M.V. HOLIDAY ISLAND

INSTRUCTION MANUAL

CONTROL SYSTEM.

for AEG 3753

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I N S T R U C T I O N M A N U A L

for AEG.3753

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I N D E X

INTRODUCTION.

This control system is designed to control the speed and direction of a double ended ferry. The pitch control levers are mounted in both bridges at either end of the ship and the Voith Schneider propellors, each powered by its own engine, are also mounted at either end of the vessel.

By the design of the propellor the thrust from the blades can be made to act in any direction, and so control not only the ahead/astern thrust but also athwart ships thrust. The controller in the bridges have a lever and handwheel to control the ahead/astern and athwart ships thrust respectively.

To assist in understanding the layout of the vessel refer to drawing AE.2508.

CHAPTER 1 - OPERATION

1.1 The system is split into two completely independent control systems with their own independent power supplies. Provision is made for automatic transfer of supply power if either of the battery supplies fail.

1.2 With the main d.c. isolator 'on' (SW1 mounted on the fuse plate) both power supplies are connected to their respective control systems and the 'control supply healthy' indicators will be illuminated (LP1 & LP3).

1.3 The following lamps will also be illuminated:

1LP2	No.1	power off indicator)	
2LP2	No.2	power off indicator)	
1LP5	No.1	control off indicator)	Engine Room
2LP5	No.2	control off indicator)	
1LP4	No.1	Barring gear out)	
2LP4	No.2	Barring gear out)	
1LP16	No.1	power off indicators)	Borden Bridge
2LP16	No.2	power off indicators)	
1LP21	No.1	power off indicators)	
2LP21	No.2	power off indicators)	Tormentine Bridge

STARTING ENGINES.

1.5 On verbal instruction from the bridge the Engineer will manually start both main engines. The main engines will be prevented from starting if the barring gear is engaged, by means of an interlock which de-energises the master air valve and so isolates the starting air.

SPEED AND POWER SETTING.

1.6 When the engines are running and the clutch engaged the speed may be set to any one of the preset speeds by setting the speed control

switch (1SW4) to the required speed step. This switch is mounted in the engine room console.

CONTROL STATION SELECTION.

1.7 If for example the Borden bridge required to take control then the following procedure will have to be followed.

1.8(a) The Commander of the Borden bridge will have to insert a key into the switch (1SW2) 'CONTROL/OFF/DEMAND/ACCEPT' switch, and select the 'Control demand' position which will have the following effects:

(1) Audible alarm in engine room.

(2) Extinguish the 'CONTROL OFF' lamp(1LP8).

(3) Illuminates the 'BORDEN CONTROL DEMANDED' indicator(1LP9).

(b) The engineer will answer the bridge demand signal by rotating the 'BRIDGE SELECTOR/ (1SW1) to the BORDEN position which will have the following effects.

(1) The 'scoop' or clutch will be engaged providing that all the interlocks are closed (i.e. Barring gear out, Gearbox oil pressure normal, propellor oil pressure normal, engine running).

(2) The audible alarm will sound on the Borden Bridge.

(3) If the clutch engages satisfactorily the 'Borden Control' indicator 1LP17 will be illuminated on the Borden Bridge.

(4) The 'Borden in Control' indicator (1L19) on the Tormentine Bridge will be illuminated.

(5) The audible alarm in the engine room will be muted.

(6) The 'POWER ON' indicators will be illuminated in the engine room and on both bridges (1LP1) (1LP15) and 1LP20.

(7) The 'POWER OFF' indicators in the engine room and both bridges will be extinguished (LP2) (1LP16) and (1LP21).

(8) The pitch control signals from the pitch control levers are connected to the electronics.(No pitch can be applied to the propellors at this stage.

NOTE: (If the 'BRIDGE SELECTOR' (1SW1) in the engine room is inadvertently selected to Tormentine then the audible alarm in the engine room will continue to sound until the correct bridge is selected.

(c) At this stage the propellor will be turning with zero pitch in all directions. The bridge now has on audible alarm and 'Power On' indication. To cancel the audible alarm the bridge must rotate the selector switch to the 'CONTROL ACCEPTED' position. The following actions will be initiated.

(1) The audible alarm will be muted in the bridge.

(2) The 'BORDEN CONTROL DEMANDED' indicator (1LP8) in the engine room will be extinguished.

(3) The zero pitch solenoids on the propellor will be energised and so allow pitch to be applied.

1.9 The Borden Bridge now has full control of the pitch on No.1 propellor.
For No.2 propellor the means of taking bridge control is exactely as described for No.1.

AHEAD/ASTERN PITCH CONTROL

1.10 The pitch control system is a closed loop system that compares the command signal with the feedback, and energises the appropiate control valve until a balance is obtained.

COMMAND SIGNAL:-

The command signal is a variable d.c. signal derived from 'Linear Variable Differential Transformers' (L.V.D.T'S) which are mechanically connected to the pitch control lever and the handwheel. The signals from either bridge station will be connected to a common 'load control amplifier' via [illegible] switch 1SW1 when the engineer selects which bridge is to take control of the ship.

LOAD CONTROL AMPLIFIER:-

The load control amplifier receives its input signals from the L.V.D.T's and passes an amplified version of these signals to the two 'command amplifiers'. There are provisions on the board for individually adjusting the gain applied to the two input signals. A third input from the engine governor is fed into the 'load control amplifier' and is only present if the engine is overloaded. This overload signal is amplified and passed through a pulsing network and superimposed onto the input signals from the L.V.D.T's. The result of this is to effectively reduce the commanded pitch signal if there is any overload on the main engine. This reduction of commanded pitch signal will be maintained so long as there is an overload on the engine.

COMMAND AMPLIFIER:-

The 'command amplifier' compares the commanded pitch signal from the 'load control amplifier' with an amplified version of the signal from the feedback L.V.D.T fitted on the propellor. If there is a difference between thesetwo signals the amplifier will energise the appropiate hydraulic valve until the feedback signal is equal to that of the commanded signal. The output signals to the hydraulic solenoids are chopped by a multivibrator when the error signal is small.
This has the effect of slowing down and stabilising the system as it approaches the commanded pitch position.

LOAD SUPPLY BOARDS:-

The electronic rack contains three identical power supply boards. These boards supply a stable regulated voltage for the following:-

Board (1) set at 24v.d.c. (supply to L.V.D.T.'S).

Board (2) set at 18v.d.c & 9v.d.c.(supply to electronics).

Board (3) set at 24v.d.c (supply to pitch indicators).

As can be seen, power supply board No.1 supplies a 24v.dc. source to all the L.V.D.T.'s in the ship. A protection circuit is fitted in the form of an over voltage trip in the output of this and

Power supply and is set to 20 volts D.c. Should the output from

the power. [illegible] supply exceed 26v.d.c. then the overvoltage sensor will put a short circuit across the output and so rupture the 1A fuse 1FS13.

For a technical description of the electronics see appendix I.

SURRENDER OF BRIDGE CONTROL:-

When the bridge wishes to surrender the controls to the engine room the following actions should be performed.

1.11(a) The Borden Command, will rotate the 'control off/demand/accept' switch (1SW2) to the 'OFF" position, which will have the following actions.

(1) The pitch will be reduced to zero because the 'zero pitch' solenoids will be de-energised.

(2) The 'Borden in Control' indicator will be extinguished(1LP17).

(3) The audible alarmson the Borden Bridge and the engine room will sound.

(4) The 'control off' indicatorsin the engine room console will be illuminated.

1.11(b) The engineer in the engine room will mute the audible alarms by switching the bridge selector to 'off'. This will have the following results.

(1) The clutch will be disengaged.

(2) The audible alarm in the engine room will be muted.

(3) The audible alarm in the bridge will be muted.

(4) The 'Borden in Control' indicator (1LP19(will be extinguished.

(5) The 'Power On' indicators will be extinguished in the engine room and on both bridges (1LP1), (1LP15 and (1LP20).

(6) The 'Power Off' indicator in the engine room and both bridges will be illuminated (1LP2) (1L116) and 1LP21.

(7) When the clutches are disengaged the speed will fall to idling speed. The ship has now reverted back to the postion where the main engines are running but all the clutches are disengaged.

AUTOMATIC CHANGEOVER OF POWER SUPPLIES:-

1.12 When the system is switched 'on' the 'control supply healthy' lamps LP1 and LP3 will both be illuminated. If at any time one of the 48v.d.c. supplies fail then the control circuits will be automatically connected to the healthy battery supply i.e. If No.1 battery voltage falls then No.1 controls will be automatically transfered to No.2 battery.

PITCH INDICATION:-

1.13 A potentiometer type transducer is coupled to both ahead/astern and althwart ship control pistons on the propellor unit. These transducers in turn operate pitch indicators on both bridges and in

SHAFT Tacho Indicator

1.14 The four bridge consoles have a shaft speed indicator driven directly from a tacho generator connected directly to the shaft.

EMERGENCY OPERATION:-

1.15 In an emergency the power pistons should be disconnected from the pitch control levers and the levers operated manually. The pitch indicators will still be operative due to the fact that the pitch transducers are directly connected to the control levers.

CHAPTER 2:-

2.1 DESCRIPTION:-

Drawings:	Circuit:	Layout:
Control chassis		AE.2512
Ahead/astern command unit		AJ.1269, AJ1270
Pitch Actuator		AJ.1146.
Fuse Plate		AE.2519.
Schematic No.1 system	L.1331 –	
Schematic No.2 system	L.1331A –	
Engine chassis & fuse plate	L.1332 –	
Interconnections of Engine		
Room console	L.1333 –	
Control Panels	L.1334 –	
External connections	L.1335 –	
Bridge control plate		AE.2535
Electronic Power supply	L.1318	
Electronic Command Amplifier	L.1317	
Electronic Load Control Amplifier	L.1316	
Schematic piping diagram for propellor control unit		AJ.1185
Control valve plate		AJ.1182
Pitch Actuator		AJ.1146
Diagramatic arrangement of propellor controls		AE.2508

CHAPTER 3:

RELAY FUNCTIONS:-

No.1 Engine Control Chassis

1RLA - remote, stop delay (delay off 50 secs.)
1RLB - energised when clutch engaged.
1RLC - energised when barring gear disengaged.
1RLD - energised when barring gear disengaged.

1RLE - energised when lubricating oil up to pressure(run signal).
1RLF - energised when propellor lub oil up to pressure.
1RLG - energised when gearbox lub oil up to pressure.
1RLH - energised when scoop dump button is depressed.
1RLJ - energised when both bridge panels are in the 'control off' position.
1RLK - energised when Borden bridge demands control.
1RLM - energised when Tormentine bridge demands control.

An identical arrangement is provided for No.2 machines but the relays are all prefixed 2RL.

POWER SUPPLY CONTROLS(FUSE PLATE).

RLA No.1 - battery supply failed remote indicator.
RLB No.1 - battery supply failed changeover relay.
RLC No.2 - battery supply failed remote indicator.
RLD No.2 - battery supply failed changeover relay.

RELAY SYMBOLS

(a) (b) (c) (d)

(a) 48v.d.c. coil 3 pole changeover.

(b) 'delay off' relay (contacts operate immediately but return after preset).

(c) 48v.d.c. coil with heavy duty contacts.

(d) 48 v.d.c. coil with heavy duty contacts.(15A).

CHAPTER 4:

RELAY CIRCUIT FUNCTIONS:

4.1 The following text is a technical description of the relay circuitry functions. To simplify the description of the circuits the following conditions will be assumed.

(a) The main D.C. isolator is on (SW1).

(b) The No.1 & No.2 'control supply healthy' indicators are illuminated.

(c) The Bridge plate control switches 1SW2 and 1SW3 are both in the 'off' position.

(d) Both machines are stationary.

(e) The Barring gear is disengaged.

(f) The clutches are disengaged.

(g) All pitch controls are in the zero position.

(H) The engine room bridge selector is "OFF" (1SW1)

4.2 If the above conditions are all fulfilled then the following relays and lamps will be energised.

RLA No.1 - battery supply healthy.
RLB No.1 - battery supply healthy.
RLC No.2 - battery supply healthy.
RLD No.2 - battery supply healthy.
1RLC because the barring gear is disengaged.
1RLD because the barring gear is disengaged.
1RLJ because both bridges are in the 'off position.

ENGINE ROOM LAMPS.

LP1 No.1 - control supply healthy.
LP2 No.2 - control supply healthy.
1LP2 Power Off.
1LP4 Barring gear out.
1LP8 Control off.

BORDEN BRIDGE LAMPS.

1LP16 - power off.

TORRENTINE BRIDGE LAMPS.

1LP21 - power off.

4.3 STARTING ENGINE:-

Because relays 1RLC and 1RLD are energised their contacts operate as follows :-

1C1 - is energised and so enables the master air valve to be energised.
1C2 - is open and so prevents the 'Barring gear In' indicator from being illuminated.
1D1 - changes over and illuminates the 'Barring gear out' indicator.
1D2 - closes and prepares part of the chain of contacts that interlock the 'scoop solenoid'.

4.4 With the master air valve energised the engine may be manually started by the engineer.

BARRING GEAR INTERLOCK

4.5 If the barring gear is engaged the two micro switches on the gear will be open and relays 1RLC and 1RLD will change state.

1C1 will open and prevent the master air valve from energising.

1C2 will be closed and so illuminate the'Barring gear in' lamp.

1D1 will be open and will extinguish the 'Barring gear out' indicator.
1D2 will be open and so prevent the 'scoop coupling from being engaged.

4.6 As can be seen if the Barring gear is engaged it is impossible to start the engine, or to engage the scoop coupling.

ENGINE RUNNING:

4.7 Assuming that the engineer starts the engine, then the lub oil pressure will rise and operate a pressure switch, which in turn will energise 1RLE.

1E1 closes and illuminates the 'engine running' indicator.
1E2 closes and makes part of the interlock chain that energises the scoop solenoid.

4.8 The engine is now running with the scoop disengaged and at idling speed.

NOTE: Although a speed setting may be selected the engine will not respond to the setting until the clutch is engaged.

GEARBOX OIL PRESSURE & PROPELLOR OIL PRESSURE INTERLOCKS.

4.9. Before the bridge can take control the engineer must start the standby oil pumps on the gearbox and the propellor.

If the gearbox oil pressure reaches normal pressure then it will actuate an oil pressure switch and energise relay 1RLG.

1G1 - changes over and illuminates the 'gearbox oil up to pressure' indicator (1LP7).
1G2 - closes and prepares part of the interlock chain for the scoop solenoid.

4.11 When the propellor oil pressure builds up and actuates the pressure switch it will energise relay 1RLF.

1F1 - changes over and illuminates the 'Propellor oil up to pressure' indicator.
1F2 - closes and prepares part of the scoop coupling interlock.

The engineer has now prepared the machines so that the bridge can take control as desired.

BRIDGE DEMAND CONTROL:-

4.12 If the Borden bridge wishes to take control of the ship then the Commander must place the key into the selector switch (1SW2) and rotate it to the 'DEMAND' position. This will result in the following actions.

(a) The 'Borden control demanded' indicator (1LP9) in the engine room will be illuminated.

(b) Relay 1RLK will be energised.

(c) Relay 1RLJ will be de-energised.

1K1 - closes and sounds the audible alarm.

1J1 - changes over and de-energises the 'control off' indicator 1LP8.

1J2 - opens but has no effect at this stage.

4.13 The engine room now has visual (1LP9) and audible alarms. To mute the audible alarm the engineer will rotate the 'bridge selector' (1SW1) to 'Borden bridge'.

The various sections of the switch will have the following effects:-

(a) Section 1(1SW1) - will close and switch a positive feed to energise the scoop engage solenoid if the following interlocks have been fulfilled.

contact 1H1 closed (no emergency stop present).
contact 1F2 closed (engine running).
contact 1F2 closed (propellor oil up to pressure).
contact 1G2 closed (gearbox oil up to pressure).
contact 1D2 closed (barring gear disengaged).

(b) Section 2 (1SW1) - closes and prepares 1RLH to be operated by the emergency dump buttons.

(c) Section 3 (1SW1) - closes and switches a positive feed, via switch (1SW2) on the bridge, to the Borden Bridge audible alarm.

(d) Section 4 (1SW1) - closes and switches a positive signal to illuminate the 'Borden in control' indicator (1LP19) on the Tormentine Bridge.

(e) Section 5 (1SW1) - changes to the Borden position and de-energised 1RLK. 1RLK is de-energised because the positive supply is blocked by a reverse biased diode.

(f) Section 6 (1sW1) - has no effect at this stage.

(g) Section 7 (1SW1) - connects the Borden Bridge ahead/astern pitch signals to pin no.24 on the 'load control' amplifier.

(h) Section 8 (1SW1) - connects the Borden Bridge athwart ships pitch signals to pin No.22 on the 'load control amplifier'.

4.14 If in 4.13(a) the clutch engages then the micro switch on the clutches will change state as follows.

(a) As the clutch disengages the 'power Off' indicators in the engine room and on both bridges will be extinguished 1LP2, 1LP16 and 1LP21.

(b) As the clutch engages relay 1RLB will be energised.

contact 1B1 closes and illuminates the 'power on' indicator 1LP1
contact 1B2 closes and illuminates the 'power on' indicators on both bridges 1LP15 and 1LP20.
contact 1B3 closes but has no effect because the selector switch 1SW1 is in the 'borden' position.
contact 1B4 closes and connects a positive feed (via 1SW2) to illuminate the 'Borden in control' indicator, 1LP17 on the Borden Bridge.
contact 1B5 closes and prepares to energise the zero pitch solenoids via bridge selector switches 1SW2 and 1SW3.
contact 1B6 changes over and prevents the barring gear from inadvertently being engaged while the engine is running.
contact 1B7 closes and enables the engineer to select the desire engine speed.

4.15 The clutch is now fully engaged and the state of the instruments on the bridge will be as follows:-

'Power off' lamp	1LP16	-	extinguished.
'Power on.' lamp	1LP15	-	illuminated.
'Tormentine in control'	1LP14	-	extinguished.
'Borden in control'	1LP17	-	illuminated.
'Selector switch'	1SW2	-	in the 'demand' position.
'Shaft tachometer'		-	registering shaft revolutions.
'Audible alarm'		-	sounding.

NOTE: At this stage no pitch can be applied.

4.16 To mute the audible alarm the switch 1SW2 on the bridge should be set to the 'accept' position.
This will have the following results.

(a) Section 1 (1SW2) opens and mutes the audible alarm on the bridge.

(b) Section 2 (1SW2) does not change state.

(c) Section 3 (1SW2) opens and extinguishes the 'Borden control demanded' indicator (1LP9) in the engine room console.

(d) Section 4 (1SW2) does no change state.

(e) Section 5 (1SW2) does not change state.

(f) Section 6 (1SW2) closes and energises the zero pitch solenoid.

NOTE: When ever the zero pitch solenoid is energised it allows the pitch to be applied.

4.17 The Borden Bridge is now in full control of the ship with control over both ahead/astern and athwartships pitch.
Although the text has described the procedure with the Borden Bridge and No.1 machine the procedure is exactly the same for the Tormentine Bridge.
The No.2 machine can be operated from either bridge and the control system is an exact replica of the No.1 controls.

COMMAND PITCH INDICATION:

4.18 The athwart ships pitch controller is in the form of a 6 turn handled. The neutral position is located by an indent and a spring loaded roller. The intermediate pitch positions are indicated on a milliamp meter which is powered from a potentiometer driven directly from the handwheel. There are two adjustments on the potentiometer chain.

1RV3 potentiometer adjusts the zero or neutral point.

1RV5 potentiometer adjusts the range of the meter.

The resistance network is driven from a stabilised 24v power supply.

APPLIED PITCH INDICATORS:

4.19 The amount of pitch applied to the propellor is sensed by a potentiometer directly coupled to the Voith pitch control spindle by a lever. The length of this lever is adjustable so that the length of potentiometer

Stroke can be adjusted. The potentiometer chain driven three MA meters in series. (engine room, Borden bridge and Tormentine Bridge). The two methods of adjustment are available.

1RV1 or 1RV2 potentiometer adjusts the zero points of the meters.

The adjustment on the Voith lever adjusts the range of the instruments.

SURRENDER OF BRIDGE CONTROL:

4.20 When the bridge Command has finished with the engines he should rotate the bridge control switch 1SW2 to the off position. This will have the following effects:-

(a) Section (1) (1SW2) - the audible alarm on the bridge will sound.

(b) Section (2) (1SW2) - the 'Borden in Control' indicator will be extinguished.

(c) Section (3) (1SW2) - has no effect at this stage.

(d) Section (4) (1SW2) - has no effect at this stage.

(e) Section (5) (1SW2) - re-energises relay (1RLJ).

(f) Section (6) (1SW2) - de-energises the zero pitch solenoids and so reduces all pitch to zero.

When relay (1RLJ) de-energises its contacts operate as follows:-

1J1 closes and illuminates the 'control off' indicator. in the engine room.

1J2 closes and sounds the audible alarm in the engine room.

4.21 To mute both audible alarms the Engineer should rotate the control switch to the 'off' position. This will have the following effects.

(a) Section (1) (1SW1) - opens and de-energises the main scoop coupling.

(b) Section (2) (1SW1) - opens but has no effect at this stage.

(c) Section (3) (1SW1) - opens and mutes the audible alarm in the bridge.

(d) Section (4) (1SW1) - opens and extinguishes the 'Borden in control' indicator (1LP19) on the Tormentine Bridge.

(e) Section (5) (1SW1) - opens but having no effect at this stage.

(f) Section (6) (1SW1) - opens and mutes the audible alarm in the engine room.

(g) Section (7) (1SW1) - opens and removes the ahead/astern pitch command signal from the amplifier.

(h) Section (8) (1SW1) - opens and removes the athwart ships pitch command signal from the amplifier.

4.22 When the main clutch disengages the micro switches on the clutch will cause the following actions.

(a) The 'power off' indicators 1LP2, 1LP16 and 1LP21 will be illuminated.

(b) Relay 1RLB will be de-energised.

1B1 - opens and extinguishes the 'power on' lamp 1LP1.

1B2 - opens and extinguishes the 'power on' lamp 1LP15, 1LP20.

1B3 - both open but have no effect at this stage.
1B4

1B5 - opens and ensures that no pitch can be applied.

1B6 - changes over and permits the barring gear to be engaged.

1B7 - will open and reduce the engine speed to idle.

The Borden bridge has now completely surrended command to the engine-room.

4.23

EMERGENCY SCOOP DUMP:

If the situation is that described in para 4.17 then for emergency use the following procedure may be carried out.

If any of the 'emergency scoop dump' buttons 1PB3, 1PB5 or 1PB7 are depressed then relay 1RLH will be energised.

1H1 - changes over, de-energised the scoop solenoid and locks on 1RLH.

1H2 - changes over and 'illuminates the coupling emergency dump' indicator 1LP11 in the engine room.

1H3 - closes and sounds the audible alarm in the engine room.

When the clutch disengages the effects described in para 4.22 will occurr.

4.24 To mute the audible alarm the Engineer will have to rotate switch (1SW1) to the 'off' position, which in turn will de-energise 1RLH.

1H1 - will change over and release 1RLH.

1H2 - will extinguish the 'coupling dump' indicator 1LP11.

1H3 - will open and mute the audible alarm, in the engine room.

POWER SUPPLY FAILURE:-

4.25 If both 48v.d.c. battery supplies are healthy then relays RLA, RLB and RLC, RLD are energised.

A1 - is closed and energises RLB.

A2 - is open and prevents LP2 No.1 feeder failed from being illuminated.

A3 - is open and so does not give a remote alarm.

B1 - is closed and connects battery No.1 positive rail to No.1 control.

B2 - is open.

B3 - is closed and connects battery No.1 negative rail to No.1 controls.

B4 - is open.

The same goes for No.2 controls.

4.26 If No.1 Battery supply fails relays RLA and RLB will de-energise.

1A1 - will open and de-energise RLB.

1A2 - closes and illuminates the 'No.1 feeder failed' indicator LP2.

1A3 - changes over and sounds the remote alarm.

1B1 - opens and disconnects No.1 battery piston from the controls.

1B2 - closes and connects No.2 battery to No.1 controls.

1B3 - opens and disconnects No.1 battery negative from the control.

1B4 - closes and connects No.2 battery to No.1 controls.

This means that No.1 controls are being powered from No.2 battery supply.

WARNING: This condition should be rectified at the earliest possible opportunity since the ship has no reserve power supply.

4.27 If the actual supply to No.1 controls fail then LP1 the 'control supply healthy' indicator will be extinguished.

The same automatic changeover is applicable if No.2 battery supply fails.

A P P E N D I X 1

COMMAND AMPLIFIER- COMPARATOR & SOLENOID DRIVE. - L1317

Function:

To compare the outputs from the command and feedback linear voltage differential transformers (L.V.D.T's) and energise the respective increase or decrease pitch solenoid valves in such a manner that the pitch takes up the command position.

To improve the system stability a circuit is incorporated that causes the solenoid valves to be pulsed at a pre-determine rate when the feedback L.V.D.T output approaches that set on the command L.V.D.T, thus slowing the approach rate to the balanced condition.

Technical Description:

The command L.V.D.T. output appears at SKT9 as a ± 2v. signal about + 9v. (SKT23) after passing through a calibration amplifier on board L1316.
The feedback L.V.D.T. is fed to SKT23 and SKT22 (+9v.) and gives an output of between ± 4 to ± 7v. for full pitch. This output is attenuated by resistor network R2 and R46 and amplified by the operational amplifier 1C1.

The adjustable feedback resistor across 1C1 is used to control its gain such that ± full pitch on the feedback L.V.D.T. will give an output at Test Point 'A'(TPA) of ± 2v. The input from SKT9 is fed to pins 3 of 1C2 and 1C3 which compare this voltage with the output from 1C1.

If the voltage at pin 9 is positive with respect to the output from 1C1 then the output from 1C2 and 1C3 (TPB & TPC) will be positive with respect to the +9v. supply.

If the output from 1C3 exceeds approximately 4½ volts (with respect to +9v.) then TR1 will conduct, which in turn will cause TR3 and TR14 to conduct and hence energise the solenoid valve connected between SKT1 and the +48v. supply.

If the voltage at SKT9 is negative with respect to the output from 1C1 thenTR2, TR4 TR5 and TR12 will conduct causing the solenoid connected between SKT2 and the +48v. supply to energise.

When the output voltage from 1C2 is greater than 4.5 volts positive with respect to +9v then TR7 will conduct causing TR6 to short out the base current feed to TR18 causing this transistor to become non-conducting, thus cutting off the supply to the multivibrator TR15, TR16 and TR17.

If the output of 1C2 falls to below 4.5volts negative with respect to +9v. then TR8 and TR9 will conduct and cause TR10 to short out the current feed to TR18 and hence to the multivibrator.

If the output from 1C2 is between ± 4.5. volts with respect to +9volts it will be seen that TR18 conducts and the multivibrator will produce a square wave, the mark space ratio of which is adjustable by means of RV.4: this will cause TR11 and TR13 to conduct when the collector of TR17 goes positve hence shorting the base emitter of TR14 and TR12 and causing the solenoid valves to pulse on at the multivibrator frequency if they are in an energised condition due to 1C3 unbalance.

APPENDIX II

RELEVANT TEST VOLTAGES:

1. The voltage from the L.V.D.T's should be ± 4v. for full pitch. This voltage is adjusted by use of the potentiometer in series with the L.V.D.T.'s.

2. For full details of electronic and boards see appendix I.

LOAD CONTROL AMPLIFIER - L1316

Function:

To off load both forward/aft and athwartships pitch when the engine governor shows that an overload condition is being approached.

Technical Description:

The L.V.D.T. in the governor produces a negative going signal to SKT14 with respect to SKT20 (+9v.) when the engine approaches overload. This causes the output of 1C1 (TPA) to go negative with respect to 9v. and will cause current to flow through TR1 proportional to the negative swing at test point 'A' (TPA). (hence proportional to overload)

The current through TR1 will unbalance the multivibrator TR3, TR4 which originally produced a unity mark space ratio square wave.

The square wave ouput from the multivibrator (TPB) normally switches TR6 and TR7 F.E.T's on and off at unity mark space ratio and act as a +2 attenuator to the signals from the for/aft and athwartships L.V.D.T's entering SKT24 and SKT22 respectives. The chopped signals are amplified and intergrated in the feedback amplifiers 1C2 and 1C3 RV3 and RV4 being used to set the outputs to ± 2 volts for full pitch demand in either direction.

We have seen that under overload conditions the multivibrator becomes assymetrical; this causes the 'ON' pulse to TR6 and TR7 to become shorter than the 'OFF' pulse thus causing the attenuation of the network to increase and the outputs from 1C2 and 1C3 to fall for a given L.V.D.T. command input and hence a reduction in the actual pitch setting both in the for/aft and the athwartship direction.