#### F.S./1

Tail plane

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Trim tabs

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# RESTRICTED

### Chapter 3

# TAIL UNIT

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#### DESCRIPTION

Each of the four main control 2. surfaces (elevator and rudder) has a trim tab. The elevators each have, in addition, a balance tab and the rudder a spring tab.

#### TAIL PLANE (fig. 2)

#### General

3. Each half of the tail plane, which is constructed in light-alloy, has a front and a rear spar to which nose and centre ribs are attached by vertical angle strips riveted to the spar webs. To the aft face of the rear spar are attached three elevator hinge brackets, each of which is shrouded by a sealing box. The inboard bracket on each side gives the datum. Laminum washers are fitted, as necessary, under the

Fin and rudder ... ... ...

#### Introduction

The tail unit consists of a twin spar 1. tail plane with a fin and rudder at each extremity. Former and rib positions are shown in fig.1. Constructed in two halves, which are bolted together inside the fuselage; the tail plane is attached by bolts to formers 37 and 41. The fins are bolted to the ends of the tail plane spars.

Fig. 1 2 2A 🏲 3

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base of the brackets to align the hinges. Shoe brackets are attached, by countersunk screws, to the top and bottom of each spar at the inboard end. The corners where these brackets are fitted are reinforced by riveted gusset plates.

4. The assembly is secured to the fuselage by the bolts which pass through holes in the spars each side of the central joint inboard of each No.1 rib.

#### Spars

5. Two extruded angle-section booms, which taper outboard, are riveted to a web, which also tapers outboard. Vertical angle strips, riveted to both faces of the front spar and to the forward face of the rear spar, provide attachments for the ribs.

#### Main ribs

6. These are chiefly flanged pressings with flanged lightening holes and vertical

top-hat section stiffeners between the lightening holes. The outside flanges of the webs are cut away to take the stringers. Ribs 2, 8 and 12 are reinforced on the outboard face at their rear ends to provide extra stiffeners where the elevator hinges are attached to the rear spar. This stiffening is obtained by lengths of lipped channel section riveted to the rib webs and inset by an amount sufficient to allow the stringers to clear them. The stiffeners are bolted, at their rear ends, to the attachment forks which are, in turn, secured to the rear spar booms by the bolts which carry the elevator hinges. In addition, vertical rib stiffeners, which are secured to the lengths of channel section by gusset plates, are provided.

7. In each half of the tail plane, rib No.1, at which point the tail plane passes through the fuselage skin, is constructed of a top and bottom boom of extruded Tsection with two vertical and three diagonal struts of angle section. At the ends are web plates with stiffening flanges. All joints in the framework are made with riveted gusset plates. Rib B, inboard of rib 1, is of normal construction. The innermost rib, A, is of sheet reinforced by lipped channel-section booms and vertical top-hat-section struts. At rib 1 (port half only) and between ribs 12 and 13 (both half), are mountings for the rudder control rod bellcranks which are shown in fig.2 and 2A.

8. The top and bottom flanges of the ribs are tied by transverse stringers of lipped L-section let into the ribs and secured by riveted brackets. Plating of light-alloy sheet is riveted to the ribs and stringers. On pre Mod.1471 aircraft two porous metal de-icing inserts are fitted in the leading edge of each tail plane. On post Mod.1471 aircraft four porous metal de-icing panels are fitted on the leading edge of each tail plane.

#### FINS (fig.3)

#### 9. These are each built up on two fin



Fig.1. Rib positions, tail plane and fin



Fig. 2. Tail plane (pre. Mod. 1471)

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Fig. 2A. Tail plane (post Mod. 1471)

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Fig. 3. Fin and rudder.

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posts with an intermediate post running the full height of the fin. The posts are built up from web plates riveted to angle-section booms and are tapered to form the aerofoil shape. The leading edge carries two de-icing inserts and is lapped over the plating. All of the rib sections are flanged pressings with lightening holes. Strips of flexible rubberized fabric are riveted to the fin post and secured to the shroudings between the rudder horns to blank off any airflow between that part of the rudder and the fin.

10. The system of rib numbering applicable to the fins, and to the rudders described later, is based on the vertical height of each rib in inches above, or below, the fin and rudder datum line as shown in Table 1. The rib positions are given, with their corresponding identification numbers prefixed A for above the datum line, B for below the datum line.

11. The webs of the front and rear fin posts are reinforced between ribs 8 and 9 where the attachment bolts pass through to secure the fin to the projecting ends of the tail plane spar. Also bolted to the forward face of the rear fin post between ribs 8 and 9 are, a bossed plate carrying a screwed shaft and sprocket which operates the rudder trim tab, and the rudder locking bolt assembly. Secured to the aft face of the rear post is a locking bolt guide and a rudder stop assembly. The locking bolt engages a bush in the stop and locking assembly on the rudder post when the pilot's rudder locking lever is pulled back. Three double ribs, 3, 7 and 11, between the intermediate and rear fin posts, provide reinforcement for the rudder hinge brackets secured to the rear face of the rear fin post by studs. Post Mod.1159 slotted nuts are fitted at both ends of the studs, the nuts inside the fin being torqueloaded to 5 lb. ft. on assembly. The deicing pipe shown leading to the de-icing insert is clipped at ribs 2, 4, 6 and 8.

#### RUDDERS (fig.3)

12. The rudders are of similar con-

struction to the fins and are attached to the latter by three ball bearing hinges. The rudder is of the horn balance type with a full length rudder post and thirteen horizontal ribs (refer to para.10 for the system of rib identification). Ribs 3, 7 and 11 are double, providing reinforcement where the hinge brackets are secured to che forward face of the rudder post by studs. Post Mod.1159 slotted nuts are fitted on both ends of the stude, the nuts inside the rudder being torque-loaded to 5 lb.ft. on assembly. Ribs 1 to 3 (upper) 12 and 13 are in two parts extending forward into the horns and aft to the trailing edge. Ribs 3 (lower) to 11 (upper) extend aft only from the rudder post, and ribs 6 to 11 end at the trim tab post. Ribs 4 to 11 have no corresponding ribs forward of the rudder post, the leading edge between ribs 3 and 11 being formed by eight shroud ribs of semi-circular shape. In the horns forward of the rudder post, are vertical intercostals between the ribs and the end sweep, to give additional strength, and in the leading edge of each horn are the main mass-balance weights, bolted to a web. riveted between the inner and outer side of the leading-edge plating. A mass-balance tube bolted to the rear face of the web in each horn accommodates lead and wooden plugs to give the correct rudder balance. A cover plate, secured by screws, retains the plugs in each tube.

13. On the forward face of the rudder post at rib 8, a rudder stop and locking assembly is secured by bolts. Additional reinforcement, to relieve the concentrated load imposed on this assembly by wind pressure when the rudder is locked, is provided by two flanged plates riveted to two angle brackets held by the assembly attachment bolts. The semi-circular stop-and-locking member embodies a locking-bolt bush and two stop blocks which are shown in the illustration.

14. Aft of the rudder post, a stringer on each side runs vertically from top to bottom. Further aft, two stringers run from rib 1 to rib 13, where they are each extended by a tapered intercostal. On the trim tab post are four hinges, one each at ribs 6 and 8 for the trim tab and at ribs 9 and 11 for the spring tab. The trim tab control rod is connected at its forward end to the trim tab operating assembly on the fin hinge post. It passes aft inside the rudder and emerges outboard, level with the hinge between ribs 8 and 9, the opening being faired over.

#### Trim tabs

15. These are the upper tabs on the rudders. They are each built up on a pressed, flanged spar with triangular ribs riveted to its aft face. The rear points of these ribs are joined together by the trailing-edge U-section, the whole being covered with light-alloy plating having a round cover to form a leading edge. This is cut away, to give access to the two hinge brackets. The trim tab control arm is riveted on the outboard face of the tab.

#### TABLE 1

#### FIN AND RUDDER RIB NUMBERS

Rib	Rib No.		
1	A 102 in.		
2	A 90 in.		
3 Deutite	[A 77 in.		
3 Double	A 74.6 in.		
4	A 66 in.		
5	A 54 in.		
6	A 42 in.		
7]	(A 30 in.		
7 Double	A 28 in.		
8	A 18 in.		
9	A 6 in.		
Datum	Datum		
10	B 6 in.		
111 Double	∫B 16 in.		
11 Double	1B 18.4 in.		
12	B 28.6 in.		
13	B 42 in.		



Fig. 4. Elevator.

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Spring tabs

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These are fitted below each trim 16. tab and are hinged to the two lower brackets on each rudder tab post. Construction is similar to that of the trim tabs. Each has a control arm on its outer side which is secured to the rear end of its operating rod. The forward end of the rod is connected to the lever at the lower end of the spring tab torsion bar described and illustrated in Chap.4 of this Section.

#### ELEVATORS (fig. 4)

17. The spars are made from steel tube with a welded blanking plate at each outboard end. They are of uniform diameter throughout their length and are cut away on their forward face at three hinge positions. The square holes thus formed are filled in with welded boxes. reinforcement plate is riveted inside each spar at each opening before the box is welded into position. At the inboard end is a light-alloy bush which receives the end of an attachment tube, the latter being secured in position by three threaded taper pins. Three sets of nuts and

lockwashers in conjunction with a bearing plate secure the pins. At the inboard end of the attachment tube is a riveted flange which is bolted to a similar flange on a torque tube connecting the two elevators together, inside the fuselage. To the rear of the inboard end of each spar is a tube which forms a guard for the trim tab operating cable. The sprocket and operating gear for the tab are shown in the illustration.

18. The ribs, through which the spar passes, are flanged and have three lightening holes aft of the spar. The nose of ribs 1, 2 and 3 is cut away to accommodate a mass-balance tube which has an open end accessible from the inboard hinge recess in the leading edge. Lead and wood plugs are inserted into the tube to give the correct mass-balance. The main mass-balance weight is provided by steel rods, one fitted to the nose of ribs 4 to 9 and another to the nose of ribs 10 to 13. There are three stringers let into both upper and lower flanges of the ribs and secured by riveted brackets. The aft ends of ribs 1 to 9 are squared and riveted to a channel-section rear member

#### SERVICING

#### LUBRICATION

All lubrication of the tail plane, 22. fins, rudder and elevators, excepting the elevator and rudder hinges, is confined to the flying control and locking systems and is described in Chap.4 of this Section.

The elevator and rudder hinge bearings are sealed bearings which are packed with grease, XG-295, on assembly and do not require periodic lubrication.

#### NOTE ...

Where an operation key number is not bracketed in any key to a figure or in a paragraph, the operation is not shown on the associated illustration. If the operation is illustrated or described elsewhere, a reference is given.

# To remove a rudder and fin refer to ✓ fig.6 and its associated key and to fig.10.

#### RUDDER AND FIN ASSEMBLY

24. Assembly of the fin and rudder to A.P.101B-1703-1B1, Sect.3, Chap.3 A.L.32, May 69

which carries the hinges for the trim and geared tabs, the remaining ribs continue aft to the trailing-edge and are secured by rivets to a U-section trailing-edge member. The elevators are covered with light-alloy sheet.

#### Trim tabs

19. Each tab is located at the inboard end of its respective elevator, and is operated by a push-pull rod which is connected to an arm riveted to its undersurface and to the fork-end of the operating gear screwed rod (fig.4 detail C). Constructed of light-alloy, the tabs have triangular-shaped ribs secured forward to a channel-section spar and aft, to a trailing edge member. The tabs are covered with light-alloy sheet.

#### Balance tabs

These are similar in construction to 20. the trim tabs. Each is operated by a rod connected to an arm on the underside of the tab end and at its forward end, to a static lever on the bottom face of the elevator centre hinge (fig.4, detail A).

the tail plane is a reversal of the operations given in the key to fig.6 with the addition of the following instructions:-

(1) Before assembling the fin to the tail plane spars all the contacting surfaces must be thoroughly cleaned

# RIGGING

Rigging data and instructions for 21. the tail plane and fins are given in Sect.2, Chap.4 and those for the elevators and rudders, together with their associated tabs, are in Chap.4 of this section.

# REMOVAL AND ASSEMBLY

RUDDER AND FIN REMOVAL

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and then coated with Celloseel (Ref.No.33H/113).

(2) The shanks of the attachment bolts, the contacting surfaces of the washers and nuts must also be coated with Celloseel (Ref.No. 33H/113).

#### NOTE ...

The threads of the bolts and nuts must be kept free of Celloseel.

(3) Before assembling the rudder trim tab sprocket assembly, to the front face of the fin rear post, clean the contacting surfaces and coat with Celloseel (Ref.No.33H/113).

#### Rudder

- (4) The bearing retaining plate on the rudder centre hinge bracket must be secured on the bottom surface of the hinge bracket.
- (5) During assembly, the 22 gauge special washer must be fitted at the centre hinge between the bearing in the rudder hinge bracket and bottom arm of the fin hinge bracket.
- (6) During assembly, the hinge bolt of the top hinge must be inserted from the bottom and the bottom hinge bolt inserted from the top.
- (7) After assembly of the rudder tabs, the hinge bolts must be wire-locked to the tab hinge brackets to prevent the bolts rotating.

#### ELEVATOR AND TAIL PLANE REMOVAL

To remove an elevator and tail plane 25. tefer to fig.7 for the elevator and to fig.8 and 9 for the tail plane.

#### ELEVATOR ASSEMBLY

Assembly of an elevator to the tail 26. plane is a reversal of the operations given in the key to fig.7.

#### TAIL PLANE ASSEMBLY

To assemble the tail plane to the 27. fuselage proceed as follows:-

- (1) Clean all contacting surfaces and coat the tail plane front spar, where it contacts fuselage former 37, with Celloseel (Ref.No.33H/113).
- (2) Trestle both halves of the tail plane and insert them into the openings, one each side of the fuselage.
- (3) Fit the bolt securing the tail plane front spar to fuselage former 37. This bolt must be fitted with the head facing forward. Fit the washer and nut to the bolt and tighten.
- (4) Grease the threaded bush, used at the tail plane rear spar to fuselage former 41 attachment point, with grease XG-295. Insert the bush from the rear and screw it in finger tight, ensuring it contacts the rear face of the rear spar.
- (5) Fit the tapered bolt securing the tail plane rear spar to former 41. This bolt passes through the threaded bush with the bolt head facing to the rear. Fit the special washer and nut and partially tighten.
- (6) Tighten the front attachment bolt until the front spar is making good contact with former 37. Adjust, if necessary, the rear attachment threaded bush until it is again finger tight and partially tighten the rear attachment bolt.

#### (7) Measure the gap, if any, between the front and rear spars at the centre joint and insert packing in the form of shims, which are as spares for this provided purpose. The thickness of packing to be inserted in the gap, according to its size, is obtainable from the following table:-

Gap	Packing	Ref.No. Section 26FP			
(over)	(s.w.g.)	Front spar	Rear spar		
0.015 in.	22	1475	1477		
0.0625 in.	16	1480	1478		
0.0775 in.	16 + 22	-	-		
0.125 in.	10	1476	1479		
0.140 in.	10 + 22				

It is essential that the same combination of shims is used at both spar joints.





Fig.5. Slinging tail unit

- (8) Where the gap is less than the total thickness of shimming to be inserted, the upper end of the shimming can be inserted first by lowering the beams of the tail plane support trestles until the gap between the two upper pairs of shoe brackets are opened sufficiently to allow the shimming to be inserted and located. The shims can then be swung down into their final position by raising the trestle beams to open the lower part of the gap.
- (9) Remove the protective treatment from the centre attachment nuts and bolts. Ensure that no moisture remains on the nuts and bolts, especially due to handling.

- (10) Assemble the nuts and bolts in the centre attachments and tighten the nuts to a torque of 330 lb.ft. Increase the torque until the split pins can be inserted ensuring that the torque does not exceed 400 lb. ft. Lock the nuts by the split pins.
- (11) Coat the joints with protective PX-9 (Ref.No. 34B/100489).
- (12) Tighten the bolts securing the front and rear spars to formers 37 and 41 respectively and lock the nuts with split pins.

A clearance of 0.02 to 0.10 in.

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must exist between the undersurface of the rear spar tapered attachment bolt head and the flange of the threaded bush.

- (13) Connect the flying control systems disconnected on tail plane removal.
  - (14) Connect the de-icing system pipes disconnected on tail plane removal (Key to fig.8 and 9). Test the system as given in Sect.3, Chap.10.
  - (15) Fit the access panels to the tail plane and fit the fairing pieces at the joint between the fuselage and the tail plane.

NOTE ...



, Fig. 6. Removal of rudder and fin

#### **KEY TO FIG.6**

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#### Removal of rudder and fin

Removal of rudder

- (1) Remove the screws securing the edge of the fabric to the shroud on the rudder post.
- (2) Remove the access panels from the shroud on the rudder post.
- (3) Remove the screws securing the hinge outboard cover plates and remove the plates.
- (4) Disconnect the rudder-operating rod from the rudder-operating arm by removing the bolt.
- (5) Disconnect the tab-operating rod from the screw jack by removing the split pin, washer and connecting pin from the universal joint.
- (6) Support the rudder using a sling (Ref.No.26FP/315). Remove the nuts, bolts and bonding clips from the hinges and withdraw the rudder from the hinges.

Removal of fin

(7) Attach the sling (Ref.No.26FP/315) to the slinging point shown in fig.5 at the top of the fin post.

- (8) Disconnect the aerial by removing the weak link at the rear insulator.
- (9) Remove the panel on the outboard face of the fin at the tail plane level.
- (10) Disconnect the de-icing system pipe at its union.
- (11) Release the trim tab control cables at the turnbuckles through the access door in the upper surface of the tail plane. Withdraw the control chain from the tail plane.
- (12) Remove the attachment bolts and remove the rudder trim tab control gear.
- (13) Disconnect the outer end of the rudder locking system push-pull rod in the tail plane from the bellcrank in the fin.
- (14) Remove the bolts securing the fin to the front spar of the tail plane.
- (15) Remove the bolts securing the fin to the rear spar of the tail plane and swing the fin clear of the spars before lowering.



' Fig.7. Removal of elevators. **RESTRICTED** 

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### **KEY TO FIG.7**

#### Removal of elevator

(1) Disconnect the elevator control rod at the torque shaft lever.

#### NOTE ...

On assembly ensure that packing washers are fitted between inside faces of lever arm and outside faces of control rod eye end.

- (2) Remove the bonding leads from the torque shaft couplings and lever.
- (3) Disconnect the couplings at each side of the torque shaft and remove the centre portion of the shaft.
- 4. Disconnect the elevator trim tabs at the cable joints in the fuselage between former 34 and 35, and at the turnbuckle in the transverse run aft of the centre of the tail plane rear spar.
- (5) Remove the pulleys at former 40 and 41.

(6) Remove the fairlead and pass the cables of each half elevator through the opening.

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- (7) Remove the access doors in the top and bottom surfaces of the elevator.
- (8) Remove the three taper pins securing the elevator torque shaft couplings to the elevator spars and draw the coupling into the fuselage.
- 9. Remove the access doors in the bottom skin just aft of the hinges.
- (10) Remove the bolt and two washers securing the geared tab operating rod to the arm under the centre hinge.
- (11) Support the elevator, remove the split pins and nuts from the hinge bolts and withdraw the elevator until the hinge bolts are clear of the spar.

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Fig.8. Removal of tail plane (pre Mod. 1471)

### **KEY TO FIG.8**

Removal of tail plane (pre Mod. 1471)

- 1. Trestle both sides of the tail plane (fig.5 and Sect.2, Chap.4).
- 2. Remove the rudder and fin (fig.6).
- 3. Remove the elevator (fig.7).
- (4) Remove the tail plane root fairings.
- 5. Remove the two inspection panels (four if both halves of the tail plane are to be removed) on the undersurface of the tail plane in the fuselage.
- (6) Disconnect the fin de-icing system piping at the T-union aft of the front spar.
- (7) Disconnect the tail plane leading edge de-icing system piping through the access panel on the undersurface of the tail plane.
- (8) Disconnect the rudder locking controls and bonding at the points illustrated and at the other end of the control rod (8A) at the tail plane centre (not illustrated). Secure the rod (8B) to the control rod leading aft to the elevator locking system.
- (9) Disconnect all bonding and the starboard rudder push-pull control rod from the lever on the upper torque tube, and the upper torque

tube from the fuselage vertical torque tube.

(10) Disconnect the rudder trim cables at the chain joints aft of the sprocket shaft above the front spar. Free the cable from the pulleys, disconnect the turnbuckles in the transverse run and coil the ends inside their respective halves of the tail plane.

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- (11) Disconnect the short turnbuckle connecting the bell-crank at the aft end of the elevator locking control rod to the sliding bar in the port elevator stop bracket on the aft face of the rear spar. Remove both the stop brackets from the rear spar to allow withdrawal of the starboard half of the tail plane.
- (12) Remove the bolts at the top and bottom joints at the centre of the tail plane.
- (13) Remove the bolts securing the tail plane front and rear spars to fuselage formers 37 and 41.

#### WARNING . . .

Care must be taken when removing the port half of the tail plane to ensure that the shoe brackets of the centre joint do not foul the brackets supporting the rudder and elevator locking systems.

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Fig.9. ,Removal of tail plane (post Mod. 1471)

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#### KEY TO FIG.9

### Removal of tail plane (post Mod.1471)

- 1 Trestle both sides of the tail plane (fig.5 and Sect.2, Chap.4).
- 2 Remove the rudder and fin (fig.6).
- 3 Remove the elevator (fig.7).
- (4) Remove the tail plane root fairings.
- 5 Remove the two inspection panels (four if both halves of the tail plane are to be removed) on the undersurface of the tail plane in the fuselage.
- (6) Disconnect the fin de-icing system piping at the T-union aft of the front spar.
- (7) Disconnect the tail plane leading edge de-icing system piping from the proportioner unit fitted on the forward face of former 37.
- (8) Disconnect the rudder locking controls and bonding at the points illus-

trated and at the other end of the control rod (8a) at the tail plane centre (not illustrated). Secure the rod (8b) to the control rod leading aft to the elevator locking system.

- (9) Disconnect all bonding and the starboard rudder push-pull control rod from the lever on the upper torque tube from the fuselage vertical torque tube.
- (10) Disconnect the rudder trim cables at the chain joints aft of the sprocket shaft above the front spar. Free the cable from the pulleys, disconnect the turnbuckles in the transverse run and coil the ends inside their respective halves of the tail plane.
- (11) Disconnect the short turnbuckle connecting the bellcrank at the aft end of the elevator locking control rod to the sliding bar in the port elevator stop bracket on the aft face of the rear spar. Remove both the

stop brackets from the rear spar to allow withdrawal of the starboard half of the tail plane.

- (12) Remove the bolts at the top and bottom joints at the centre of the tail plane.
- (13) Remove the bolts securing the tail plane front and rear spars to fuselage formers 37 and 41.
- (14) Withdraw the tail plane from the fuselage, simultaneously withdraw the de-icing pipes disconnected in op.(7). Care must be exercised to ensure the de-icing pipes are not damaged.

#### WARNING ...

Care must be taken when removing the port half of the tail plane to ensure that the shoe brackets of the centre joint do not foul the brackets supporting the rudder and elevator locking systems.



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Fig. 10. Fin and tail plane attachments

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