Chapter 7

FUSES AND FUSE BOXES

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INTRODUCTION

Function

1. Fuses are included in the aircraft wiring system to protect equipment and cables against overload. Should a fault in a particular circuit cause the current to rise above a pre-determined limit, the fuse in that circuit will operate, thus cutting off the supply and isolating the circuit before the excessive current causes damage or fire.

2. A fuse operates when the current flowing through it is sufficient to melt the wire or strip element. The time taken for this to happen varies inversely with the current. A comparatively heavy current will vaporize the element almost immediately, whereas a lower value of current may not open-circuit the fuse for, possibly, several minutes. The time-current characteristic of a fuse is dependent upon its cooling surface, and so varies with the design of the fuse, and to a lesser extent, upon the method of mounting in the fuse box.

Rating

3. Prolonged heating of the fuse causes deterioration of the element, with a resultant lowering of the melting point. The characteristic of the fuse will thus be changed, and it will eventually open-circuit at too low a value of current.

4. Fuses are therefore given a rating to indicate the current that they will carry, either continuously or for a stated period (intermittent rating), without unduly heating up and deteriorating.

5. A fuse for a particular circuit is therefore chosen such that its rating is not less than the normal current flowing in that circuit, but such that it will open-circuit at a current level below the safety limit of the equipment or cables. For this reason, it is important to ensure that only the specified fuses are installed in a system.

Mounting

6. Fuses are secured between vibration-proof terminals of adequate current carrying capacity, which are designed to ensure a good electrical connection and yet permit of easy removal of the fuse. The terminals are mounted on a fuse block forming part of a fuse box.

General

7. The fuses referred to in the following paragraphs are of the cartridge type, consisting of a tubular glass body, two turned or pressed end caps, and a fuse element. The end caps fit over the ends of the body and are secured by a suitable paste or cement. The element, passing axially through the body, consists of one or more strands of wire, or else a metal strip, conforming to a specification which governs the characteristic of the fuse.

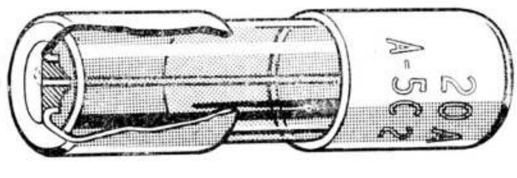

Fig. 1. Fuse assembly

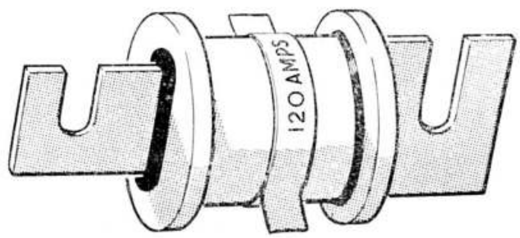

Fig. 2. Fuse, Type N

8. In the type of fuse shown in fig. 1 the ends of the wire element emerge through holes in the metal end caps, to be soldered in either slots or depressions in the caps themselves. A hermetically sealed cartridge is thus formed, the end caps of which act as the fuse contacts. The rating of the fuse is marked on these end caps.

9. The type of fuse shown in fig. 2 has a strip metal element which passes through slots in the end caps, the joints being sealed with cement. With this type of fuse, the ends of the element form the fuse contacts. The rating of the fuse is marked on a band surrounding the body.

PREFERRED TYPES

10. The types of fuses listed in Table 1 should be used wherever possible, and should replace obsolescent types of the same rating. The table gives the dimensions and rating of each preferred type of fuse.

Type S fuses

11. These fuses are of the type shown in fig. 1, and utilize a single strand wire element enclosed within a soda glass tube. The 20 amp. continuously rated fuse has an element of 27 S.W.G. fine silver wire, whilst the remainder have elements of tinned copper wire, conforming to B.S.128. The gauges of the 2·5, 5·0 and 10·0 amp. elements are 41, 38, and 33 S.W.G. respectively. The 20 amp. intermittent fuse has a 28 S.W.G. element.

TABLE 1

Fuse type	Stores Ref. No. 5CZ/	Rating		Overall length (in.)	End cap diameter (in.)
		Amp.	Period		
S	879	2·5	Continuous	1·0	0·3
S	880	5·0	,,	1·0	0·3
S	881	10	,,	1·0	0·3
S	1255	20	1 min.	1·0	0·3
S	4057	20	Continuous	1·0	0·3
A	204	20	,,	1·5	0·45
G	907	25	5 min.	1·5	0·45
R.1	3445	30	Continuous	1·5	0·5
R.2	3207	40	,,	1·5	0·5
R.3	3446	50	,,	1·5	0·5
R.4	3208	60	,,	1·5	0·5
R.5	3209	60	15 sec.	1·5	0·5
R.6	3210	100	,,	1·5	0·5
N	1963	120	Continuous	2·24	—

Types A and G fuses

12. These are similar to the Type S, having single strand tinned copper elements of 26 S.W.G. and 24 S.W.G. wire for Types A and G respectively.

Type R fuses

13. Types R.1 and R.3 have fine silver elements enclosed in special low expansion glass tubes. Type R.1 employs two strands of 28 S.W.G. wire, whilst Type R.3 has a single strand of 22 S.W.G. wire. The remainder utilize tinned copper wire in soda glass tubes. Types R.2, R.5 and R.6 have single strands of 22, 21, and 19 S.W.G. wire respectively, whilst Type R.4 has twin strands of 22 S.W.G. wire.

Type N fuse

14. This type is of the form shown in fig. 2. The soda glass tube is enclosed by slotted end caps manufactured from an insulating material. The element consists of a strip of electrolytically pure zinc, electro-tinned, which is 0·028 in. thick. The centre of the strip is cut to a specified width, and the ends are slotted for terminal connection.

OBSOLESCENT TYPES

15. Cartridge fuses not listed in Table 1 are obsolescent or obsolete. When renewing such a fuse, a preferred type of the same rating should be used as a replacement. A list of obsolescent fuses and their preferred replacements is given in Table 2. The fuses listed are of similar construction to the type shown in fig. 1, except that those indicated have end caps of square cross-section.

16. It should be noted that Types B and D fuses are not dimensionally interchangeable with their preferred replacements of Type S. The Types B and D fuses must therefore continue to be used as replacements, unless the fuse box itself is also replaced by the type accommodating the preferred Type S fuse.

17. There is no preferred replacement for the Type K fuse, and this fuse should continue to be used where an intermittent rating of 150 amp. is specified.

TABLE 2

Fuse type	Stores Ref. No. 5CZ/	Rating		Overall length (in.)	End cap (in.)	Preferred fuse No. 5CZ/
		Amp.	Period			
D	515	5	Continuous	1·5	0·45 (Dia.)	880
B	463	10	,,	1·5	0·45 (,,)	881
L	1666	60	15 sec.	1·5	0·45 (,,)	3209
Q	3155	30	Continuous	1·5	0·50 (Square)	3445
E	550	40	,,	1·5	0·50 (,,)	3207
P	2953	50	,,	1·5	0·50 (,,)	3446
M	1667	60	,,	1·5	0·50 (,,)	3208
F	878	60	15 sec.	1·5	0·50 (,,)	3209
J	1321	100	15 sec.	1·5	0·50 (,,)	3210
K	1882	150	80 sec.	1·5	0·50 (,,)	—

FUSE BOXES

General

18. The fuse box comprises a fuse block, mounting the terminals, and a cover. The box may house one or more fuses, the larger boxes containing the fuses of several circuits grouped together. The block and cover are usually mouldings of insulating material, drilled to accept fixing screws and to mount the terminals.

PREFERRED TYPES

19. The preferred fuse boxes are given in Table 3, which indicates the fuse types appropriate to each box.

TABLE 3

Fuse box type	Stores Ref. No.	Number of ways	Dimensions (in.)			Fuse types housed
			Length	Width	Height	
S	5H/73	3	2·24	1·75	1·77	S
S	5H/74	6	3·74	1·75	1·77	S
S	5H/75	12	6·74	1·75	1·77	S
B. No. 1	5CZ/549	1	3·31	2·00	1·64	R, A, G
J	5CZ/1962	1	2·80	2·90	2·75	N
J.2	5CZ/3935	1	3·67	1·20	3·64	N
A	5CZ/3741	1	2·53	1·10	—	S
Plessey*	5X/6395	4	2·16	1·32	1·81	S

* See para. 23

Note . . .

The fuse box, Type B, No. 1, will also accommodate the obsolescent fuse Type K.

Type S fuse box

20. The three forms of this fuse box differ only in length, and hence number of fuses. The 6-way box is shown in fig. 3. The fuse block is a moulding of insulating material, provided with two fixing holes located in feet projecting from the ends of the block. The terminal socket and fuse holder assemblies are mounted on the block, each fuse way being separated from its neighbour by an insulating barrier moulded integral with the base of the block. The terminal sockets with the cable clamping screws and U-shaped fuse clips are shown in (b) of fig. 3. When the box serves as a distribution point, a commoning link is fitted to the supply side, as in (a) of fig. 3.

21. Each U-shaped clip stands on a base which is pressed into the block. The two halves of the split cable socket are positioned by a screw which engages with a floating nut located within the block. Since the nut is spring-loaded, the two halves of the socket are under spring pressure, which may be increased by tightening the screw. The sockets are shaped to mate with ferrules on the ends of the connecting cables. The cables are pushed into the sockets and held there by the spring pressure.

22. The moulded cover (*fig.* 4) is provided with a white label which is protected by a transparent synthetic resin plate secured to the cover by screws. Fuse identification may be marked on this label, and to ensure that the markings will always correspond with the fuses, a locating lug projects from one end of the cover. This lug fits between the pro-

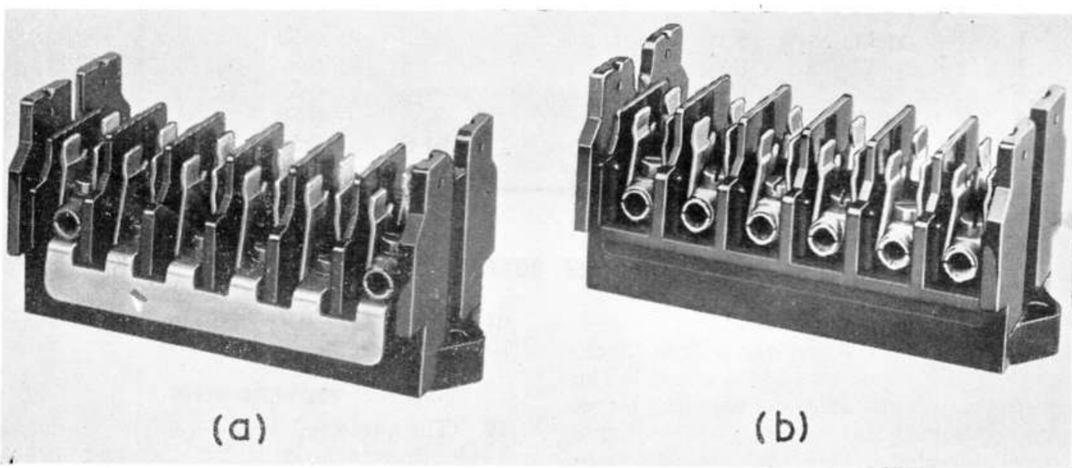

Fig. 3. Fuse box, Type S

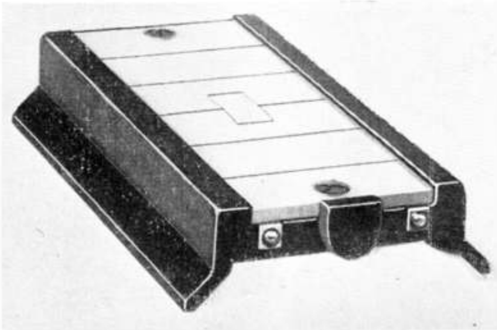

Fig. 4. Cover for Type S box

jecting end plates of the block at one end only. A pair of press studs are fitted at each end of the cover, and when it is pressed down, these studs engage in seats formed by holes in the end plates. The cover is thus held secure, enclosing the fuses and shrouding the terminal sockets.

Plessey type fuse box

23. The use of this box is restricted to installations where saving of space is the major factor. The box is of similar construction to the Type S, but its overall dimensions are smaller. It is described and illustrated in Chap. 1 of this publication.

Type B. No. 1 fuse box

24. This box is shown in fig. 5, and consists of a moulded block and cover. Two lugs on the block are provided with bushed holes to accept fixing screws. The cover is fitted with a pair of captive knurled nuts which secure the cover to two screws projecting from the block. The cover is recessed to accommodate a spare fuse which is secured by clips.

25. The fuse is retained by two spring clips, which are extended at the base and fixed over bushes moulded into the block. The bushes are spun over to secure the clips, and are threaded internally to accept the terminal screws. An insulating shrouding, secured to the block by a screw, protects the screw heads. Both the shrouding and the block are channelled to provide a side entry for the connecting leads.

Types J and J.2 fuse boxes

26. These boxes are designed to accommodate the Type N fuse, and are fitted with wing nut terminals suitable for the heavier current rating of this fuse.

27. The Type J box (b of *fig.* 6) consists of a moulded block and cover. The block is provided with two fixing holes in diagonally opposite corners. The cover is held in position by two long captive screws. The fuse is secured by a pair of wing nuts fitting on pillar mountings projecting from the block. Connecting strips join the fuse terminals to the lead terminals which are fitted with hex/hd. nuts. Each side of the block is recessed to provide a cable entry.

28. The interior of the cover is ribbed, so that when fitted, the fuse and wing nut terminals are sectioned off from the lead terminals. The cover also accommodates a spare fuse secured by a clip riveted to the moulding. To avoid the risk of the spare fuse coming into contact with the fuse terminals and paralleling the fuse in use, the end connections of the spare fuse must be protected by insulating sleeves. If not already provided, suitable sleeves can be made from insulating tubing of 13 mm. diameter (Stores Ref. 5F/2031) and 8 mm. diameter (Stores Ref. 5F/2036), for the wide and narrow ends respectively, cut into 0·7 in. lengths.

29. The Type J.2 fuse box (a of *fig.* 6) is somewhat similar, but is narrower and deeper. It is designed for back-of-panel lead connection, the screwed pillars which mount the wing nuts passing through the block to emerge from its base. Insulating mouldings surround the lead terminal stems to prevent contact with the panel.

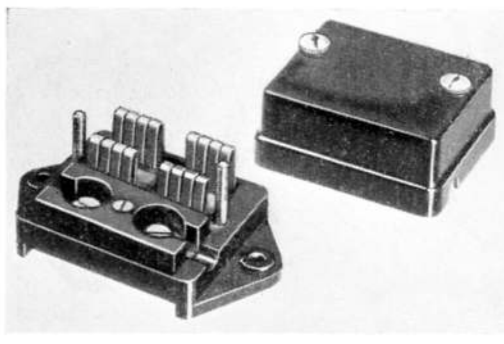

Fig. 5. Fuse box, Type B. No. 1

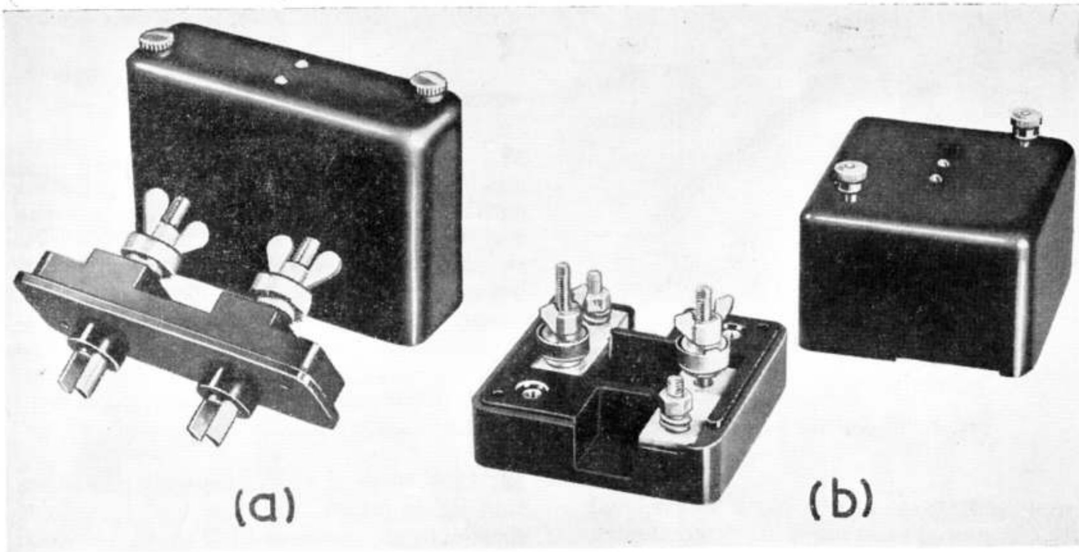

Fig. 6. Fuse boxes, Types J and J.2

Type A fuse holder

30. This type is shown in fig. 7, and is designed for panel mounting. The fuse is secured within the cylindrical moulding by two annular spring clips, one of which is visible in the illustration. These spring clips connect to terminals inserted in the base of the moulding. The terminals are protected by a circular end plate which is attached to the base of the holder by two countersunk screws. The connecting leads enter through ports in the side of the holder adjacent to each terminal. When the front cap is unscrewed, the fuse is partially ejected under the action of a spring-loaded plunger within the holder, thus facilitating the extraction of the fuse. A fuse is not correctly positioned in the holder until the front cap is screwed fully home.

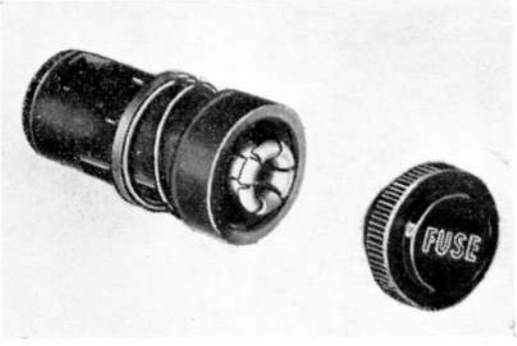

Fig. 7. Fuse holder, Type A

31. The holder is secured in position on the panel by means of a spring-loaded collar. The holder is first inserted in the hole in the panel from the front. The spiral spring is then placed around the body of the holder behind the panel, and the collar offered to the rear of the holder so that the keyways in the collar line up with the keys on the side of the holder. The collar is then pushed towards the panel until past the keys and then rotated through a quarter turn to lock. In some forms of the holder the collar is held firm by the spring pressure, whilst in other forms the collar is also secured by a circlip.

OBSOLESCENT TYPES

32. The fuse boxes listed in Table 4 are obsolescent. Referring to this table, the maximum fuse rating for boxes E, F, and G is 10 amp. If this rating is exceeded, overheating will occur. It should be noted that the preferred replacement for the Type L fuse, which is Type R.5 (*Table* 2), may be accommodated in boxes A, C, or D.

TABLE 4

Fuse box type	Stores Ref. No. 5CZ/	Number of ways	Dimensions (in.)			Fuse types housed
			Length	Width	Height	
E	882	1	2·7	1·6	1·41	S (10 amp. max.)
F	883	4	4·0	1·6	2·22	,,
G	886	8	6·2	1·6	2·22	,,
A	445	1	2·5	1·6	1·21	A, B, D, G, L
C	758	4	4·6	2·4	2·29	,,
D	761	8	7·4	2·4	2·29	,,
B. No. 2	2727	1	3·3	2·0	1·64	E, F, J, K, M, R

INSTALLATION, OPERATION, AND SERVICING

33. Fuse boxes should be mounted in an accessible position, allowing space for the removal of the cover. They are usually grouped together on an instrument or electrical panel with other electrical apparatus, or alternatively, mounted inside junction boxes (*Chap.* 1 *and* 2).

34. The blowing of a fuse always indicates a fault in the circuit or misuse of some part of the equipment. Fuses should *not* be renewed, therefore, until the cause of the excess current has been ascertained and the fault rectified. When a spare fuse is carried in the box, this should be used as a replacement, and a new spare of the correct rating obtained from stores at the earliest opportunity.

35. Fuses should be periodically inspected and if there are signs of overheating or sagging of the element, the fuse should be renewed. Any overheating of a copper fuse element is indicated by discolouration of the tin coating. This may turn light yellow in colour at first, and from dark yellow to blue in later stages if the overheating is continued.

36. The fuse box clip and the fuse cap should be kept clean so as to make a good contact, since a bad contact will cause local overheating even when only the rated current is flowing. An overheated clip is very apt to lose its resilience and so make even poorer contact. The clips are shaped and aligned during manufacture and they should not, therefore, be bent or otherwise mishandled. Care should also be taken to ensure that the cable connections are secure.

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