Chapter 2-1

DESIGN ASPECTS OF CORROSION PREVENTION

CONTENTS

(continued)

CONTENTS (continued)

Introduction

1 Prevention of corrosion and resistance to corrosion are two of the many important factors that must be considered when aircraft equipment and components are being designed. Means of preventing or retarding corrosion on specific parts may be important from the standpoint of ensuring proper engineering function, contributing to service life or producing and maintaining good appearance. Corrosion is best combated at an early stage in design and an awareness of this fact is evident, as more contractual control is incorporated in design specifications. Minimum standards of protection for Service aircraft are laid down in Def Stan 00-970 and similar instructions.

2 The choice of corrosion preventive methods is greatly affected by the environment and other effects to which the component may be subjected. The environment may include factors such as sunlight, moisture, temperature, chemical action, salt, galvanic action, wear, abrasion and stress.

3 In general, the corrosion resistance requirements of most aircraft parts may be satisfied by one or more of the following choices:

3.1 Selection of a suitable material or metal.

3.2 Design of parts with corrosion resistance and production considerations in view.

3.3 Use of suitable inhibitors.

3.4 Suitable choice of protective treatments and/or protective coatings.

3.5 Allowance for the effects of moisture.

Metal selection

4 The selection of a metal is a complex process and generally corrosion resistance is not the most important consideration in its selection. The factors that must be considered include the following:

4.1 The rate of corrosion of the metal in service.

4.2 The physical properties of the metal.

4.3 Ease of fabrication and the properties of the metal after it has been worked.

4.4 Availability and cost.

DESIGN AIDS

Design relative to environment

5 The duration of the exposure of a component, the nature of the corroding environment and the materials used in manufacture determine the protection that must be given to ensure the required corrosion resistance.

6 Much can be done to minimize corrosion by avoiding, as much as possible, the exposure of metal parts to wetness, salt water and other corroding influences. It is often more economical to avoid wet conditions by providing good drainage and ventilation than to use special corrosion resistant materials and/or protective coatings. A combination of good design technique and protective coating is required to achieve the necessary protection and fig 1 to 20 illustrate design principles that may be used to combat corrosion.

Water and dirt traps

7 Whenever possible water and dirt traps should be avoided. Flanges should point downwards as illustrated in fig 1, 2 and 3 so that if the component is wetted the water will drain off. Fig 3 shows channel and angle sections and it can be seen that they may act as water troughs when positioned in certain ways (fig 3a and b). If the channel or angle cannot be suitably positioned as at fig 3d then drain holes should be provided as in fig 3c. In certain circumstances the channel or angle may be sealed as shown in fig 3e and 3f. Open channels with correctly sited drain holes are preferred, sealed channels promote condensation and make corrosion difficult to detect. If sealed channel sections must be used, they should be coated internally, where possible, with a long term protective treatment such as PX-32.

8 Fig 4 shows typical faying surfaces as found in an aircraft. Where water is likely to collect care should be taken that it is not trapped as in fig 4a. Fig 4 also illustrates generally the principles that water traps should be avoided and that water should not be allowed to seep between mating surfaces. Where possible, drainage should be provided by positioning drain holes as close to trap-causing members as strength and fatigue considerations permit. Consideration should be given to the use of lightweight, non-porous filler over a sealant bed to fill likely entrapment areas (fig 4b and 4c).

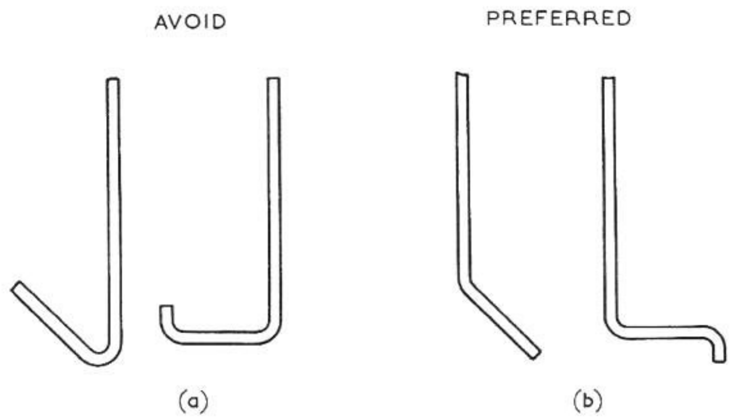

Fig 1 Flange design

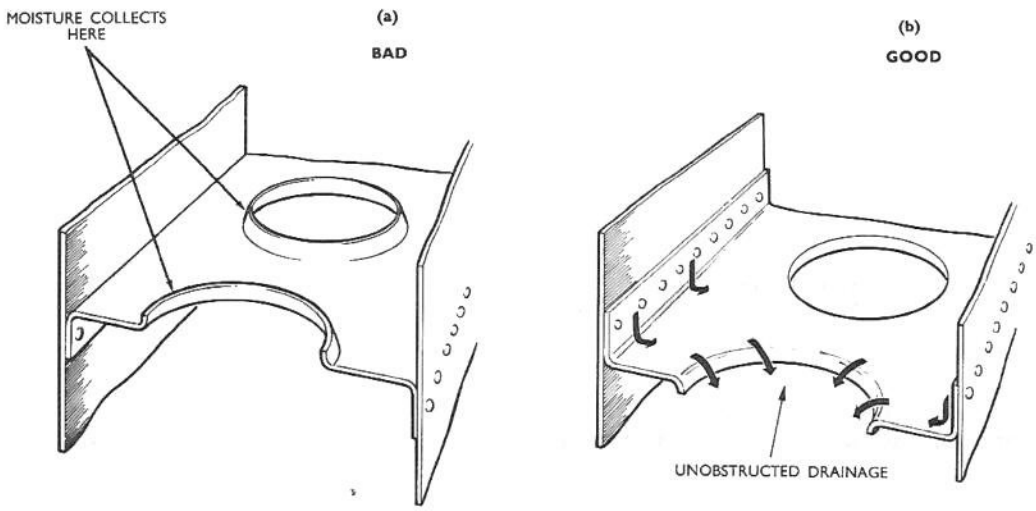

Fig 2 Lightening holes in horizontal diaphragms

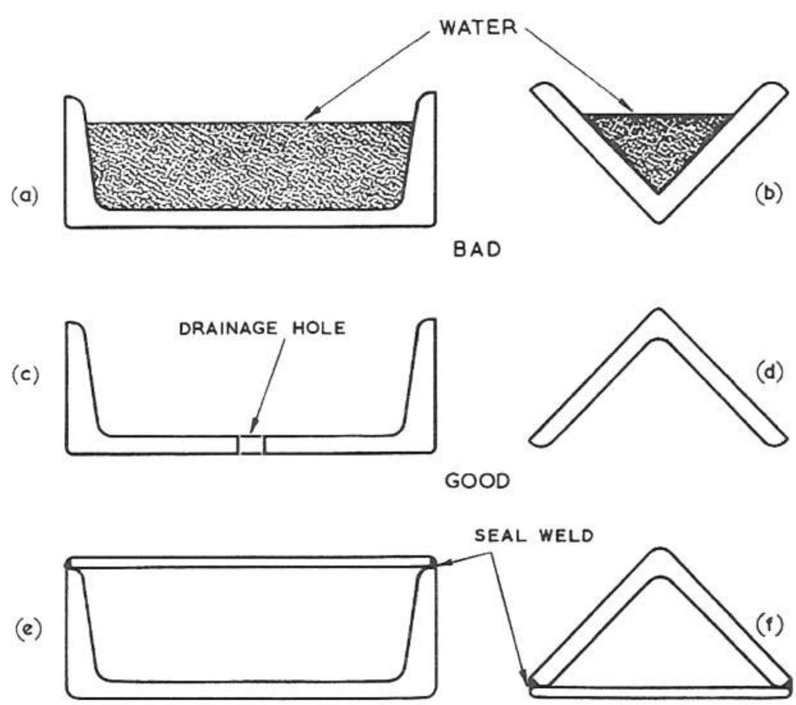

Fig 3 Design of channels and angles

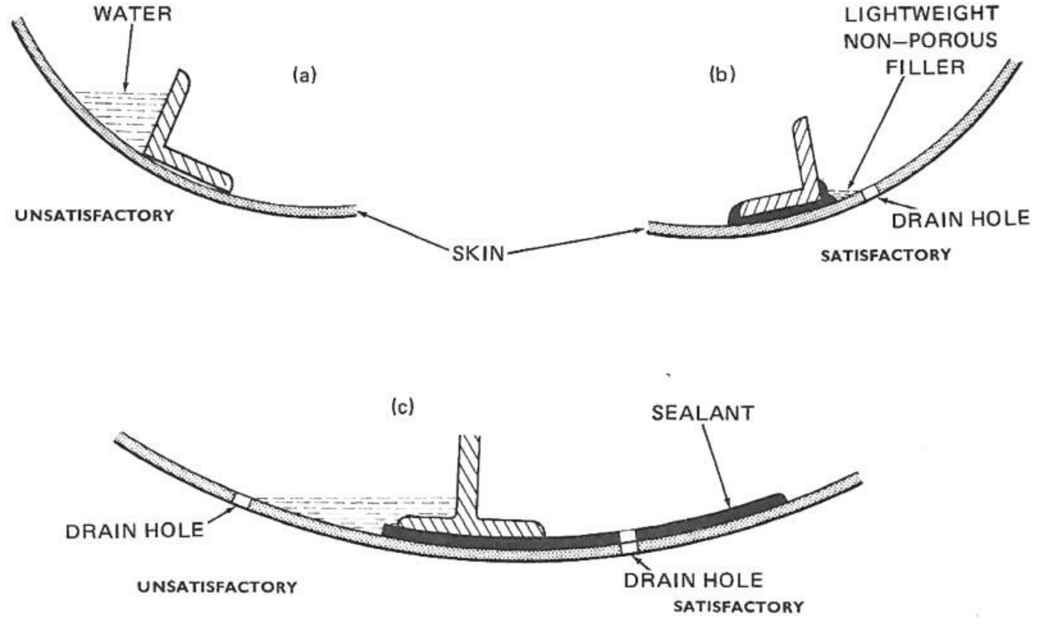

Fig 4 Water traps and faying surfaces

9 Internal corners should be rounded as shown in fig 5. If this is not done the corner may be difficult to clean and residual dirt may tend to retain moisture and promote corrosion.

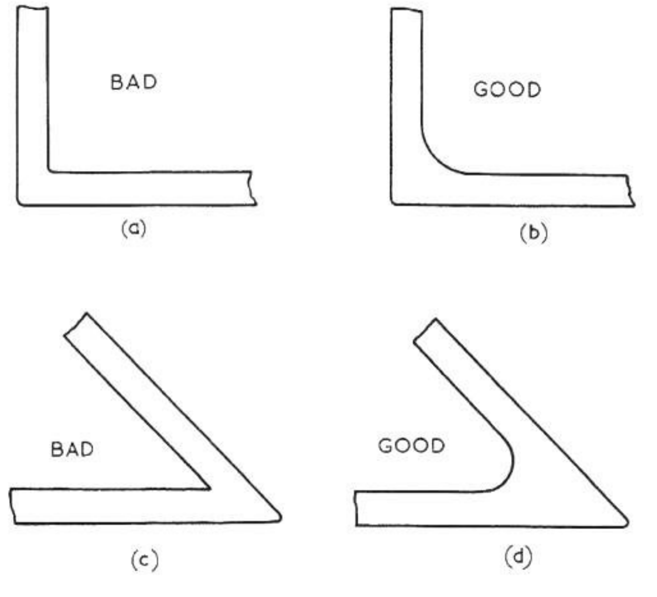

Fig 5 Design for easy cleaning

NOTES TO TABLE 1

(a) Where contact between magnesium and magnesium alloys is necessary, the use of aluminium alloys with low or negligible copper content is preferred.

(b) In contact with thin (decorative) chromium plate use class C. With thick plating, as used for wear resistance, use class B.

(c) When contacts between copper or copper rich materials and aluminium alloys cannot be avoided, a much higher degree of protection against corrosion is obtained by first plating the copper rich material with tin or nickel and then with cadmium, than by applying a coating of cadmium of similar thickness. The aluminium in contact with the copper rich material should be anodised when practicable.

(d) When magnesium corrodes in sea water or certain other electrolytes, alkali formed at the aluminium cathode may attack the aluminium.

(e) When it is not practicable to use other more suitable methods of protection (for example, spraying with aluminium), zinc may be useful for the protection of steel in contact with aluminium despite the accelerated attack upon the coating.

(f) This statement should not necessarily discourage the use of the second metal as a coating for the metal considered, provided that continuity is good. Under abrasive conditions, however, even a good coating may become discontinuous.

(f) In these cases the second metal may provide an excellent protective coating for the metal considered. The latter is usually electrochemically protected at gaps in the coating.

(h) When aluminium is alloyed with appreciable amounts of copper it becomes more noble and when alloyed with appreciable amounts of zinc it becomes less noble. These remarks apply to bimetallic contacts and not to inherent corrosion resistance. Such effects are mainly of interest when the aluminium alloys are connected with each other.

(j) No data available.

(k) In some immersed conditions the corrosion of copper or brass may be seriously accelerated at pores or defects in tin coatings.

(l) Serious acceleration of corrosion of 18/2 stainless steel in contact with copper or nickel alloys may occur at crevices where the oxygen is low.

(m) Normally the corrosion of lead/tin soldered seams is not significantly increased by their contact with the nickel base alloys but under a few immersed conditions the seams may suffer enhanced corrosion.

(n) Tin should not be used in contact with cadmium in joints liable to be heated above 120°C (248°F).

(p) Joints liable to crevice corrosion when the oxygen supply is limited.

(q) Under some circumstances cadmium can penetrate titanium alloy and embrittle it. A warning of the danger is given in Def Stan 00-970 Leaflet 801/1.

(r) There is evidence that elevated temperatures in certain atmospheres, for example exhaust gases, silver coatings may cause cracking of stressed titanium alloy parts.

TABLE 1 DEGREE OF CORROSION AT BIMETALIC CONTACTS

Note . . . .

Where a metal is plated the behaviour should be sought under that of the plated coating

KEY Class A The corrosion of the first metal is not increased by the second metal
Class B The corrosion of the first metal may be slightly increased by the second metal
Class C The corrosion of the first metal may be markedly increased by the second metal
Class D The corrosion of the first metal may be very seriously increased by the second metal

First metal \ Second metal	Gold platinum, rhodium, silver	Monel, inconel, nickel/molybdenum alloys	Cupronickels, silver solder, aluminium bronzes, tin bronzes, gunmetals	Copper, brasses, nickel silvers	Nickel	Tin and soft solders lead	Steel and cast iron	Cadmium	Zinc	Magnesium and magnesium alloys (chromated)	Stainless steels: Austenitic 18/8 Cr/Ni	Stainless steels: 18/2 Cr/Ni	Stainless steels: 13% Cr	Chromium	Titanium	Aluminium and aluminium alloys
Gold, platinum, rhodium, silver	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A (r)	A
Monel, inconel, nickel/molybdenum alloys	B	–	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Cupronickels, silver, solder, aluminium bronzes, tin bronzes, gunmetals	C (f)	B or C	–	A	A	A	A	A	A	A	B or C	B	A	B or C	B or C	A (c)
Copper, brasses, nickel silvers	C (f)	B or C	B or C	–	B or C	B or C (k)	A	A	A	A	B or C	B or C	A	B or C	B or C	A (c)
Nickel	C	B	A	A	–	A	A	A	A	A	B or C	B or C	A	B or C	B or C	A
Tin and soft solder, lead	C	B or C (m)	B or C	B or C	B	–	A or C	A	A or C	A	B or C	B or C	B or C	B or C	B or C	A
Steel and cast iron	C	C	C	C	C (f)	C (f)	–	A (g)	A (g)	A	C	C	C	C (f)	C	B (g)
Cadmium	C	C	C	C	C	B (n)	C	–	A	A	C	C	C	C	C (q)	B
Zinc	C	C	C	C	C	B	C	B	–	A	C	C	C	C	C	C (e)
Magnesium and magnesium alloys (chromated)	D	D	D	D	D	C	D	B or C	B or C	–	C	C	C	C	C	B or C (e)
Stainless Steel: Austenitic 18/8 Cr/Ni	A	A	A	A	A	A	A	A	A	A	(p)	A	A	A	A	A
Stainless Steel: 18/2 Cr/Ni	C	A or C (l)	A or C (l)	A or C (l)	A	A	A	A	A	A	A	(p)	A	A	(j)	A
Stainless Steel: 13% Cr	C	C	C	C	B or C	A	A	A	A	A	C	C	(p)	C	C	A
Chromium	A	A	A	A	A	A	A	A	A	A	A	A	A	–	A	A
Titanium	A (r)	A	A	A	A	A	A	D (q)	A	A	A	A	A	A	–	A
Aluminium and aluminium alloys (h)	D	C	D (c)	D (c)	C (f)	B or C	B or C	A	A	A (d)	B or C	B or C	B or C	B or C (b)	C	(h) (p)

Inaccessible spaces

10 Box sections (fig 6) cannot usually be inspected and cleaned without dismantling. Consideration should be given to the provision of inspection apertures for intrascope access. These apertures can also be utilised for the application of protectives such as PX-32, subject to the approval of the Design Authority or Engineering Authority as appropriate. Apertures may be left open to facilitate ventilation (and so prevent condensation) or if this is impractical, rubber plugs or grommets may be inserted.

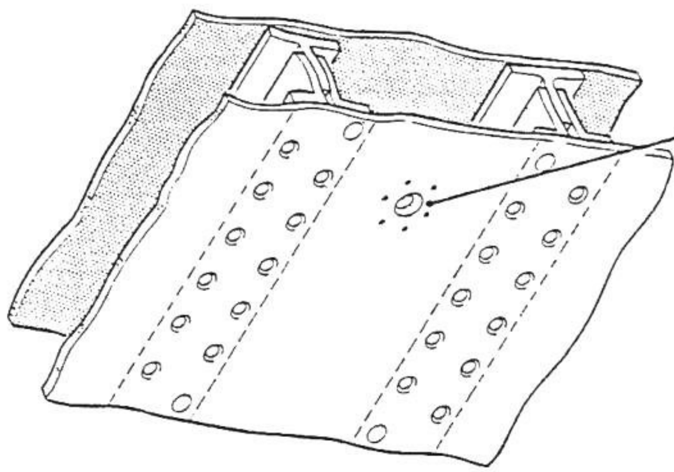

Fig 6 Box section

Dissimilar metal contact

11 Fig 7 and 8 give examples of dissimilar metal joints. Where dissimilar metals are joined, it is important that there should be an effective seal between mating surfaces. Examples of such seals are given in fig 7b and 8c. In some instances it may not be possible to avoid the contact of dissimilar metals. Where this occurs, it should be ensured that the anodic or less noble metal has the greater exposed area. The design of fig 7a would be improved if a steel rivet could be used in place of the aluminium rivet. Fig 8a and 8b show how corrosion occurs at the aluminium rivet when passed through a steel structure and of a steel rivet through an aluminium structure. Both conditions are undesirable and should be avoided.

12 Table 1 shows the degree of extra corrosion that can occur on a metal owing to bimetallic contact with another metal. The table replaces earlier tables of potential difference which could be misleading. Although the potential difference is the prime driving force of the corroding current, the magnitude of the potential is not a reliable guide to the degree of corrosion suffered by any particular contact.

13 The information contained in Table 1 is largely qualitative. Knowledge and experience of certain combinations of metals shown in the table is not comprehensive and it is not possible to tabulate the effects of a wide variety of exposure conditions. The classes show the acceleration of corrosion resulting from the dissimilarity of the metals in contact. No information is given on the basic corrosion resistance inherent in the particular metal. It should be noted that carbon fibre composite (CFC) materials will behave as noble metals. Care should be taken to ensure that CFC components are insulated electrically, either by the use of adhesive bonding techniques or by painting the CFC component prior to wet assembly. Direct contact with magnesium alloy, aluminium alloy, non-corrosion resisting steel, cadmium and

zinc surfaces should be avoided.

14 For further details on dissimilar metal corrosion and potentials, reference should be made to Chapter 1-2. For information on earth points and corrosion prevention see AP 113A-0307-1.

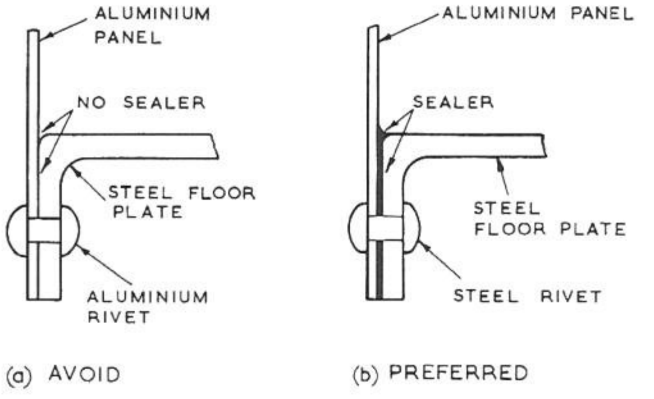

Fig 7 Dissimilar metal corrosion (floor attachment)

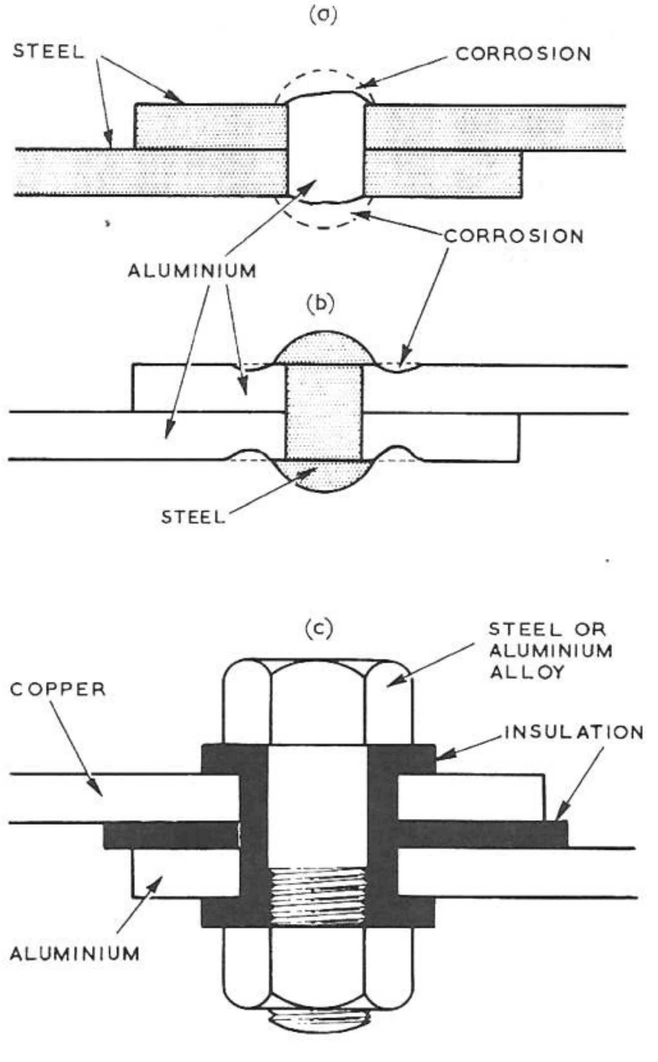

Fig 8 Dissimilar metal corrosion (bolted and riveted joints)

Condensation

15 Condensation occurs on uninsulated structures. Moisture from the surrounding atmosphere is deposited on the cold metal and electrolytic corrosion may occur. If the structure can be insulated as shown in fig 9a condensation will be reduced, but will still occur on the skin as a result of heat loss from the 'I' section member. Further insulation as shown in fig 9b will prevent almost all condensation.

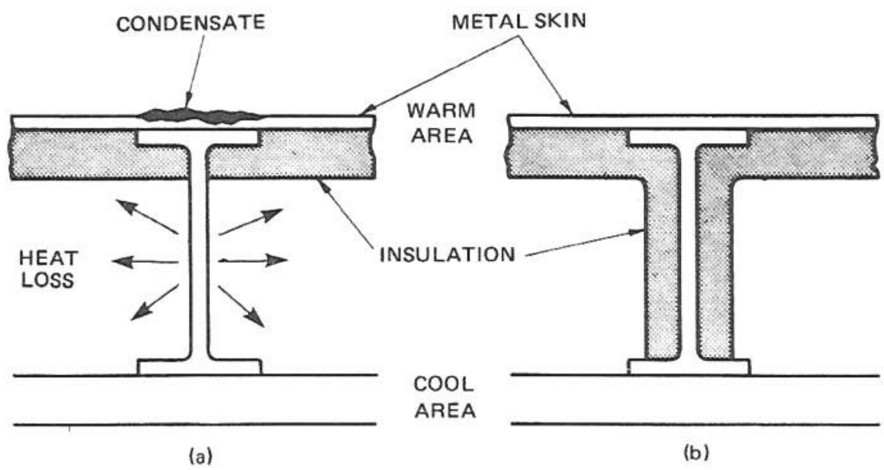

Fig 9 Preventing condensation on structures

16 Fig 10 shows a box fitted with a vent pipe. The chilling of moist air in a confined space causes condensation and this can cause misting of viewing windows, corrosion of internal components and emulsification of oil. Provision should be made for closed boxes to be ventilated or for the internal temperature to be maintained above the dew point. In some instances the air in the box can be dried before the box is sealed and then a vent pipe is unnecessary.

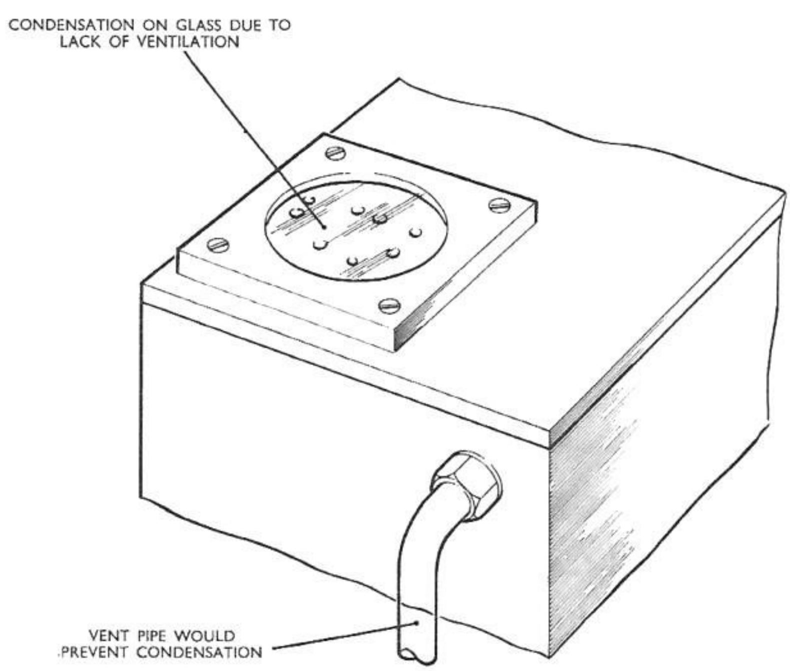

Fig 10 Preventing condensation in boxes

Pipe connections

17 Fig 11 shows good, bad and poor pipe connections. It is good engineering practice to ensure that pipe flows are smooth and uninterrupted. This is particularly important where toilet and galley pipes are involved, since waste elements trapped in crevices may have a strong corrosive effect on metal pipes. Plastic pipes may be effectively employed in some circumstances. For further information on aircraft drainage systems in toilets and galleys, refer to para 55.

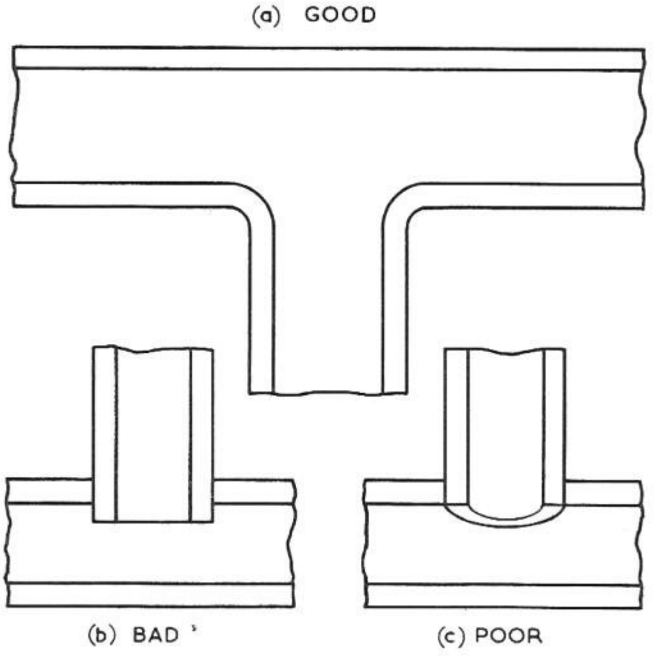

Fig 11 Pipe connections

Sealing

18 Fig 12 to 15 show general sealant applications. Dimensions shown on the figures are for guidance only and further information should be obtained from the manufacturers concerning a particular sealant application. Information on the application of sealant is normally contained in Topic 1 and/or 6 for the aircraft concerned. The object of sealing is to prevent the ingress of dirt, water and contamination, to prevent or mitigate vibration and noise, to present a surface for paint. For information concerning sealant as a supplementary protective, refer to Chapter 2-2.

Riveted and welded joints

19 Ideally, sealant should be used between the mating surfaces of riveted joints as in fig 16c. The omission of sealant may lead to dissimilar metal corrosion or crevice corrosion. Even if the mating parts are constructed of the same metal, there may be slight differences in composition of the parts which, if they are in direct contact, may lead to dissimilar metal corrosion. It is not to be expected that the use of sealant between faces will totally insulate the metals from each other. The electrical resistance between the metals may be considerably increased as the result of the application of sealant and will thus reduce or eliminate electrolytic corrosion between them.

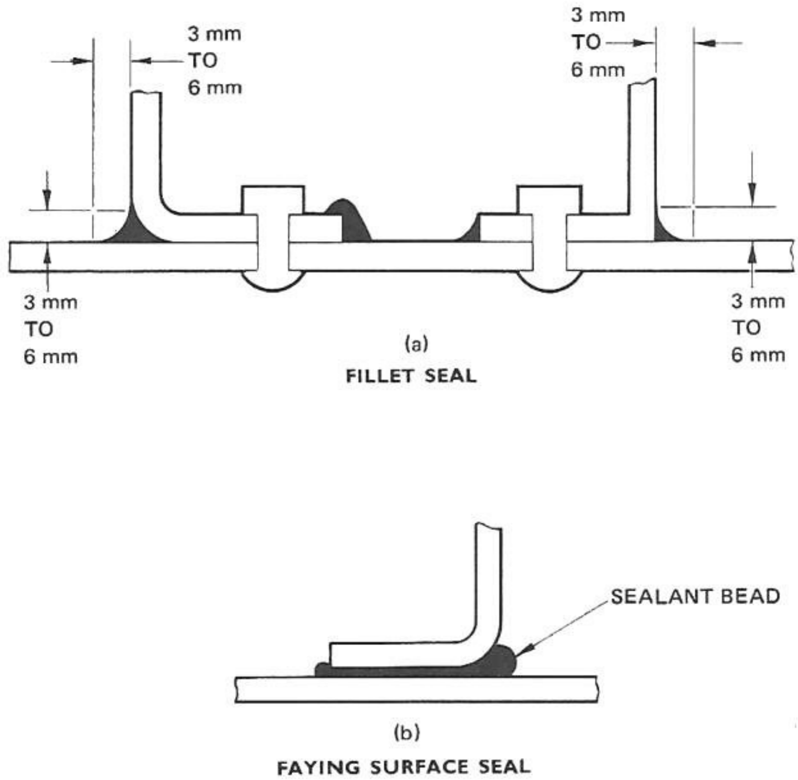

Fig 12 Sealing fillets and faying surfaces

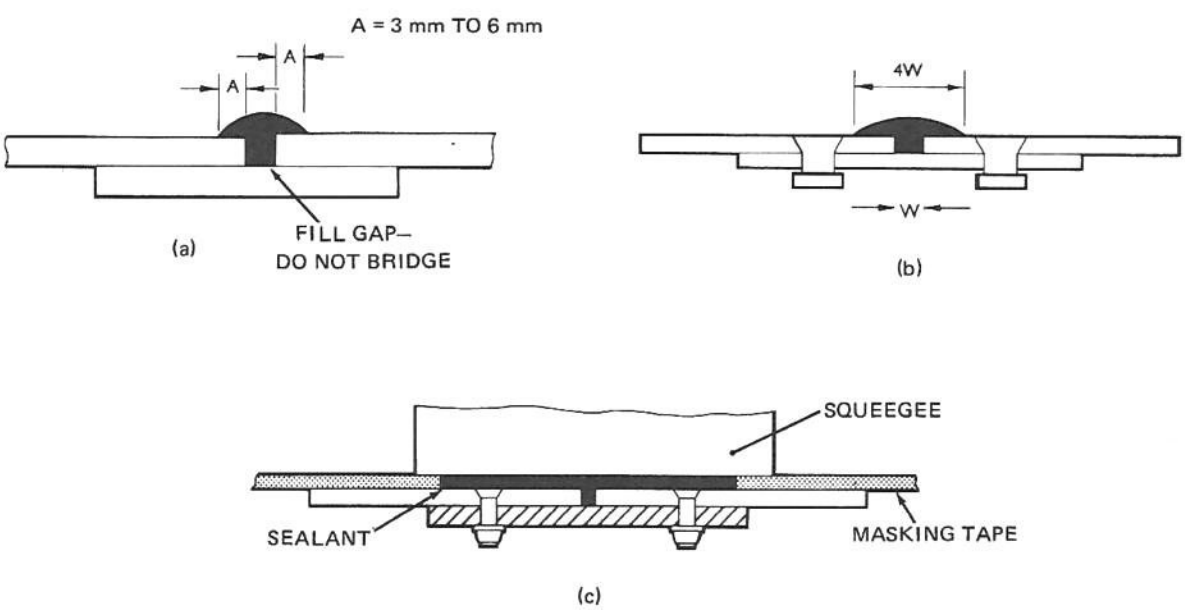

Fig 13 Sealing butt joint gaps

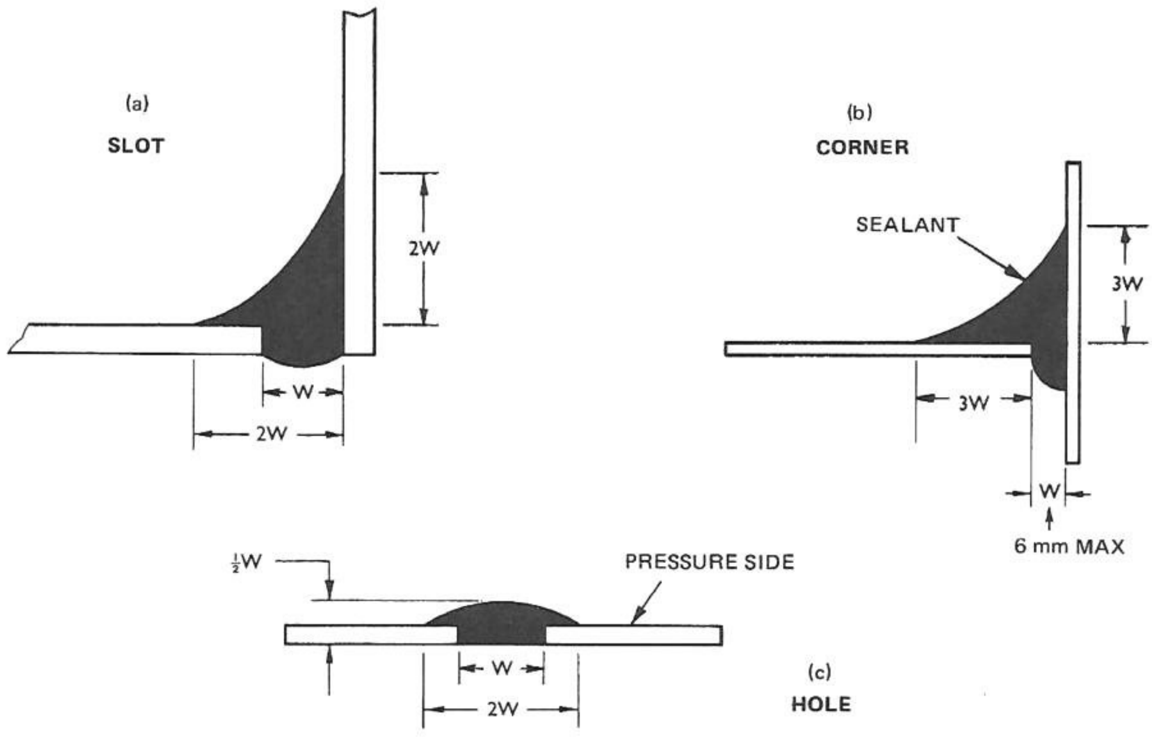

Fig 14 Sealing holes, slots and corners

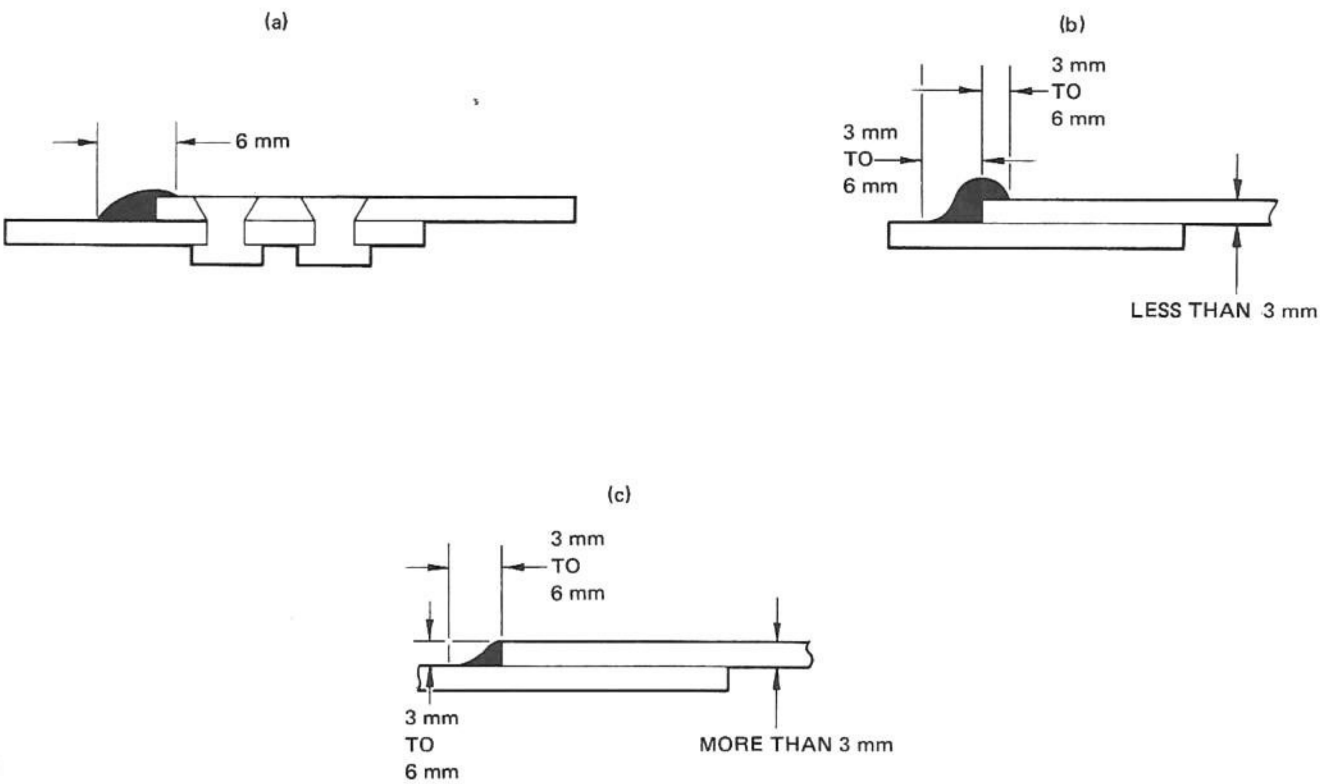

Fig 15 Sealing lap joints

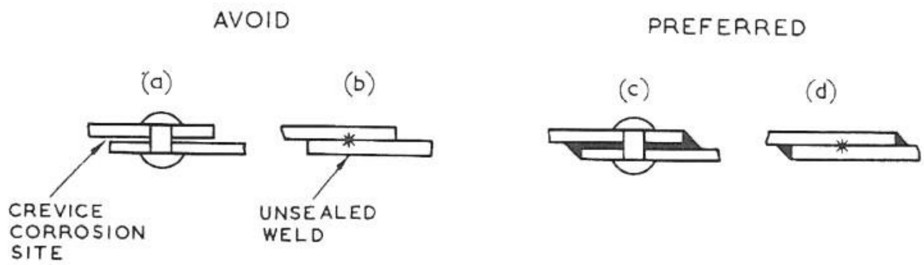

Fig 16 Sealing a butt joint

20 Fig 17 shows two parts spot welded together. It is difficult to ensure that spot welded joints are protected from corrosion. One solution is to seal the edges of the joint, however this is not effective if water is trapped in the joint or if corrosion exists before the sealing is done. Sealants are available which can be placed in position before welding, and remain effective after welding. Manufacturers should be consulted about these materials. (See also Def Stan 00-970, Leaflet 402/1.

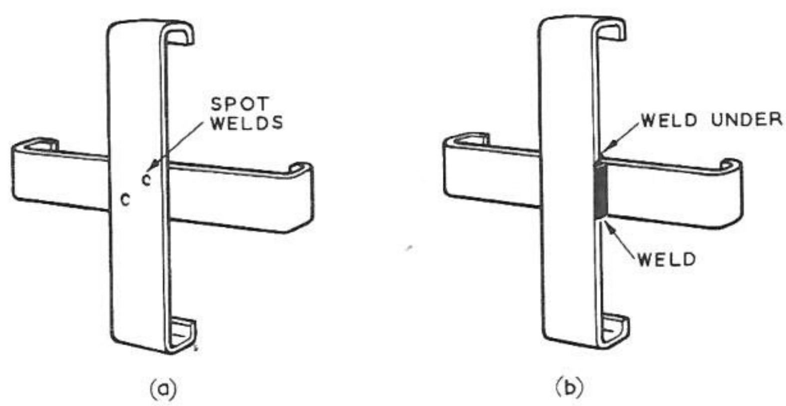

Fig 17 Method of welding straps

Paint adhesion at corners

21 Fig 18 and 19 illustrate painting features. Paint adheres poorly at sharp corners. If possible sharp corners should be avoided where paint or other protective coating is applied.

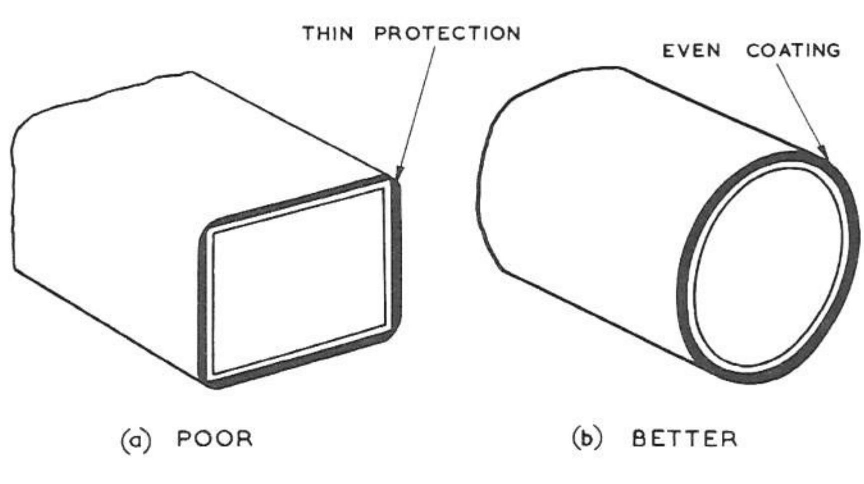

Fig 18 Paint adhesion on rectangular and circular components

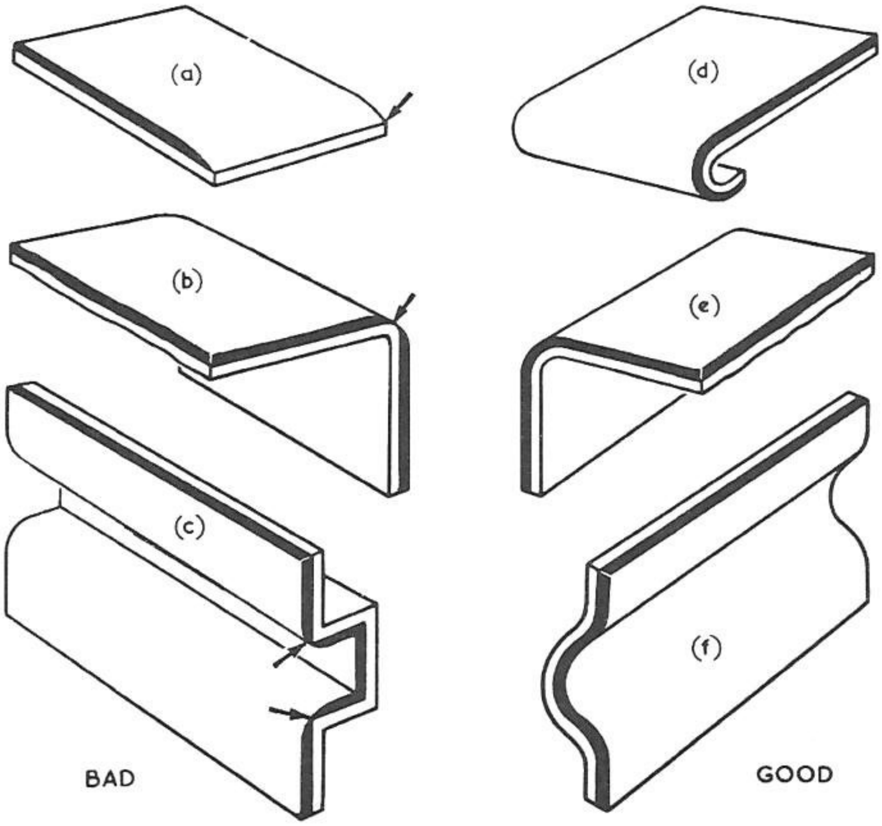

Fig 19 Paint and sharp corners

Heat treatment and machining

22 As a result of machining, an unsatisfactory heat treatment zone may be exposed in a plate or alloy extrusion (fig 20). Wherever possible, machining cuts should be so positioned that regions of poor metallurgical condition, identified in practice by NDT, are not exposed.

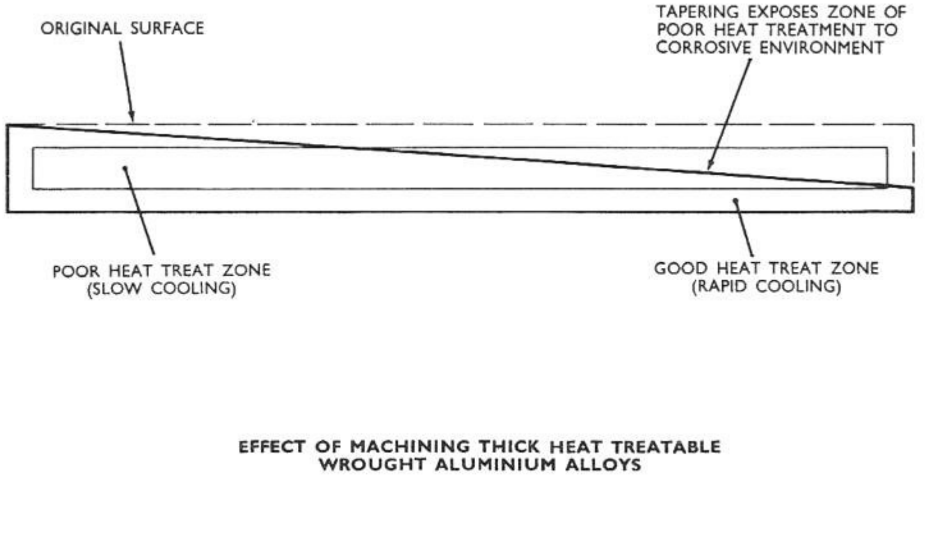

Fig 20 Machined plate or alloy extrustion

STRESS CORROSION

Introduction

23 Only aspects of stress corrosion cracking of particular interest to the designer are discussed here. A detailed discussion of stress corrosion is given in Chapter 1-2.

Mitigation of stress corrosion cracking of metals

Variables to be considered

24 The interactions of tensile stress, temperature, and corrosive environment may eventually lead to stress corrosion cracking. Ajusting one or more of these factors may reduce the tendency of a component to crack. Stress corrosion cracking is not limited to metals. Fig 21 illustrates in diagrammatic form the effect of stress, temperature, environment and time on stress corrosion cracking. Another important factor is alloy composition.

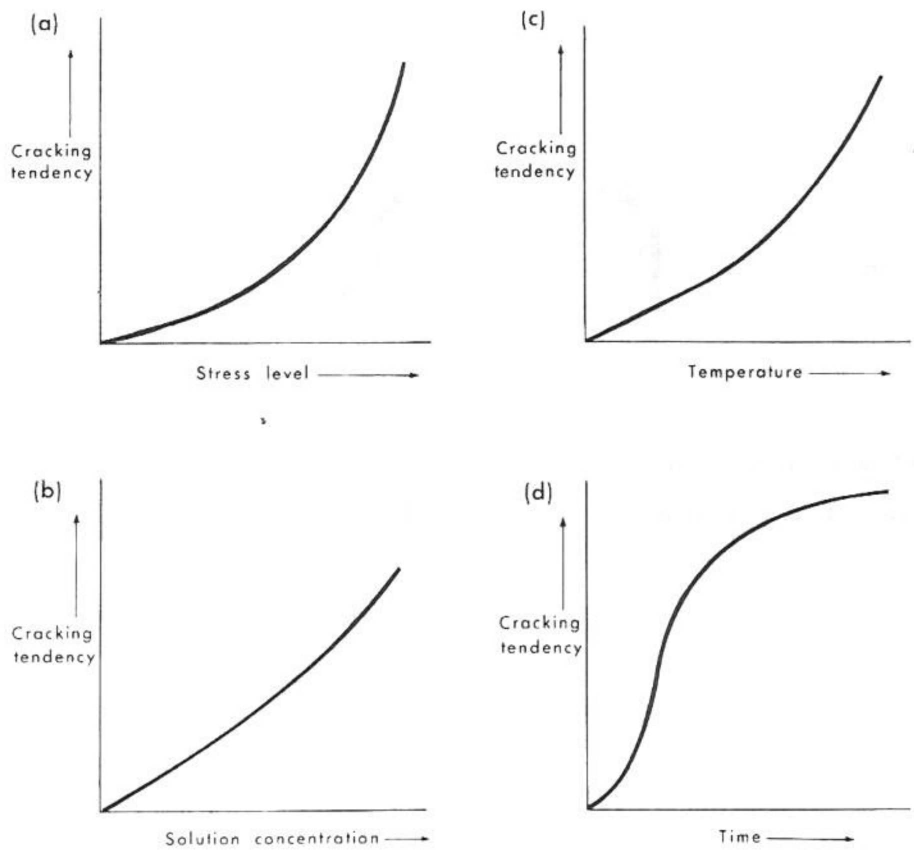

Fig 21 Variables which affect stress corrosion cracking

25 The term stress corrosion cracking suggests general procedures for the mitigation of this type of failure: if tensile stresses can be avoided in the structure or if the corrosive environment can be eliminated, the problem ceases to exist. However, many uses subject materials to stress in corrosive environments.

Reduction of residual tensile stresses

26 Surface, tensile stresses may be caused by residual strains within the material or by externally applied loads. Typical causes of residual stresses are deformation of a metal during manufacture and assembly by welds, rivets,

bolts, press fits, shrink fits, spinning, deep drawing, rolling, punching, unequal cooling of a section after heat treatment or manufacturing process, phase change or re-arrangement of the crystal structure within a metal. Residual stresses may occur in a component as the after effect of external loads.

27 In some instances it may be practical, economical and desirable to stress relieve components after or during the manufacturing process. Specifications for stress relieving by annealing and heat treatment may be obtained in standard specifications, or from metal manufacturers. Certain aluminium alloys may be converted by duplex ageing heat treatment to the tempers which are less susceptible to stress corrosion cracking. Specialist advice and approval must be obtained before such heat treatment is applied.

Inducing surface compressive stress

28 Stress corrosion cracking can be delayed by introducing a compressive stress into the surface of the metal. This can be done by shotpeening, tumbling, rolling, swaging or stretching. Care must be taken to ensure that the compressed skin is not removed by machining or corrosion.

Reduction of applied loads

29 The stresses resulting from operating conditions can often be lowered by changes in design. Increasing the metal thickness in thin sections, when design considerations will permit, is an effective method of lowering the applied stress by distributing it over a larger cross sectional area. Increasing the mass of metal in a component may lead to difficulties of heat treatment and an increase in residual stresses.

30 Applied stresses may be reduced by avoiding misalignment of bolted or welded connections, avoiding thermal differential expansion if possible and by lowering operating loads.

The corrosive environment

31 Cracking in aqueous solutions is the most common form of stress corrosion; some moist gases can also promote it. Many high strength alloys are susceptible to stress corrosion attack in certain environments.

32 Generally, little can be done to alter a corrosive environment. The component can be protected by a coat of paint or other protective material. In some instances it may be possible to remove an item from its corrosive environment. For example, an aircraft may be placed in a hangar or stored away from a sooty, sulphur laden atmosphere. Inhibitors may be placed in the water that collects in bilges.

33 Crevices, potentially sites for solution concentration, should be eliminated where possible by the use of sealants. Design should avoid producing stagnant spots. For example, baffles in fuel tanks may cause such a situation however, by the utilisation of the swirl pattern produced by fuel movement through the baffle, the creation of totally stagnant areas may be reduced or avoided. Generally, environmental variations are detrimental.

Alteration of temperature

34 As shown in fig 21c, the cracking susceptibility of a metal increases with increase in temperature. Exceptionally, this relationship is inverted when low alloy and carbon steels are heated in an environment of hydrogen sulphide.

35 If the operating temperature is high, its reduction may prevent cracking. High temperatures are not likely to present problems in aircraft structures except in the vicinity of exhaust gas emission.

Choice of alloy

36 The solution of many stress corrosion problems, is to substitute an alloy that is more resistant to failure under the conditions of use than the alloy which has given trouble. Reference should be made to Chapter 1-2 for some details concerning alloys and their corroding environments.

Effect of exposure time

37 Generally, the time to failure decreases with increasing stress levels, temperature and environment concentration. However, under a given set of conditions it has been found that the time to failure of replicate specimens may vary widely, but there is reason to assume that the time to failure in a given instance varies in a statistical manner. If some knowledge of the time to failure is known, this may influence a designer to adopt alternative designs. Reference should be made to Chapter 1-2 for further details on exposure time and to fig 21.

Designing around stress corrosion

38 Most of the designer's efforts to check stress corrosion cracking are concentrated on minimizing surface stresses and controlling grain flow so that exposure of transverse (across the grain) flow to the action of a corroding environment is minimized.

39 One method of improving grain flow in a manufactured component is shown in fig 22. Fig 22a shows the forging and the manner in which the component is manufactured from the forging before modification.

40 Fig 22b shows a modified forging. In this the leg of the 'T' section has been lengthened and the grain flow for the finished product has been improved. In the forging shown in fig 22a the vertical legs are satisfactory but the horizontal legs expose a transverse grain section (end grain) to the environment. Extending the leg as in fig 22b improves the grain flow and in the finished product there is less exposed transverse grain.

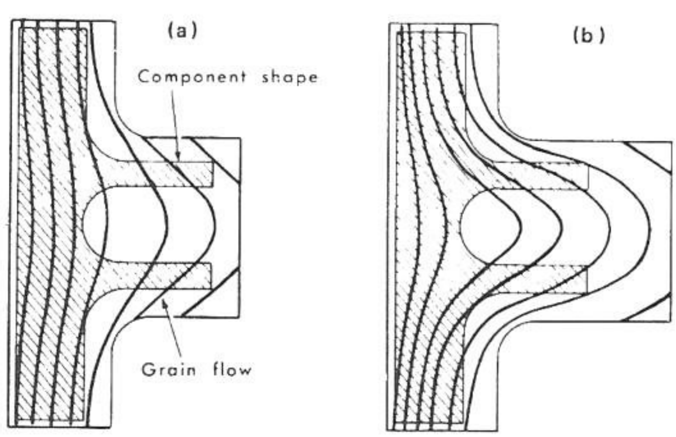

Fig 22 Improving grain flow

41 Sudden discontinuities should be avoided and fig 23 shows an example of how the grain flow can be improved by the incorporation of a fillet in the component forging. It is also evident that the stress concentration at

corners is improved by the inclusion of this fillet.

Laminated sections

42 In addition to the measures taken in the preceding paragraphs, designers may sometimes reduce stress concentrations in components by constructing them of laminated sections. In some instances where a difficult stress corrosion problem exists this may be a solution.

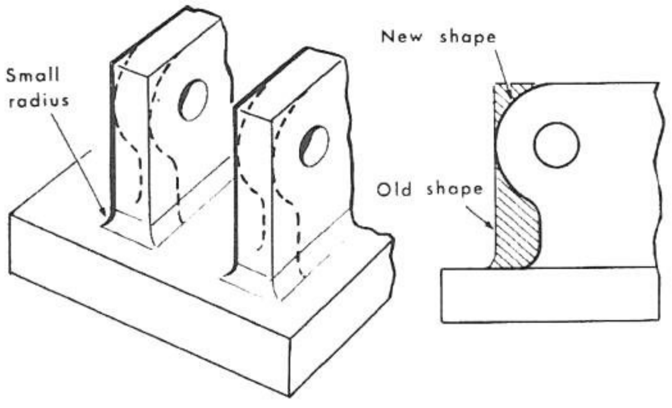

Fig 23 Improving contour

FATIGUE AND THE CORROSION ENVIRONMENT

43 Information on the nature of corrosion fatigue may be obtained from Chapter 1-2.

Combating corrosion fatigue

44 Many methods for combating fatigue corrosion have been adopted. These include the addition of chromate inhibitors and emulsifying oils to corrosive environments or the use of protectve coatings on metal surfaces. Ceramic coatings, paints and other organic coatings have all proved beneficial. Certain metal coatings, in a state of compression and free from cracks, can also increase the fatigue life of a metal specimen.

45 Peening and nitriding are two further methods for improving the fatigue behaviour of metals. In peening, the surface of a component is bombarded with small, hard particles moving at high speed. These treatments put the metal surfaces into a state of compression and make it more difficult for cracks to start in them.

46 Fig 24 and 25 show the improvement that may be expected in corrosion fatigue life as the result of shot-blasting and peening. The influence of surface pretreatments is still effective under corrosion fatigue conditions and full paint protection can improve the results so that the behaviour of samples is similar to that of the plain untreated specimens without salt spray.

47 Nitriding has a similar effect to peening but is only applicable to steels. The component is heated in an atmosphere of cracked ammonia at a temperature of about 500°C (932°F) so that hard, voluminous nitrides of the alloying elements are formed which again put the surface into a state of compression. The alloying elements may be chromium, aluminium or molybdenum.

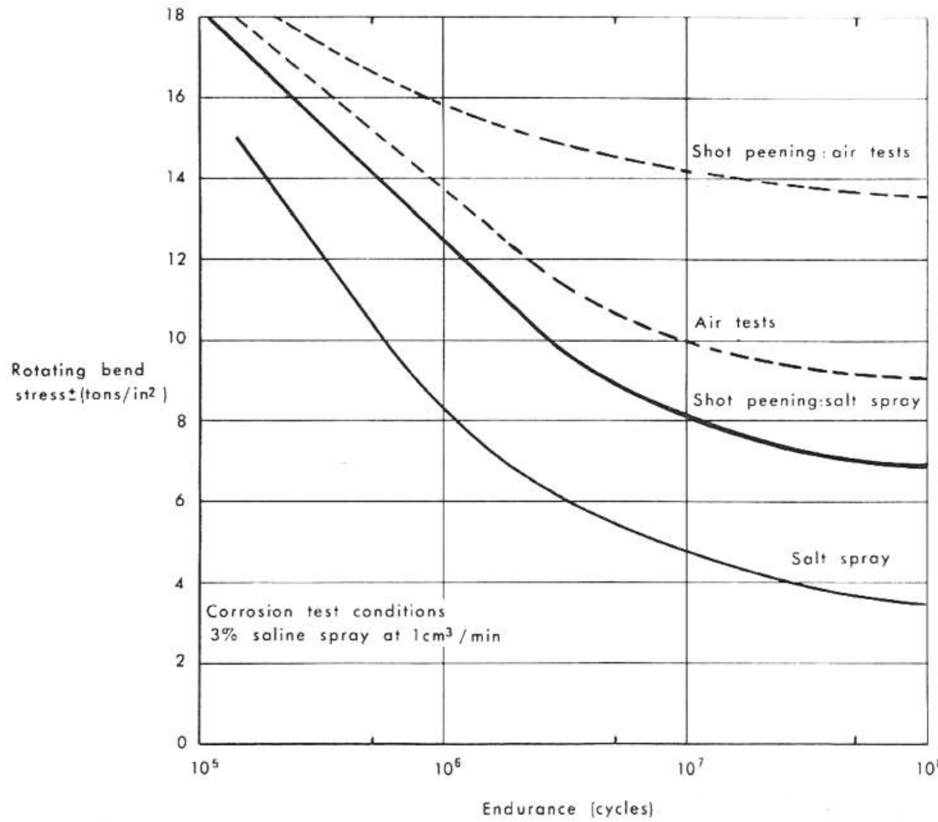

Fig 24 The improvement of corrosion fatigue strength by shotpeening Al/Zn/Mg alloy (DTD 363)

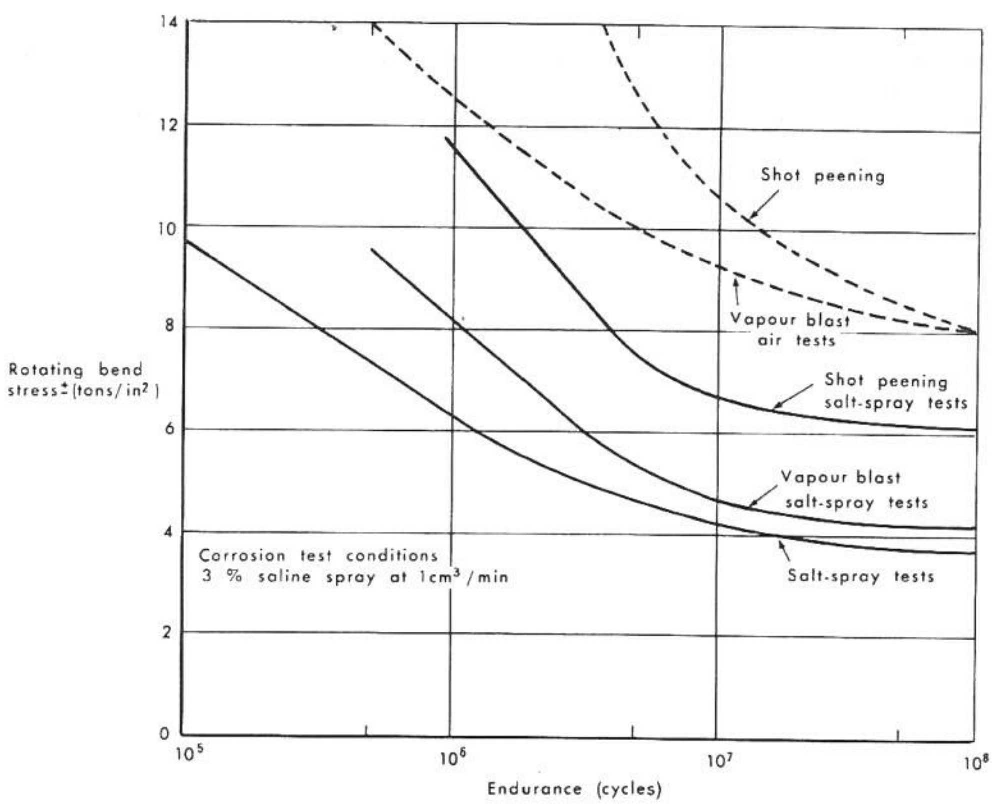

Fig 25 The influence of shotpeening and vapour blasting on the fatigue and corrosion fatigue resistance of Al alloy (RR 58)

48 During manufacture, sharp corners and notches should be eliminated wherever possible and all angles replaced by smooth, rounded fillets. Surfaces with a high polish are much less liable to carry dangerous, stress raising notches than rough surfaces.

MISCELLANEOUS CORROSION ASPECTS

Microbiological contamination of fuel tanks

49 The subject of microbiological contamination is discussed in Chapter 1-2. Design efforts should be aimed at the provision in fuel tanks of coatings that are resistant to micro-biological attack. It should be possible to clean and maintain the fuel tanks and to drain water from the bottoms of the tanks. Inhibitors may be added to the fuel or contained in porous bags suspended in the tanks.

Fretting of joints

50 The rubbing action between two joint parts, even if it is only elastic movement, may cause attrition of the metal surface and promote failure by fatigue earlier than it might otherwise occur. By selection of the correct surface treatment and/or organic protective, joint life can be prolonged. Reference should be made to Chapter 1-2 for further information on fretting corrosion.

Deterioration of organic materials

51 Even non-metallic materials are subject to the effects of the environment. The corrosion of metallic parts can be accelerated by the breakdown products of organic materials and by crevices formed at contacts with non-metallic components which have themselves deteriorated.

52 Plastics crack when subjected to stress and the action of certain solvents. It should be ensured that plastic materials are stressed within safe limits and that they are able to resist the environment.

53 Rubbers also crack in a similar manner to that of the plastics. This may be caused by stress, age hardening or the action of substances such as ozone. Advice on the choice and use of rubber materials should be obtained from manufacturers.

Corrosion of bearings

54 Bearings are a constant cause of concern since they are particularly susceptible to seizure resulting from general corrosion, as well as being liable to fail as a result of stress and intergranular corrosion. Provision should be made for easy lubrication of bearings in designs, or sealed bearings should be used. They should be protected from water ingress as far as possible.

Toilet and galley installations

Poor design features

55 Many toilet and galley installations in aircraft have design features which by their very nature create corrosion problems. Some of the more common design failings are:

55.1 Inadequate splash guards and drip trays in toilet compartments.

55.2 Unsealed floor coverings in toilet and galley compartments.

55.3 Leaking drain pipes and connections.

55.4 Badly routed drain systems incorporating sharp bends and unsuitable materials.

55.5 Inadequate protection of structures against materials liable to contaminate them. For example, structures may be left unpainted or painted with inferior paint schemes.

Desirable design features

56 The following features are considered essential if corrosion is to be avoided:

56.1 The installation should be fabricated and, where possible, installed as a self contained unit which is in contact with the aeroplane structure only at its points of attachment. At these points the best available protective materials and sealants should be used. The unit should be easily removable from the structure.

56.2 The complete unit should stand on a one piece non-metallic tray which should enclose the drainage and replenishment pipes. The edges of the tray should extend upwards, except at the entrance which should be well away from any potential spillage, and should be well sealed to the side walls of the compartment. The unit should be designed to be easily cleaned, with no sharp corners, water or dirt traps. It is recommended that the maximum use of glass fibre reinforced plastic or plastic materials should be made.

56.3 The floor and underfloor tray should have adequate drain paths to ensure that any fluid spilt in the compartment quickly reaches the drain point.

56.4 Both the compartment and the air space around it should be adequately vented.

56.5 The necessary service drainage and venting should be contained within the installation and should also be non-metallic. Only electric power services should be supplied from the aircraft system. Water replenishing points should be readily accessible from outside the aircraft; they should be located as close as possible to the toilet or galley installations which they serve.

57 A schematic layout of a permanent toilet installation incorporating the design features in para 56 is shown in fig 26. The complete unit stands on a tray (fig 27) and the arrangement allows the whole compartment to be liberally swabbed whilst posing minimum risk to the aircraft structure.

58 Galley units should be designed to incorporate the above features where applicable. In this instance it is important there should be no leak paths from the working surfaces and sink units and that all possible dirt traps should be eliminated. This can best be achieved by making maximum use of non-corrodible moulded units.

Improved design of hinge

59 Some designs require hinge pins to be held in position by means of a nut which if tightened, has the effect of pulling together the two arms of the hinge. Tightening can cause unnecessary bending stresses in the arms of the hinge which may lead to stress corrosion cracking. A design, with the pin held axially on one arm of the hinge as shown in fig. 28, is an improvement which helps to avoid unnecessary bending stresses.

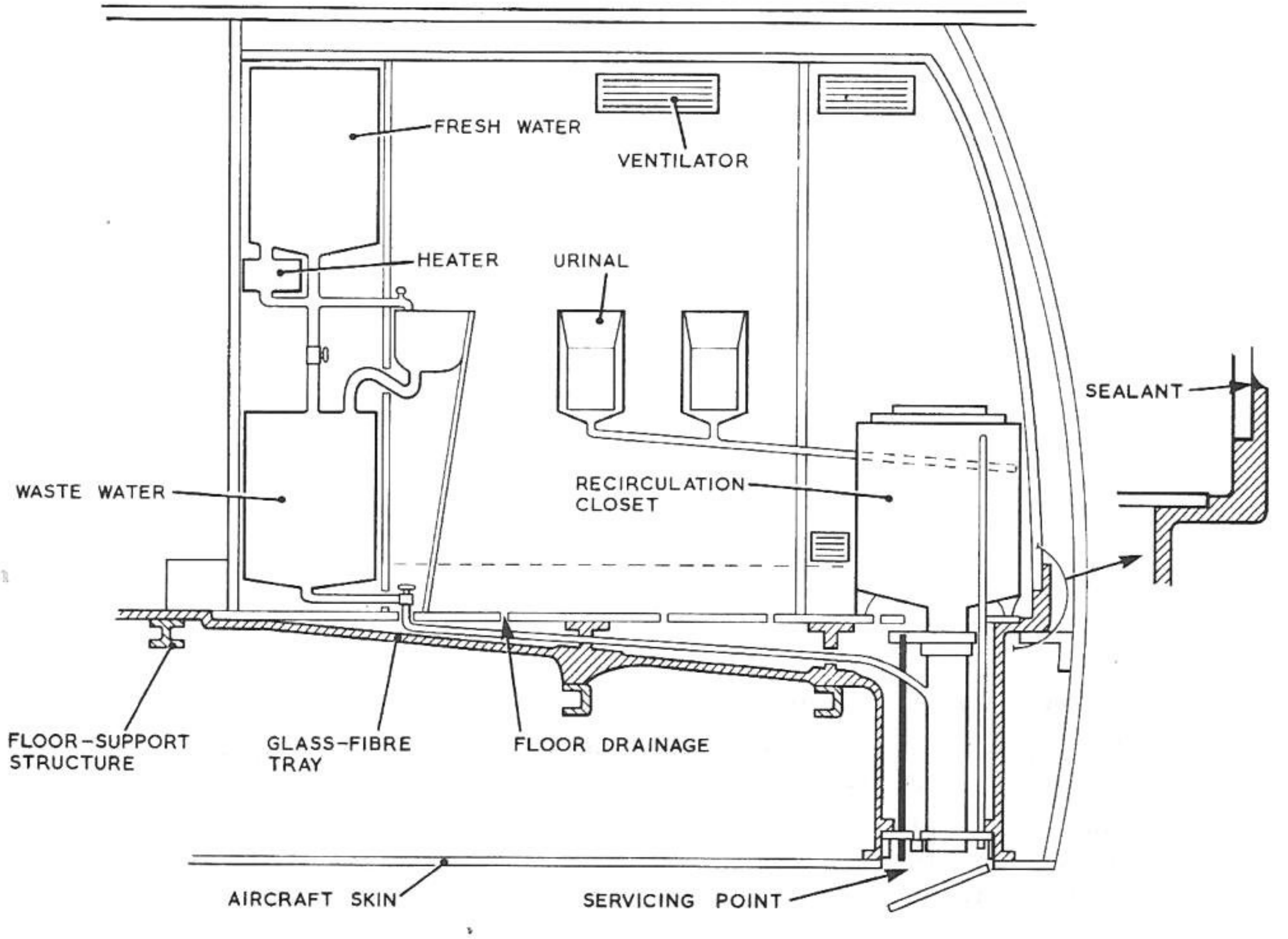

Fig 26 Schematic layout of a toilet installation

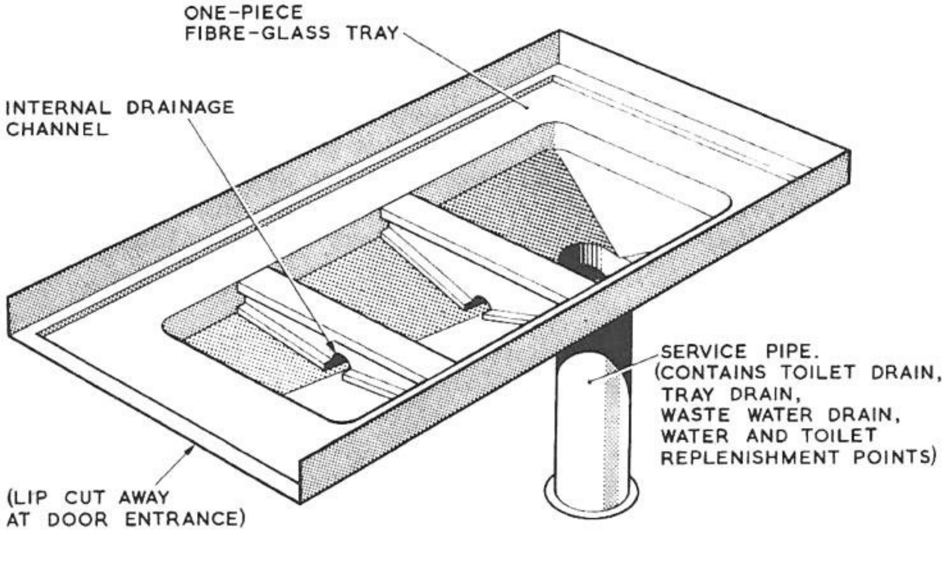

Fig 27 Toilet compartment tray

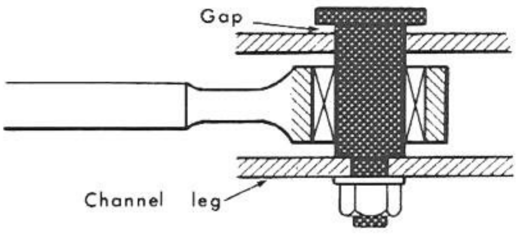

Fig 28 Improved design of hinge

Aircraft aerial installation

60 Some aircraft aerial installations are a source of severe corrosion. To maintain the structural and electrical integrity of the installation the following points should be observed:

60.1 The aerial base and airframe are to be clean metal or chemically surface etched prior to installation.

60.2 Aerials should be assembled onto aircraft using a gasket sandwiched between them and the airframe.

60.3 Where the aerial base and airframe are aluminium, the gasket should be aluminium or aluminium loaded.

60.4 The gasket must be able to withstand the environment specified in BS 3G 100 Part 2 Sect 3.

60.5 'Wet assembly' techniques should be used, including release agents where necessary. This is essential to prevent moisture/fluid ingress from inside and outside the aircraft and to permit aerial removal.

60.6 A PRC seal should be applied around the periphery of the aerial base where it joins the faying surface (AvP 25 refers).

60.7 Dissimilar materials, including adhesives and varnishes, should be avoided to prevent corrosion due to galvanic action.

Use of graphite pencils on aircraft structures

61 The use of graphite 'leaded' pencils on aircraft structures has resulted in cases of severe dissimilar metal corrosion. 'Lead' pencils should be used as a short-term aid only, any marks being removed as soon as possible. Complete removal of marks may be achieved by the use of white spirit, MEK, or 111-trichloroethane. When it is necessary to leave a mark in place for more than a few hours, a grease pencil of any colour except black should be used.

Effect of PVC on stainless steels

62 Under certain conditions, PVC covering on pipe clips can produce acids which may result in pitting corrosion of stainless steel pipelines.