leads from J15 and J16 on the Damper Amplifier Calibrator to J10 and J11 on the same unit. The VTVM on the Auxiliary Test Set should read less than \_\_\_\_ volts if the servo feed-back is properly adjusted.
- (e) Select the SERVO SELECTOR switch on the Auxiliary Test Set to the RUD. NOR. position and move the test leads to J10 and J80 on the Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read zero and the SERVO CONTROL CURRENT meters on the same Test Set should read within \_\_\_\_ milliamps of each other and less than \_\_\_\_ milliamps or a faulty servo amplifier is indicated.

If all the above checks prove satisfactory the servo unit must be faulty.

5.4.14 q d a (Pitch Rate Times Aileron Position)

5.4.14.1 Where a "no-go" reading has been obtained with the TEST SELECTOR B on the Damper Test Set selected to the "q d a" position carry out the following:

- (a) Select the TEST SELECTOR B on the Damper Test Set to the "Y" position. If a GOOD reading is obtained on the SURFACE INDICATOR on the Damper Test Set the fault lies with either the EGL53A-1 amplifier, the aileron potentiometer or the "q c" adjust potentiometer. If a "no-go" reading is obtained a faulty ratio adjustment potentiometer is indicated. Check this by switching the TEST SELECTOR B to the "a y" position and obtaining a "no-go" indication.
- (b) Check the EGL53A-1 bridge amplifier and the aileron potentiometer by connecting test leads from J1 and J2 on the Auxiliary Test Set to J9 and J13 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_ volts if good.
- (c) Check the "q c" setting by moving the test leads from J9 and J13 on the Amplifier Calibrator to J11 and J13 on the same unit. The VTVM on the Auxiliary Test Set should read \_\_\_\_ volts if correct.



SECRET

70/MAINT 13/1

5.4.15 r (Yaw Rate)

- 5.4.15.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J18 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts if the "q c" setting is correct.

5.4.16 a y (Lateral Acceleration)

- 5.4.16.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J13 and J15 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.
- 5.4.16.2 An incorrect reading may also be caused by the low speed switch not operating and therefore high-passing a portion of the "a y" output. Check by connecting test leads from J1 and J2 on the Auxiliary Test Set to J19 on the Damper Test Set and J15 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read zero volts.

5.4.17 a (Aileron Position)

- 5.4.17.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J16 and J18 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.

5.4.18 HP (High Pass)

- 5.4.18.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J15 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts then reduce to \_\_\_\_\_ volts if the high pass is operating properly.

Emergency Rudder Axis

5.4.19 SL (Streamline)

- 5.4.19.1 Carry out the following checks:

- (a) Check for zero bridge voltage by connecting test leads from J1 and J2 on the Auxiliary Test Set to J47 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test set should read zero.



SECRET

70/MAINT 13/1

- (b) If the bridge voltage is not zero move the test leads to J49 and J50 on the Amplifier Calibrator to check the high pass output. The VTVM on the Auxiliary Test Set should read zero.
- (c) If the bridge voltage is zero select the DAMPER POWER ON-OFF switch in the pilot's cockpit to first the OFF then the ON position to disengage the Damper. If the SURFACE INDICATOR on the Damper Test Set does not read zero the surface potentiometer is misadjusted.
- (d) If the surface potentiometer output is zero move the test leads from J49 and J50 on the Damper Amplifier Calibrator to J46 and J47 on the same unit. The VTVM on the Auxiliary Test Set should read less than \_\_\_\_\_ volts if the servo feed-back is properly adjusted.
- (e) Select the SERVO SELECTOR switch on the Auxiliary Test Set to the RUD. EMG. position and move the test leads to J46 and J80 on the Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read zero and the SERVO CONTROL CURRENT meters on the same Test Set should read within \_\_\_\_\_ milliamps of each other and less than \_\_\_\_\_ milliamps or a faulty servo amplifier is indicated.
- (f) If the above checks prove satisfactory the servo unit must be faulty. To establish if the servo is faulty, press the SERVO TEST switch on the Auxiliary Test Set and note the reading on the SERVO CONTROL CURRENT meters. If there is no change in the currents the EGL13 amplifier is faulty and if the currents fall within tolerance, the servo unit is at fault.

#### 5.4.20 r (Yaw Rate)

- 5.4.20.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J52 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts if the "q c" setting is correct.

#### 5.4.21 a y (Lateral Acceleration)

- 5.4.21.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J47 and J49 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.



SECRET

70/MAINT 13/1

5.4.21.2 An incorrect reading may also be caused by the low speed switch not operating and therefore high-passing a portion of the "a y" output. Check by connecting test leads from J1 and J2 on the Auxiliary Test Set to J20 on the Damper Test Set and J49 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read zero.

5.4.22 6 a (Aileron Position)

5.4.22.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J50 and J52 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.

5.4.23 HP (High Pass)

5.4.23.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J49 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts then reduce to \_\_\_\_\_ volts if the high-pass is operating properly.

5.4.24 PITCH GEAR DOWN

5.4.24.1 Check that the Damper is engaged by pressing the DAMPER ENGAGE push-switch on the Damper Test Set. Connect test leads from J1 and J2 on the Auxiliary Test Set to J35 and J63 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.

5.4.25 ROLL GEAR DOWN

5.4.25.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J59 and J80 on the Damper Amplifier Calibrator. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.

5.4.26 g c NCR. (Normal)

5.4.26.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J1 and J2 on the Damper Test Set. Connect the MB-1 Pitot-Static Test Set to the pitot-head mounted on the nose boom of the aircraft and apply a differential pressure of \_\_\_\_\_ PSF. The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts.

5.4.27 ALT. (Altitude)

5.4.27.1 Connect test leads from J1 and J2 on the Auxiliary Test Set to J64 and J80 on the Damper Amplifier Calibrator.



SECRET

70/MAINT 13/1

5.4.27.1 (continued)

The VTVM on the Auxiliary Test Set should read \_\_\_\_\_ volts otherwise the altitude or "q c" setting is incorrect.

NOTE

When the operation of the "qc" scheduler is suspected through a series of "no-go" readings proceed as follows:

- (a) Connect test leads from J1 and J2 on the Auxiliary Test Set to J1 on Dampener Test Set per and ground.
- (b) Select on the Auxiliary Test Set the VTVM INPUT switch to the EXT. position, the MODE SELECT switch to the MAN. "q c" x 10 position, and the "q c" ADJUST PSF switch to the \_\_\_\_\_ PSF position. The VTVM should read \_\_\_\_\_ volts if the "q c" scheduler is good.



## 6. SECOND LINE TESTING

Second line tests on the Damper System will be concerned principally with the verification of faults discovered in the equipment during the First Line tests. When a suspected component has been discovered on the aircraft it is removed and replaced with a known good one. The suspected component is then subjected to further tests on the UG 6003A-1 Damper Test Stand and/or the UG 6002A-1 Rate Table.

The test equipment required to carry out Second line testing is as follows:

- |     |            |                           |
|-----|------------|---------------------------|
| (a) | UG 6003A-1 | Damper Test Stand         |
| (b) | UG 6002A-1 | Rate Table                |
| (c) | UG 6004A-1 | Damper Test Set           |
| (d) | UG 6005A-1 | Damper Auxiliary Test Set |
| (e) | MB-1       | Pitot-Static Test Set     |
| (f) | UG 6006A-1 | "G" Limiter Test Set      |

Following are the procedures for using the Second line equipment.

### 6.1 UG 6003A-1 Damper Test Stand (Reference Figure 14)

#### 6.1.1 Preparation for Test

6.1.1.1 With all power switches in the OFF position connect the UG 6005A-1 Damper Test Set and the UG 6005A-1 Damper Auxiliary Test Set to the UG 6003A-1 Damper Test Stand as follows:-

- (a) Cable P29 and P30 from the Damper Test Set to J \_\_\_\_\_ and J \_\_\_\_\_ on the Junction Box of the Damper Test Stand.
- (b) Cable P30 from the Damper Test Set to J \_\_\_\_\_ on the Hydraulic Simulator on the Damper Test Stand.
- (c) Cable P6, P7A and P7B from the Damper Auxiliary Test Set to P \_\_\_\_ P \_\_\_\_ and P \_\_\_\_ on the Test Stand.
- (d) Cable P5 from the Damper Auxiliary Test Set to P28 on the Damper Test Set.

6.1.1.2 Select on the UG 6004A-1 Damper Test Set the EXTERNAL-INTERNAL switch to the INTERNAL position, the ZERO TRIM controls to their centre position and then the DIRECTION, ELEVATOR/AILERON and TEST SELECTOR switches to their full left position.



SECRET

70/MAINT 13/1

- 6.1.1.3 Select the POWER switch on the Damper Function Selector, located on the Damper Test Stand to the ON position.
- 6.1.1.4 Select the A-C POWER switch on the Damper Test Set to the ON position, the D-C POWER switch to the TEST STAND position and then ensure that the POWER ON lights are illuminated.
- 6.1.1.5 Adjust the D-C voltage by pressing the D-C PRESS TO ADJUST push-switch on the Damper Test Set and rotating the D-C ADJUST CONTROL on the Hydraulic Simulator, located on the Damper Test Stand until the pointer of the SURFACE INDICATOR, located on the Damper Test Set is deflected to the D-C VOLTAGE ADJUST line.
- 6.1.1.6 Obtain a simulated control surface streamline condition by selecting the TEST SELECTOR A on the Damper Test Set to the first ELEVATOR SL position. Adjust the ELEVATOR AXIS DIFFERENTIAL SERVO control on the Hydraulic Simulator to obtain a minimum reading on the SERVO CONTROL CURRENT meters on the Damper Auxiliary Test Set. This corresponds to the control surface moving to its commanded position, and the feed-back from the servo position transformer being fed into the EG 113 servo amplifier and in turn nulling out the command signal and minimizing the servo current. The SURFACE INDICATOR on the Damper Test Set should now read GOOD.
- 6.1.1.7 Select on the UG 6004A-1 Damper Test Set the ELEVATOR/AILERON switch to the "R" position and providing the SURFACE INDICATOR does not read too far off zero adjust the ZERO RIGHT TRIM until it does read zero. Should the right elevator be off streamline by a large amount a malfunction in the Servo Amplifier in the Damper Amplifier Calibrator is indicated. (See sub para 5.3.5)
- 6.1.1.8 Select the TEST SELECTOR A on the Damper Test Set to the "CSS" position. The SURFACE INDICATOR on the Damper Test Set will probably go off scale and the SERVO CONTROL CURRENT meters on the Auxiliary Test Set will read a high value. Adjust the ELEVATOR AXIS DIFFERENTIAL SERVO control on the Hydraulic Simulator to obtain minimum reading on the SERVO CONTROL CURRENT meters. The SURFACE INDICATOR on the Damper Test Set should now read GOOD.  
(This corresponds to sub-para 5.3.6)



SECRET

70/MAINT 13/1

- 6.1.1.9 Select the DIRECTION switch on the Damper Test Set from the "+" to the "-" position. This causes the elevators to deflect in the opposite (down) direction and a GOOD reading on the SURFACE INDICATOR located on the Damper Test Set confirms the symmetrical operation of the elevators. Return the DIRECTION switch to the "+" position.
- 6.1.1.10 Select the TEST SELECTOR A on the Damper Test Set to the "n" position. A GOOD reading on the SURFACE INDICATOR, located on the Damper Test Set should be obtained without having to adjust the Hydraulic Simulator more than a small amount (Refer sub-para 5.3.9).
- 6.1.1.11 Select the TEST SELECTOR A on the Damper Test Set to the "q" position. A GOOD reading on the SURFACE INDICATOR, located on the Damper Test Set should be obtained.
- 6.1.1.12 Select on the Damper Test Set the TEST SELECTOR A to the "q h" position and press the HP-INTEG push-switch. When the TEST SELECTOR A is first selected to the "q h" position the SURFACE INDICATOR pointer will deflect off scale but should come back to the GOOD portion of the scale within \_\_\_\_\_ seconds after the HP-INTEG. push-switch is pressed. A GOOD reading will indicate that the high-pass portion of the pitch rate circuit is operating properly.  
(Refer sub-para 5.3.11.)
- 6.1.1.13 Select the TEST SELECTOR A on the Damper Test Set to the "PD" position and adjust the ELEVATOR AXIS DIFFERENTIAL SERVO control on the Hydraulic Simulator for minimum current in the SERVO CONTROL CURRENT Meters on the Auxiliary Test Set. The SURFACE INDICATOR on the Damper Test Set should read approximately 5°. Press the PITCH ROLL DISENGAGE push-switch on the Damper Test Set. The SURFACE INDICATOR reading should now decrease to zero as the ELEVATOR AXIS DIFFERENTIAL SERVO control is rotated for minimum current in the SERVO CONTROL CURRENT meters. (Refer to sub-para 5.3.12).
- 6.1.1.14 Select the TEST SELECTOR A on the Damper Test Set to the "SL" position and check that the SURFACE INDICATOR on the Damper Test Set is at "zero" deviation for both left and right elevators as in Steps 6.1.1.6 and 6.1.1.7. This checks for spurious signals in the bridge before checking the operation of the pitch axis integrator. (Refer to sub-para 5.3.13).



SECRET

70/MAINT 13/1

- 6.1.1.15 Select on the Damper Test Set the TEST SELECTOR A to the "INTEG". position as in sub-para 5.3.14 and press the HP-INTEG push-switch. A "no-go" indication will be obtained on the SURFACE INDICATOR. Adjust the PITCH AXIS DIFFERENTIAL SERVO control on the Hydraulic Simulator for minimum readings on the SERVO CONTROL CURRENT meters on the Auxiliary Test Set. The SURFACE INDICATOR should now read GOOD.
- 6.1.1.16 Repeat the Tests outlined in sub-para 5.3.15 to 5.3.24 inclusive of this report, obtaining the correct surface position by adjusting the appropriate PITCH AXIS DIFFERENTIAL SERVO controls.
- 6.1.1.17 Select the TEST SELECTOR B on the Damper Test Set to the PITCH GEAR DOWN position and "engage" the Damper by pressing the DAMPER ENGAGE push-switch on the Damper Test Set. Connect test leads from J1 and J2 on the Auxiliary Test Set to test points J\_\_\_\_\_ and J\_\_\_\_\_ on the Damper Amplifier Calibrator. Select on the Auxiliary Test Set the VTVM INPUT selector to the EXTERNAL position and the VTVM RANGE switch to the \_\_\_\_\_ volt range. Operation of the differential servo fader will be indicated by the VTVM deflection reducing to zero. Select the TEST SELECTOR B to the EMERGENCY RUDDER position and then return it to the PITCH GEAR DOWN position. This disengages the servo putting the Damper in the emergency mode. Remove the test leads from J\_\_\_\_\_ and J\_\_\_\_\_ on the Damper Amplifier Calibrator and connect them to J\_\_\_\_\_ and J\_\_\_\_\_ of the same unit. Select the VTVM RANGE switch to the \_\_\_\_\_ volts position. Press the DAMPER ENGAGE push-switch on the Damper Test Set. The VTVM needle will again go from zero to approximately \_\_\_\_\_ volts, indicating that the fader in the pitch axis parallel servo circuit is operating satisfactory.  
(Refer to sub-para 5.3.27 of this report)
- 6.1.1.18 Select the TEST SELECTOR B on the Damper Test Set to the ROLL GEAR DOWN position and adjust the ROLL AXIS DIFFERENTIAL and PARALLEL SERVO controls on the Hydraulic Simulator for minimum current reading on the SERVO CONTROL CURRENT meters on the Auxiliary Test Set. (It will be necessary to select the SERVO SELECT switch on the Hydraulic Simulator from the ROLL AXIS PARALLEL position to the ROLL AXIS DIFFERENTIAL position to ensure that all servo valve currents are at a minimum). A GOOD indication should be obtained on the SURFACE INDICATOR on the Damper Test Set, indicating correct operation of both differential and parallel servos. (Refer to sub-para 5.3.28)



SECRET

70/MAINT 13/1

- 6.1.1.19 Select the TEST SELECTOR B on the Damper Test Set to the "q c NOR" position and apply a differential pressure of \_\_\_\_\_ pounds to the Pitot-Static System by means of the MB-1 Pitot-Static Test Set. Adjust the RUDDER AXIS DIFFERENTIAL SERVO control on the Hydraulic Simulator for minimum reading on the SERVO CONTROL CURRENT meters on the Auxiliary Test Set. A GOOD indication should be obtained on the SURFACE INDICATOR on the Damper Test Set indicating correct operation of the "q c" scheduler system as described in sub-paras 5.3.29 and 5.3.30.
- 6.1.1.20 Select the TEST SELECTOR B on the Damper Test Set to the "ALT". position and apply a pressure corresponding to \_\_\_\_\_ feet of altitude and a differential pressure of \_\_\_\_\_ pounds to the Pitot-Static System. Adjust the PITCH AXIS PARALLEL SERVO control on the Hydraulic Simulator for a minimum reading on the SERVO CONTROL CURRENT meters on the Auxiliary Test Set. A GOOD indication on the SURFACE INDICATOR on the Damper Test Set will signify correct operation of the altitude scheduler transducer, as the "q c" scheduler has been previously tested. (Refer to sub-para 5.3.32)
- 6.1.1.21 Qualitative operation of the sensors should be checked in a manner identical to that for the sensors on the aircraft, that is, null voltages will be measured by means of the VTVM which is part of the Auxiliary Test Set and the procedures outlined in sub-paras 5.3.33 to 5.3.36 inclusive should be followed.
- 6.1.1.22 Control surface deflections can be measured in a manner similar to that described in sub-para 5.3.38 but it will be necessary, to adjust the appropriate HYDRAULIC SERVO SIMULATOR controls for null voltage on the SERVO CONTROL CURRENT meters, in order to simulate control surface motion before reading the surface deflection on the SURFACE INDICATOR on the Damper Test Set. A faulty operation on any of the above tests should correspond to the faulty operation obtained on the aircraft, for example, if the Damper Amplifier Calibrator is the suspected component a "no-go" indication should be obtained for the same switch positions on the Damper Test Set as was obtained on the aircraft, thus confirming the location of the fault.

6.2 UG 6002A-1 Rate Table (Reference Figure 15)

- 6.2.1 Place the mounting beam on top of the turn table and fasten it down with the bolts provided. Attach the proper mounting brackets to the ends of the mounting beam. Reference should be made to Table 3 for the mounting positions of the accelerometers, the turning rates required and the readings that should be obtained.

TABLE 3

Accelerometer	Bracket and Location	Speed of Rate Table	Balance Reading	VTVM Reading

- 6.2.2 Mount two similar accelerometers at opposite ends of the beam on the appropriate brackets. Connect the cables, select the MODE SELECT switch to the BALANCE position and start the Rate Table. Select the GYRO/ACCELEROMETER switch to the ACCELEROMETER position. Gradually increase the speed of the Rate Table to the value shown in Table 3. Press the METER SENSITIVITY switch down to increase the sensitivity of the meter. The meter deflection should not vary more than  $\pm$  \_\_\_\_\_ volts throughout the range of operation. This test assures the linearity of the accelerometers and is a check for sticking wipers and a test of the maximum turning rate. Should the operation of the accelerometers be within tolerance they may be removed from the Rate Table and installed in the aircraft. This test may be repeated for all the accelerometers using the appropriate mounting brackets and mounting positions.
- 6.2.3 Should the reading between the two accelerometers exceed the allowable limits it is obvious that one of the units is faulty. In this case select the MODE SELECT switch to LEFT ACCELEROMETER position and repeat the test through the range where the faulty operation was discovered, measuring the output of the accelerometer with the VTVM at the discreet speeds indicated in Table 3. Readings corresponding to those listed on Table 3 should be obtained. If this is the case repeat the tests with the MODE SELECT switch selected to the RIGHT ACCELEROMETER position. Faulty readings should be obtained indicating that this accelerometer is non-serviceable.



- 6.2.4 Those accelerometers that have heater units will be tested by pressing the HEATER TEST push-switch and observing if the HEATER TEST lamp illuminates. Should the lamp not illuminate it will be necessary to press the lamp itself to assure that it is not burned out. Pressing the lamp completes a circuit causing the lamp to illuminate if it is serviceable.
- 6.2.5 Accelerometers that perform switching functions are tested by rotating them at a speed such that the acceleration applied is just below that required to operate the switch. The indicator lamp on the control console will not be illuminated. The speed of the turntable is then increased to a value just above that required to activate the switch and the lamp should illuminate, indicating closure of the switch in the accelerometer.
- 6.2.6 Remove the mounting beam and brackets from the turntable and store them in their position behind the control console. Place the gyro mount at the centre of the turntable using the mounting holes provided, and attach the gyro package with the base of the package parallel to the surface of the turntable. This will permit the yaw rate gyros to be tested. Set the speed of the turntable to the discreet values given in Table 4 and observe that the VTVM readings are within the limits shown in Table 4.

TABLE 4

GYRO	POSITION	SPEED	VTVM READING

- 6.2.7 Repeat the tests for the pitch rate and roll rate gyros by placing the gyro package on the mount so that the appropriate axis is activated, and setting the table speeds to the values given to Table 4, checking that the VTVM readings are again within tolerance. These tests will indicate satisfactory operation in so far as linearity, maximum turning rates and sensitivity of the various gyro units are concerned. Should a faulty operation be recorded it will be necessary to replace the faulty gyro, re-checking the calibration of the package to make sure that the alignment of the unit is correct.
- 6.2.8 If the Rate Table is connected to the Damper Test Stand by means of the cables provided and the TEST STAND RATE TABLE switch placed in the RATE TABLE position, it will be possible to feed signals directly from the sensor on the Rate Table into the Damper bridge.



SECRET

70/MAINT 13/1

6.2.8 (continued)

It will be necessary to use the Hydraulic Simulator on the Test Stand in the manner described previously in this report in order to set up the proper simulated control surface position.

6.2.9 The proper operation of the "G" Limiter System may be tested by placing the "G" Limit accelerometers on the mounting beam on the Rate Table and applying their output to the "G" Limiter Amplifier Calibrator mounted on the Test Stand. Set the "G" Limiter Accelerometers on the beam in the positions shown in Table 3 and gradually increase the speed of rotation of the Rate Table through the range shown. (The Damper should be in the ENGAGED mode). Below a value of \_\_\_\_\_ rpm the Damper should remain engaged, but, for a speed greater than \_\_\_\_\_ rpm proper operation of the "G" Limiter system will be indicated by the DISENGAGE LAMP illuminating indicating that the Damper system is disengaged.

6.2.10 Should the Damper fail to disengage it will be necessary to check the operation of the "G" Limiter by means of the UG 6006A-1 "G" Limiter Test Set. If the Damper system disengaged, faulty operation of the "G" Limiter accelerometers may be checked in the manner described in Table 3. Should the Damper refuse to disengage it is probable that the "G" Limiter Amplifier Calibrator is out of calibration. This will be indicated by the UG 6006A-1 "G" Limiter Test Set and the appropriate calibration steps can be taken.



SECRET

70/MAINT 13/1

APPENDIX I

NO. 1

DESCRIPTION	AVRO PART NO.	MANUFACTURER'S		FUNCTION
		NAME	PART NO.	
Amplifier Calibrator	7-1362-232	M.H.	D-BG92A-1	Computes and schedules Damper signals
Function Selector Panel	7-1352-117	M.H.	D-CG77A-1	Pilot's Damper control panel
Calibrator-"G" Limiter	7-1354-233	M.H.	D-BG67E-1	Computes "G" Limiting signals
Accelerometer - Lateral Scheduling	7-1352-118	M.H.	D-GG47D-1	Schedules roll rate command with lateral acceleration
Accelerometer - Normal Switching	7-1364-236	M.H.	D-GG62B-1	Cuts auto-trim above $\pm 0.5G$ on AFCS
Accelerometer - Normal "G" Limiter (FWD)	7-1354-234	M.H.	D-GG47E-2	Supplies normal acceleration and pitch acceleration signals to the "G" limiter.
Accelerometer - Normal "G" Limiter (AFT)	7-1354-234	M.H.	D-GG47E-2	Supplies normal acceleration and pitch acceleration signals to the "G" limiter.
Accelerometer - Normal	7-1354-231	M.H.	D-GG58A-1	Supplies normal acceleration signal to amplifier calibrator
Accelerometer (Lateral EMERG)	7-1354-232	M.H.	D-GG58B-1	Supplies lateral acceleration signal to amplifier calibrator
Feel and Trim Unit-Aileron	7-1552-341	AiResearch	39872-2	Provides mean for aileron artificial feel and trim
Feel and Trim Unit - Elevator	7-1562-247	AiResearch	39872-1	Provides mean for elevator artificial feel and trim

DAMPER AND ASSOCIATED EQUIPMENT LIST



SECRET

70/MAINT 13/1

APPENDIX I

NO. 2

DESCRIPTION	AVRO PART NO.	MANUFACTURER'S		FUNCTION
		NAME	PART NO.	
Accelerometer - Lateral Switching	7-1351-33	M.H.	D-GG62C-2	Disengages normal yaw damper and engages emergency damper if yaw damper parameter limits are exceeded.
Accelerometer - Lateral Normal	7-1354-232	M.H.	D-GG58B-1	Supplies lateral acceleration signal to amplifier calibrator
Accelerometer - Roll Rate Limiting	7-1364-64	M.H.	D-GG59A-1	Disengages roll axis if max. roll rate is exceeded.
Accelerometer - Lateral Switching	7-1354-229	M.H.	D-GG62C-1	Disengages normal yaw Damper and engages emergency damper if Yaw damper parameter limits are exceeded.
Feel and Trim Emergency Release Unit - Elevator	7-1562-713	AiResearch	525328	Release trimming during emergency operation
Indicator - Side Slip	7-1252-258	Buffalo Instr. Co.	25101-A3OE-1-B1	Indicate side slip angle.
Sensor - Relative Wind & Air Pressure	7-1851-21	Buffalo Instru. Company		Provide side slip and angle of attack signal to Damper system and Indicator
Indicator - Control Surface Response	7-1252-136	Daystron Ltd.	1889 Type 8	Indicate control surface response
Transducer - Stick Force	7-1552-383	Humphrey	FT01-0101-1	Provide electrical command signal to AMP. CAL ~ to Stick force
Magnetic Amplifier	7-1583-165	Garrett	47648	Amplifiers signal from "q" transducer for "q" actuator

DAMPER AND ASSOCIATED EQUIPMENT SET



SECRET

70/MAINT 13/1

APPENDIX I

NO. 3

DESCRIPTION	AVRO PART NO.	MANUFACTURER'S		FUNCTION
		NAME	PART NO.	
GYRO-Yaw Rate (Normal)	7-1362-231	M.H.	D-GG72A-1	Supplies angular displacement rate signals to AMP-CAL
GYRO - Yaw Rate (Emerg)	7-1362-231	M.H.	D-GG72A-1	Supplies angular displacement rate signals to AMP-CAL
GYRO - Pitch Rate	7-1362-234	M.H.	D-GG72A-3	Supplies angular displacement rate signals to AMP-CAL
GYRO - Roll Rate	7-1362-235	M.H.	D-GG72A-2	Supplies angular displacement rate signals to AMP-CAL
Parallel Servo - Aileron	7-3262-167	M.H.	MG-55M-2	Provides command signal to aileron control valve
Parallel Servo - Elevator	7-3262-165	M.H.	MG-55N-2	Provides command signal to elevator control valve
Differential Servo - Left Aileron	7-3260-11	M.H.	MG-51D-1	Provides damping motion signal to left aileron control valve.
Differential Servo - Right Aileron	7-3260-11	M.H.	MG-51D-1	Provides damping motion signal to right aileron control valve.
Differential Servo - Left Elevator	7-3260-11	M.H.	MG-51D-1	Provides damping motion signal to left elevator control valve.
Differential Servo - Right Elevator	7-3260-11	M.H.	MG-51D-1	Provides damping motion signal to right elevator control valve
Dual Differential Servo-Rudder	7-3283-7	M.H.	D-MG62B-1	Provides damping and turn co-ordination signals to rudder control valve.
Damper Circuit Breaker Panel	7-1282-259	Avro Aircraft		Provides wiring and equipment protection.

DAMPER AND ASSOCIATED EQUIPMENT LIST



SECRET

70/MAINT 13/1

APPENDIX I

NO.4

DESCRIPTION	AVRO PART NO.	MANUFACTURER'S		FUNCTION
		NAME	PART NO.	
Potentiometer - Left Elevator Differential Servo position	7-1162-173	Garrett		Provides signals to Damper "G" Limiter
Potentiometer - Right Elevator Differential Servo Position	7-1162-173	Garrett		Provides signals to Damper "G" Limiter
Potentiometer - Left Aileron Position	7-1164-11	Helipot Corp.	RP17-0101-1	Provides L. Aileron position to indicator. Provides L. Aileron position for ground Tests
Potentiometer - Right Aileron Position	7-1164-11	Helipot Corp.	RP17-0101-1	Provides R. aileron position to indicator. Provides R. aileron position for ground Test.
Potentiometer - Rudder Position	7-1100-21	Helipot Corp.	SX-1274	Provides rudder position to indicator. Provides rudder position for ground test
Potentiometer - Left Elevator Position	7-1100-21	Helipot Corp.	SX-1274	Provides L. Elevator position signal to indicator
Potentiometer - Right Elevator Position	7-1100-21	Helipot Corp.	SX-1274	Provides R. elevator position signal to indicator
Differential Transformer - Left Aileron Position	7-1100-23	GL Collins	LMT-1241X	Provides L Aileron position signal to Damper during normal and emergency damper operation
Differential Transformer - Right Aileron Position	7-1100-23	G.L. Collins	LMT-1241X	Provides R. Aileron position signal to Damper during normal and emergency damper operation

DAMPING AND ASSOCIATED EQUIPMENT LIST



APPENDIX I

NO. 5

DESCRIPTION	AVRO PART NO.	MANUFACTURER'S		FUNCTION
		NAME	PART NO.	
Linear "q" Actuator - Rudder	7-1583-61	AiResearch	2985-2	Provides displacement signal proportional to "q" to rudder feel unit.
Trim Actuator - Rudder	7-1583-63	AiResearch	39886	Provides trimming to rudder
Potentiometer - Elevator Parallel Servo Position	7-1358-13	M.H.	D-LG-16K-1	Supplies stick position signal to "G" Limiter

DAMPING AND ASSOCIATED EQUIPMENT LIST