Part I

Chapter 8—Military Flight System

List of Contents

Description

1 General

(*a*) The Military Flight System (MFS) consists of:

(i) Twin aircraft systems.

(ii) Twin compass systems.

(iii) Certain common data sources with the auto-pilot Mk. 10B.

(*b*) Basic information is displayed on the Director Horizon and the Beam Compass at each pilot's station. These two instruments, which replace the normal artificial horizon, gyro-magnetic compass, ILS indicator, PDI, Zero Reader indicator and selector and the auto-pilot heading selector, provide flight director signals for the pilots.

(*c*) ILS signals can be fed into the system, the ILS localiser information being presented on the Beam Compass and the ILS glidepath information on the Director Horizon.

(*d*) Flight director signals are fed into the Director Horizon, telling the pilot the attitude required to achieve the desired condition of flight. If the auto-pilot is in use, it is supplied with heading signals from the system.

(*e*) Track control facilities enable the navigator to apply drift and variation signals to the heading signals. The heading signals can also be linked to the NBS.

(*f*) The two halves of the system function independently but are monitored by comparator units.

2 Twin vertical gyros

(*a*) A unit in the pressure cabin, consists of port and starboard gravity-monitored vertical gyros, driven by the 115-volt AC supply. These supply pitch and roll signals to the port and starboard

Director Horizons respectively. The gyros have freedom in pitch of 85° and complete freedom in roll.

(*b*) Each system measures the aircraft attitude independently but the two are so monitored by a comparator unit that warning flags will show on both horizons if their signals differ by more than the equivalent of 10° in roll and $3\frac{1}{2}$° in pitch, due either to faults within the MFS or to power failure.

3 Twin azimuth gyro unit

Port and starboard horizontal gyros in a rack beside the vertical gyros, driven by the 115-volt AC supply, provide azimuth signals for the port and starboard compass systems. They are normally magnetically monitored and, when monitoring is taking place, the arrows in the annunciators will pulsate. If the DG facility is selected on a Beam Compass, monitoring is disconnected on that side, and the DG flag shows and the annunciator arrows centralise and remain locked. Monitoring is automatically disconnected during turns but the annunciator arrows continue to indicate monitoring current.

4 Director horizons

(*a*) Each Director Horizon is, basically, an artificial horizon on which the pitch and roll elements have been separated. The instrument indicates up to ± 40° of pitch and 60° of bank but, however, the horizon bar and bank ringsight have complete freedom in roll.

(*b*) The various components consist of:

A horizon bar
A bank ringsight pointer and bank scale
A pitch ringsight pointer
A pitch scale
A glidepath pointer
An azimuth director pointer
A pitch scale setting knob
BEAM and glidepath (GP) flags and a pitch director indicator (P) flag
An attitude warning flag

(*c*) Roll signals from the remote vertical gyro are fed to the horizon bar, which rotates in a conventional sense to indicate bank. At the same time, the bank ringsight, operating at right-angles to the horizon bar, moves over a scale to indicate the precise angle of bank; the scale is marked in 10° intervals up to 30° and then at 60°. The azimuth director pointer, moving over the same scale, is normally controlled by a heading error signal, given by the difference between the actual aircraft heading and the setting of the heading index on the Beam Compass. When ILS is selected, the pointer is controlled by the resultant of heading error and beam displacement signals. In the PDI function, track error only is given (see para. 7(*c*) (ii)). The relationship between error signal and bank displacement angle is such that a 10° error signal demands a 20° bank angle, except when ILS is selected ; in this case, a 10° heading error demands a 10° bank angle. The maximum bank angle demanded is 30°. The demand is satisfied by applying bank in the indicated direction until the ringsight pointer is over the azimuth director pointer.

(*d*) Pitch signals from the vertical gyros are fed to the ringsight pitch pointer, which moves vertically over the pitch scale. The pitch indication is non-linear and pitch scale markings indicate approximately 6° and 13° of dive or climb either side of the centre dot. The pointer displacement is less sensitive as pitch displacement increases from the neutral datum. The maximum pointer deflection is 40°; between this angle and 85°, the pointer is held in the fully deflected position.

(*e*) The glidepath pointer, which moves over the pitch scale, is controlled by the ILS glidepath signals. Both the pointer and the pitch scale can be moved up and down together behind the pitch pointer, by various methods (see para. 9). When there are no glide-

path signals, the needle remains over the centre dot on the pitch scale. When the pitch scale is being servo-driven and/or a selection other than central is made on the pitch selector switch, the P flag will show.

(*f*) The BEAM flag is permanently visible when adequate ILS localiser signals are being received; the GP flag shows when adequate ILS glidepath signals are being received. Inadequate radio signals are indicated by a pulsing of the appropriate flag.

5 Beam compasses

(*a*) Each Beam Compass is basically the remote indicator of its gyromagnetic compass system, being fed with signals from the detector units.

In addition, the Beam Compass:

(i) Acts as the heading monitor for the auto-pilot.

(ii) Acts as the heading selector for both Director Horizons and for the auto-pilot.

(iii) Shows the displacement from a selected radio beam and the aircraft heading relative to that beam.

(iv) Can provide directional gyro information.

(*b*) The various components consist of:

A rotatable compass scale
A heading pointer, with a miniature aircraft in the centre and a ringsight pointer at the tip
A heading index
Top and bottom datum marks
Radio-coupled range marks
Radio beam displacement bar and scale
DG flag
Sense switch
Setting knob
Compass warning light

(*c*) Both compass warning lights will come on, after a delay varying from 20-45 seconds, if the two heading indicators differ by more than 5°. Certain power failures may make a light come on (see para. 10(b)).

(*d*) The DG flag shows when the directional gyro function is selected on the annunciator unit.

(*e*) In order to avoid undue running of the compass system on the ground, two compass isolation switches are provided at the nav./plotter's position, for use when ground testing other equipment.

Controls and Indicators

6 Annunciator units

An annunciator unit is provided for each half of the twin compass system. The controls on the unit consist of a COMP-DG switch, a synchronising knob and a window showing the annunciating arrows. To synchronise, the knob should be turned in the direction of the annunciating arrow until the arrow pulsates. The synchronising knob is also used to set the compass when it is being used as a DG.

7 MFS selector

(*a*) One MFS selector is provided on panel AT for both pilots and carries the following switches:

A COMP switch, for compass selection
A navigational selector switch
A pitch selector switch.

(*b*) The COMP switch is engraved with an arrow, to indicate which compass system, port or starboard, has been selected to supply heading control signals to the azimuth director pointers of both Director Horizons and to the auto-pilot. All heading selections must be made on the compass selected.

(*c*) (i) The navigational selector switch has five positions:

BOMB, REMOTE, central (normal), LOC and GP.

(ii) With BOMB selected, azimuth directions are supplied from the NBS and normal heading error signals are suppressed.

(iii) With REMOTE selected, the heading information is controlled by the navigator, who can feed in variation and/or drift information, thus making it possible for the beam compass to read magnetic heading, magnetic track, true heading or true track.

(iv) With the switch at the normal centre position, only the heading error (magnetic) from the beam compass is supplied to the azimuth director.

(v) With LOC selected, and provided that the ILS is tuned in and operating, localiser beam signals will be fed into the system. The BEAM flag on the director horizon will show and the beam bar on the beam compasses will indicate the aircraft position relative to the beam. Whether ILS is tuned in or not, selecting LOC will give 1: 1 bank demand.

(vi) With GP selected, both localiser and glide-path signals will be fed into the system. Both the BEAM and the GP flags will show on the Director Horizons and the glidepath pointer will indicate the aircraft's position relative to the glidepath.

(*d*) (i) The pitch selector switch controls the servo-driven functions of the Director Horizon pitch scales and has five positions:

MACH, HEIGHT, central (normal), APPROACH and DATUM. The MACH position is at present inoperative. With any of these selections, other than central, the pitch (P) flag will show on the Director Horizons.

(ii) With HEIGHT selected, pitch directions are given to maintain the aircraft at the altitude at which it was flying at the time of selection. The pitch scale will be servo-driven up or down, the position of the centre dot indicating to the pilot the corrections needed to maintain the pressure altitude. As the variation of the pitch scale will be relative to its position at the time of selection, the aircraft should be allowed to settle to the required cruise conditions before selecting HEIGHT. In order to avoid undue attitude changes, the height facility will disconnect automatically if the deviation from the selected altitude exceeds 13 millibars (400 feet at sea level). The selector will then return to the centre position.

NOTE: If HEIGHT is selected *before* the aircraft has settled to its cruising attitude, any signals followed in the interim will result in a distorted flight path.

(iii) With the switch in the centre position, no pitch director signals will be fed to the Director Horizons and the pitch scale can be adjusted to any required attitude datum.

(iv) The APPROACH and DATUM positions are interconnected, the switch being spring-loaded to return to APPROACH when released after selecting DATUM. The selection will only be attained if the navigational selector switch is selected to LOC and GP (See 9(*b*)(ii)).

8 Navigator's controls

In addition to a compass repeater, fed from the port compass system, a track control unit is provided at the navigator's station. Both variation and/or drift values can be fed into the compass system automatically or manually. A compass selector switch enables the navigator to select which of the compass systems is to supply information to the unit and to other navigational equipment (GPI, NBS). It is essential that the compass selected by the navigator has not been selected to DG by the pilot, unless gyro steering is in progress and the navigator is fully aware of the selection made. The navigator can also check magnetic heading at any time by depressing the MAG HDG switch.

9 Pitch director function controls

(*a*) With the pitch selector switch in the central position, there are no pitch director signals and the pitch scale remains as a fixed datum. It can be adjusted, however, by the pitch scale setting knob. There are three methods of operation:

(i) *Emergency setting*. With the pitch scale knob pulled out, the pitch scale can be manually adjusted up or down to indicate a required attitude. Only the scale of the instrument so operated will move, the other instrument being unaffected. If the knob is left pulled out, the scale cannot be servo-driven on that instrument.

(ii) *Trimming setting*. With the knob in its normal position, it has restricted movement against a spring in either direction Rotation of the knob will cause the scale to move up or down slowly, until the knob is released. While the scale is moving, the pitch flag will appear. Operation of the knob in this fashion affects both instruments.

(iii) *Fast setting*. With the knob pushed in, against spring tension, both scales will move rapidly to align the centre dot with the pitch pointer; the knob must be held in until alignment is complete. While the scale is moving, the P flag will appear. This facility is not accurate if the aircraft angle of climb or dive is greater than 10°. This method of operation is particularly useful when climbing away from an overshoot; it overrides any pitch selection on the MFS selector, releasing the selector switch to its central position.

(*b*) Pitch director functions are fed into the system when the pitch control on the MFS selector is moved from its central position. The functions are as follows:

(i) With HEIGHT selected, the pitch scale is servo-driven to indicate corrections required to maintain the altitude at which the aircraft was at the time of selection (the pitch flag will show). As the directions are relative to the position of the pitch scale at the time of selection, the aircraft should be trimmed to the speed and attitude required, with the pitch pointer over the centre dot of the scale, before selecting HEIGHT.

(ii) The DATUM position of the switch, used in conjunction with LOC and GP, selects the pitch scales to centre, which is the approximate aircraft attitude on the ILS glidepath. When released, the switch returns to APPROACH and the pitch scales move slowly, if the aircraft is not on the ILS glidepath, in such a direction as to bring the aircraft back onto the glidepath. With the switch at APPROACH, a drift unit in the pitch computor unit compensates for drift except for wind shear.

10 Power supplies and failure indications

(*a*) (i) The main system is operated by 115 volt AC at 400 CPS, the 1st pilot's by No. 2 and the co-pilot's by No. 4 transformer.

(ii) *Post-Mod*. 3334

A NORMAL/EMERGENCY change over switch is fitted on the 1st pilot's instrument panel. When EMERGENCY is selected the 1st pilot's MFS power supplies are obtained from No. 3 instead of No. 2 transformer. There is no alternate power source for the co-pilot's MFS.

(iii) *Post-Mod*. 3427

Two power failure warning lamps are fitted, one on each pilot's instrument panel. In the event of a power supply failure, the appropriate lamp will illuminate.

(*b*) Complete power failure to the system will be indicated by:

(i) The failure warning flags showing on both Director Horizons.

(ii) No compass annunciation and the system going dead.

(iii) No ILS BEAM or GP flag indications.

(iv) MFS pitch selector reverting to the central position.

(v) Post-Mod. 3427 both power failure lights illuminating.

(c) Power failure to one side of the system is indicated by:

(i) Attitude warning flags on both Director Horizons.

(ii) No compass annunciation on dead side.

(iii) Starboard compass warning light if failure is in port system (no compass warning light if failure is in starboard system until there is 5° discrepancy between indicated headings).

(iv) No BEAM and GP flags.

(v) Reversion of pitch selector to central position if failure is in the starboard system.

(vi) Post-Mod. 3427 the appropriate PFWL illuminating.

(*d*) Partial power failure within the systems may be indicated as well by:

(i) The failure warning flags on both Director Horizons when a power failure leads to a discrepancy between the signals to the horizons (see 2(*b*)). Certain power failures can lead to an immediate appearance of the failure warning flag on one or both Director Horizons, before the failure has led to a signal discrepancy.

(ii) Compass warning lamp indication on one or both Beam Compasses, either immediately or when compass indications differ by more than 5° for more than 20-45 seconds.

(iii) ILS BEAM or GP flag behaviour.

(iv) Faulty flight direction facilities indicated by failure to achieve the selected manoeuvre.

NOTE: Mod. 2967 introduces an A/P/GYRO NORMAL-STANDBY switch at the navigator's station. When the switch is set to STANDBY and an external 28 volt supply is connected, the MFS 115 volt power supplies are interrupted to prevent prolonged ground running of the gyros during periods of readiness. When the switch is set to NORMAL, or the 28 volt external supply is removed, the supplies are restored.

Normal Management of the MFS

11 Full functional checks

(*a*) Before power is switched on check that the attitude failure warning flags are visible on both Director Horizons, and that these disappear when power is switched on. Have both COMPASS ISOLATION switches at the navigator's position selected to ON, and the airfield variation value set on the TRACK CONTROL UNIT.

(*b*) On the MFS selector set the navigation and pitch selector switches to the central positions. Check that the pitch and roll attitude indications on both Director Horizons settle down as the gyroscopes erect, and that both show similar indications depending on the aircraft ground attitude. Check that both setting knobs are not in the fully out positions.

(*c*) Select both compass annunciator switches to COMPASS. Synchronise both beam compasses by turning the synchronising knobs in the direction of the annunciator arrows until the arrows pulsate. Both amber compass warning lights should go out. Push and turn the setting knob of each Beam Compass to set each compass card with the aircraft heading pointer at the top compass datum. Pull and turn the setting knobs to align the heading indices under the heading pointers. Compare the heading pointer readings with the P.12 compass reading.

NOTE: Some disparity in readings may be expected if there is magnetic material in the area of the aircraft wing tips.

(*d*) At the MFS selector move the navigation selector to REMOTE. Check that the heading pointer of each Beam Compass moves in the correct direction and value of the variation set on the track control unit. Return the switch to the central position and note that the compass heading pointers return to their original positions.

(*e*) At the MFS selector turn the COMPASS selector switch to port. On the port beam compass move the heading index to port and starboard and check that the azimuth directors on both Director Horizons move freely and in the correct sense over their

full range of movement. Check that 15° displacement of heading index demands 30° bank demand of azimuth directors. Turn the compass selector switch to starboard and repeat the check on the starboard compass.

(*f*) Set both compass annunciator switches to DG and check that the DG flags appear on both Beam Compasses. Turn the synchronising knob on the starboard annunciator unit to set the starboard heading pointer at least 20° clockwise from the port heading pointer. Set both annunciator switches to COMP and check that both compass warning lights come on within 45 seconds. Set the port annunciator switch to DG, check that the lights go out, and come on again when the port annunciator switch is returned to COMP. Slowly rotate the starboard synchronising knob to bring the starboard heading pointer towards the same indication as the port heading pointer. Check that the warning lamps remain on while the readings differ by at least 7° but go out before the difference is reduced to 3°. Repeat the check after displacing the starboard heading pointer at least 20° anti-clockwise from the port heading pointer.

(*g*) Turn the compass selector to port and displace the port compass heading pointer sufficiently to illuminate the warning lights. Turn both compass annunciator knobs simultaneously in a clockwise direction, check that both warning lights go out while the heading pointers are moving, and illuminate again when the heading pointers stop. Repeat the check in the reverse direction. Re-synchronise both compasses.

(*h*) Turn the radio sense switches at the side of each Beam Compass with the arrows pointing upwards. Check that the radio beam bars on both Director Horizons are central on their scales and that no flags are visible.

(*j*) Check the operation of the pitch scale on the port Director Horizon by means of the setting knob as follows:

(i) Pull the knob fully out and check that, by rotating it, the pitch scale can be manually adjusted both up and down ; leave approximately central.

(ii) Push the knob and release it, allowing it to return to its mid position. Rotate the knob clockwise against spring pressure, note that the pitch scales on both Director Horizons move slowly to the top of their travel and that the Pitch flags appear. Release the knob.

(iii) Push the knob fully in, note that the pitch scale centre dots on both Director Horizons move rapidly to a position directly under the pitch pointers and that the Pitch flags appear. Release the knob.

(iv) Rotate the knob anti-clockwise against spring pressure, note that the pitch scales on both Director Horizons move slowly to the bottom of their travel and that the pitch flags appear. Release the knob.

(v) Push the knob fully in, note that the pitch scale centre dots of both Director Horizons move rapidly to a position directly under the pitch pointers and that the Pitch flags appear. Release the knob.

(vi) Repeat the checks on the starboard Director Horizon.

(*k*) Displace the pitch scales slightly from the pitch pointers. Select HEIGHT on the MFS pitch selector switch and check that the Pitch flags appear on both Director Horizons ; the pitch scale should move slowly towards the pitch pointer. Pull out the setting knobs on each horizon in turn and note that the Pitch flags on the respective instruments disappear. Return both setting knobs to their mid-positions and return the pitch selector switch to its central position.

(*l*) With the ILS switched OFF, select the MFS navigational switch to LOC. Check that the BEAM flags on both Director Horizons pulse fully in and out. Select LOC and GP position and check that both BEAM and GP flags pulse. If ILS signals are available, switch ON the ILS. Check that the heading index is within the radio coupling range markers and rotate the BEAM COMPASS card so that the ILS beam heading is set under the heading index.

As the ILS signals are fed to the MFS system the BEAM and GP flags should stop pulsing and remain steadily in view. The radio beam bars, azimuth directors and glidepath directors should be displaced but the direction and magnitude of their displacement will vary according to the displacement of the aircraft from the ILS beams.

(*m*) Select and hold the DATUM position on the pitch selector switch, check that both pitch scales move rapidly to the centre of the instruments and that the Pitch flags appear. Release the pitch selector switch and note that it locks on the APPROACH position. The pitch scale should move slowly towards the pitch pointer. If the heading pointer is offset from the heading index, the azimuth director pointers should move towards zero bank (drift unit function). Select the navigational switch to its central position, check that the pitch selector switch releases to its central position and that the Pitch flags disappear. Switch OFF the ILS.

(*n*) If the NBS is functioning, select BOMB on the navigational selector switch and check this function in accordance with the Navigator Radar's manipulation of the NBS equipment. On completion of the check return the navigational selector switch to its central position.

12 Pre-flight checks

(*a*) Check that the attitude failure warning flags of both director horizons are not visible, and that the pitch scale setting knobs are not in the fully out position. Select the navigation and the pitch selector switches to the central positions. Check that the pitch and roll attitude indications on both horizons are similar. Switch ON the ILS.

(*b*) By use of the pitch scale setting knob check all three modes of operation of the pitch directors on each director horizon in turn. On completion of the checks leave the pitch director set approximately 3 dots up.

(*c*) Select both compass annunciation switches to COMPASS and synchronise the compasses by turning the synchronising knobs in the direction of the annunciator arrows until the arrows pulsate. Check that both amber compass warning lights go out. Align the heading pointer and heading index over the top datum on both compasses. Set the compass selector switch to PORT, ensure that the azimuth directors are central and compare the port compass heading with the P.12 compass. Check that the azimuth directors move in the correct sense when the heading index is moved port and starboard, and return to central. Set the compass selector switch to STARBOARD and repeat the compass checks using the starboard beam compass. Leave the compass selector switch selected to the compass required.

(*d*) Set the radio sense switches of both beam compasses as required (normally pointing up) and check that the heading index is within the radio coupling range. Set the ILS QDM under the heading index. Select the navigation selector switch to LOC, check that the BEAM flags appear on both director horizons and that the beam bars and azimuth directors move in the correct sense. Then select the navigation selector switch to LOC & GP, check that the GP flags appear on both director horizons and that the glidepath directors move up. Select the pitch selector switch through APPROACH to DATUM, check that both pitch flags appear and that both pitch scales move rapidly to the centre of the instruments. Release the pitch selector switch and ensure that it springs back and remains at the APPROACH selection. Centralise the navigation selector switch and check that the pitch selector switch automatically moves to the central position. Switch off the ILS.

(*e*) If the NBS equipment is functioning select BOMB on the navigation selector switch and check this funtcion in accordance with the Navigator Radar's manipulation of the NBS equipment. Return navigation selector to central.

(*f*) Select navigation selector switch to REMOTE, note the change of heading shown on the beam compasses and confirm with the Navigator Plotter.

13 Normal flight control and en-route flying

NOTE: The Beam Compass should not be regarded as a steering compass but as an instrument for setting up courses which will be steered by obeying the direction of the Director Horizon.

(a) General

Select the required compass on the MFS selector. The heading index may be set to any position around the Beam Compass but, for normal en-route flying, it is more convenient to set the index to the top datum and rotate the compass card so that the required course is in line with the index. For course changes, rotate the compass card to bring the new course against the heading index. The azimuth director pointer on the Director Horizon will indicate the necessary bank required to turn the aircraft onto the new heading ; when this has been reached the azimuth director pointer will be vertical and the compass heading pointer will be over the heading index.

(b) Navigational control

(i) To fly magnetic headings, set the MFS navigational selector to the centre position.

(ii) To fly true track, magnetic track or true heading, set the navigational selector switch to the REMOTE position. The navigator can then feed in magnetic variation and/or drift (from the Green Satin) to the Beam Compass heading pointers. Any changed selection by the navigator will cause the heading pointer to move relative to the compass card and will necessitate resetting the heading index if the previous course is to be maintained.

(c) Selection between compasses

Before altering the selection of the compass selector switch, the heading index of the compass to be selected should be set to the aircraft heading. Failure to do this will result in an indication of bank demand on the azimuth director pointers as soon as the compass selector switch is moved.

(d) Use of pitch datum facilities

The pitch scale of the Director Horizons may be adjusted to any desired position and the aircraft then flown so as to maintain the ring of the pitch pointer over the centre dot of the pitch scale. If HEIGHT lock facility is selected on the MFS pitch selector switch, the aircraft may then be maintained at the height at which the facility was selected by maintaining the pitch pointer over the centre dot of the pitch scale.

14 Visual circuits and landings

Select the required compass on the compass selector switch and set the navigational selector switch to the central position. Before take-off set the compass card with the runway QDM at the top datum ; set the heading index at the top datum also and leave the setting knob out. All changes of heading after take-off can be made by setting the index to the required course and following the azimuth director pointer indications.

15 ILS approach

(*a*) On approach to the overhead or "gate" position switch ON the ILS and select whichever compass is required. ▶◀

(*b*) Before commencing the let-down, on the MFS selector set the navigational selector switch central (to fly magnetic headings) and the pitch selector switch central (to cancel the HEIGHT facility). Set both radio sense switches upwards. On the selected compass set the outbound heading to the top datum, and on the other compass set the localiser or runway QDM to the top datum.

(*c*) On commencement of the inbound turn, rotate the compass in use in two stages to bring the localiser or runway QDM to the top datum. Select LOC on the navigational selector switch, check that the BEAM flags appear, and follow the indications of the azimuth director pointer to join the localiser beam.

(*d*) In the presence of a cross-wind, the aircraft will be directed to adopt a drift angle at which the heading error signal balances the beam displacement signal. There will be no demand signal displayed on the azimuth director, but the aircraft will be established on a track displaced from the beam centre line, and this will be indicated by the radio beam displacement bar on the Beam Compass. Reset the heading index under the heading pointer, and check that the drift angle thus set coincides with the drift information from the Green Satin. Adjust the drift angle as required to maintain the aircraft on the localiser beam centre line.

(*e*) When level and approaching the interception with the glidepath beam, select HEIGHT on the pitch selector switch and GP on the navigaticnal selector switch. Check that the GP flags appear and are steady.

(*f*) When the glidepath pointer is over the centre dot of the pitch scale, select APPROACH & DATUM. This will cause the pitch scales to move rapidly to the approximate correct indication for the approach. Select flap and reduce power as required to follow the indications of the glidepath director.

(*g*) On overshoot, move the navigational selector switch to the central position (the pitch selector switch will automatically move to the central position), align the pitch scales using the fast setting, and align the heading index with the heading pointer if necessary. For further low-level instrument procedures rotate the heading index or compass card as required.

16 GCA approach

(*a*) *Without* ILS

Set the heading index to the top datum and rotate the compass card to the heading given by the GCA controller. Follow the indications given by the azimuth director. When the aircraft is on the approach centre line, the runway QDM may be set to the top datum and the setting knob pulled out so that new courses may be set by adjustment of the heading index. Alternatively, the heading index may be left vertical and the compass card rotated to set up the controllers' courses.

(*b*) *With* ILS *monitoring*

If it is desired to use the ILS beam for standby or monitoring information, set the compass card with the QDM of the ILS beam against the top datum. Set the heading index to the courses given by the GCA controller and follow the directions of the azimuth director pointer. As the ILS is only to be used to give beam displacement information on the Beam Compasses, set the radio sense switch arrows pointing in the opposite direction to the heading index in order to suppress radio displacement signals to the azimuth director pointer.

Malfunctioning of the MFS

17 Attitude failure

If there is a power supply failure, or if there is a difference of 10° of roll or $3\frac{1}{2}$° of pitch signals between the port and starboard system, warning flags will show on both Director Horizons. Check each Director Horizon against other flight instruments.

18 Heading failure

If the heading indications on the Beam Compasses vary by more than 5° both amber warning lights will come on after approximately 30 seconds. Check both annunciator units and, if both are functioning correctly, check each Beam Compass reading with the P.12 compass. Select the serviceable compass on the MFS selector and select DG on the faulty compass. Inform the navigator and AEO.

19 Director horizon faults

(*a*) *Reduced sensitivity*

(i) A director horizon can, although being supplied with the correct input signals, develop a fault causing reduced sensitivity of the pitch, glidepath and azimuth director pointers. Any one, two or three of the pointers can be affected. This fault causes:

The pitch pointer to indicate a smaller pitch attitude than actually exists.

The glide path or azimuth pointer to demand a smaller correction than is actually required.

(ii) During flight, cross reference should be maintained between the two director horizons and the other flight instruments and, if the fault occurs, reference be made to the serviceable instrument, i.e. the director horizon that presents the greater demand or pitch indication.

(iii) If the fault occurs during an ILS approach, the approach should be broken off and a subsequent one made using a ground interpreted aid instead, whilst reference is made to the serviceable director horizon.

(iv) As the demand signals to the auto-pilot are unaffected, an auto-ILS approach can be successfully carried out although the defective horizon will present false indications.

(*b*) *Pitch pointer fluctuation*

The pitch pointer may fluctuate slightly at times. These fluctuations are acceptable provided that the vertical gyros are erect and that the movement is less than half of the width of the pitch pointer bar.