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BOWDEN CONTROLS

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

J. Dunnett

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AMENDMENT RECORD SHEET

Record the incorporation of an amendment list by inserting the date of making the amendments and by signing in the appropriate column.

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BOWDEN CONTROLS

CONTENTS

ILLUSTRATIONS

Introduction

1. Bowden controls on aircraft are used for such purposes as gun controls, cockpit canopy releases, cabin heater controls, trim tab controls, some light types of bomb release gear, indicator movements, and the operation of the differential valves on Dunlop air brake control valves.

DESCRIPTION

General

2. The control consists of a wire cable housed in a flexible conduit. On some installations, rigid tubing is used to house the cable over long straight runs, while flexible conduit is used for bends or sections where there is

relative motion. The cable operates in tension and is returned to position by a spring. For positive movement in either direction, a twin control is used. For example, on trimming tab controls, where back-lash must be minimised, a double run of cable is used, passing over a pulley.

3. At the transmitting end of the control, the fitting takes the form of a hand lever, sometimes of the ratchet type. At the other end, the cable is connected, usually by a shackle, to the component to be operated.

4. Bowden controls are not usually longer than 6 to 8 feet. If they are longer, then part of the run should be carried in a rigid conduit, or else by a plain cable. The installations are often fitted by the aircraft manufacturer, and vary according to the aircraft, though individual components may be common to all installations.

5. The control is intended normally for 'pull' operation only, and may be fitted with a spring return. The spring may be either in tension or in compression. If it is in tension, the spring pulls the cable back through the conduit when pressure is released from the operating lever. If it is in compression, it is fitted between the end of the conduit and the end of the cable, so that when pressure is released, the spring reacts on the conduit, and the cable is returned to its original position.

6. The sizes of the cable and its corresponding conduit are as follows:-

Bowden cable	Bowdenite conduit	Maximum applied tension lb.	Approximate weight per 10 ft. run	
			Cable lb.	Conduit lb.
7/51	B.52	50	0·03	0·27
19/1	B.1	100	0·08	0·33
19/2	B.2	150	0·11	0·40
19/2	B.2H	170	0·11	0·50

Cable

7. The cable used in Bowden controls are manufactured from stainless steel wire.

8. The construction of both types of cable is the same. Sizes 7/51 and S.7/51 (the S denotes the non-corrodible type) have seven wires, while the larger sizes 19/1, S.19/1, 19/2 and S.19/2, have nineteen wires laid 12 on 6 on 1.

9. The cable dimensions are as follows:-

Ordinary cables	Non-corrodible	Nominal diameter
7/51	S.7/51	0·036 in.
19/1	S.19/1	0·062 in.
19/2	S.19/2	0·075 in.

10. When a control assembly is made up, the ends of the cable are threaded through brass nipples, various types of which are used (fig. 1), and may be soldered or swaged to the cable. Swaged nipples are found only on cables which are assembled by the manufacturers, as Service personnel are permitted to attach nipples to cables only by soldering (para. 28).

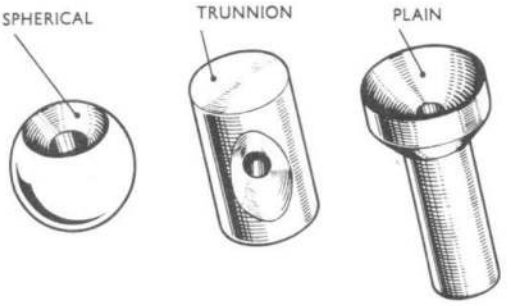


Fig. 1 Types of nipple

Conduit

11. The conduit (fig. 2) consists of a close-coiled wire covered with cotton braiding, and finished with a black waterproof coating. Caps are fitted on each end of the conduit to prevent the braiding from unravelling, and to reinforce the end of the conduit.

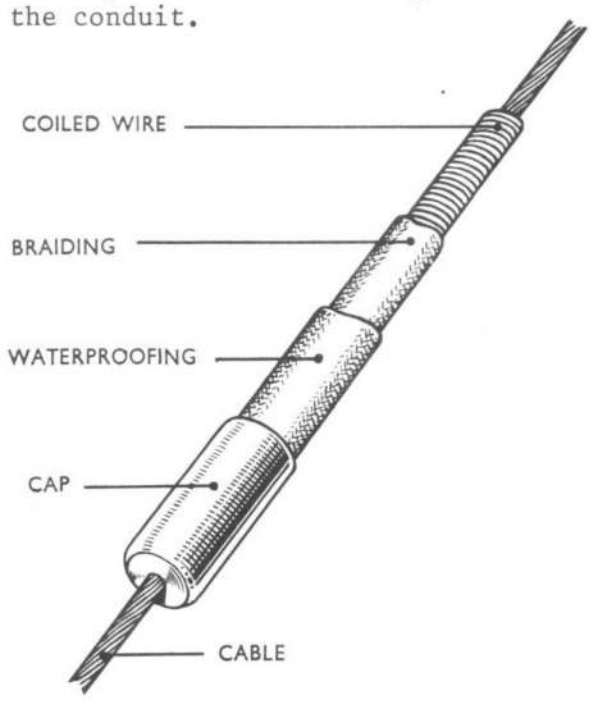


Fig. 2 Conduit and cable

12. The dimensions of the conduit are as follows:-

Type	Nominal outside diameter (in.)	Nominal bore (in.)	External diameter of cap (in.)
B.52	0·156	0·071	0·179
B.1	0·188	0·100	0·218
B.2	0·212	0·125	0·243
B.2H	0·212	0·109	0·243

Levers

13. The levers most commonly used for operating the control are shown in fig. 3; they are fitted on the control panel on adapter mountings. If it is necessary to dismantle an existing control or to fit a new one, the front of the lever may be taken off after the central screw has been removed. The cable can then be freed from its groove in the base of the lever.

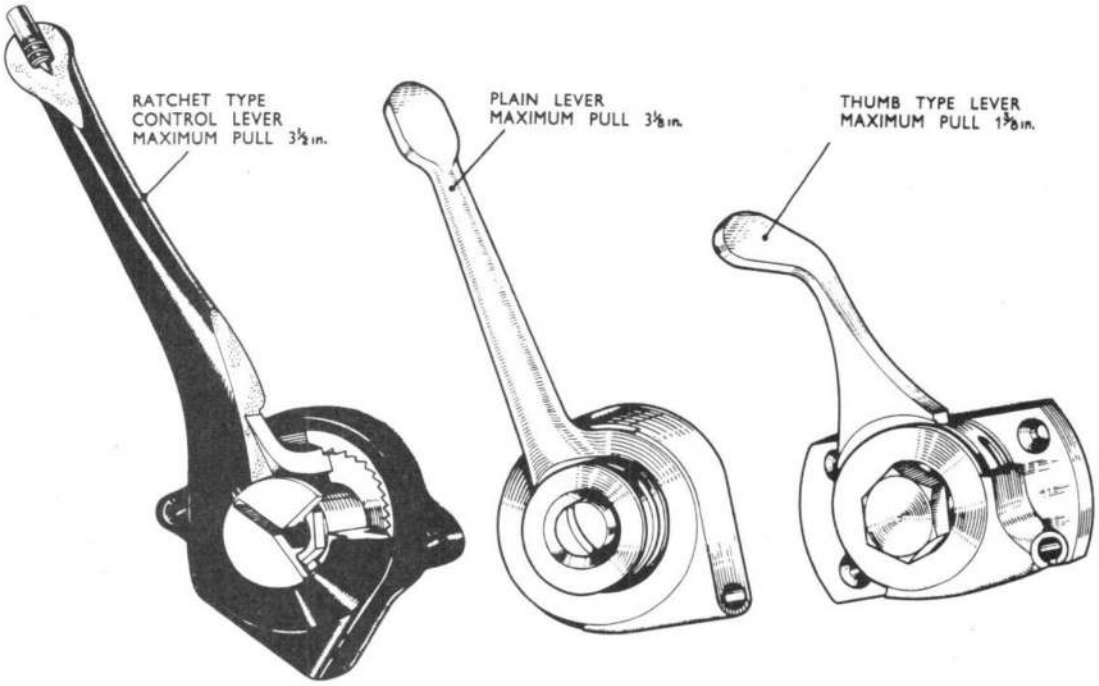


Fig. 3 Typical levers

Method of adjustment

14. The length of the conduit, but not that of the cable, is controlled by the adjustable stops. The conduit is flexible, but is incompressible lengthways. If the cable is slack, the adjuster is screwed out to take up the slack.

Plain stops

15. A plain adjustment stop (fig. 4) may be fitted at either or both ends of the conduit. The stop is a hexagon-headed screw drilled to allow the cable to pass through it. The head of the screw is counter-bored to receive the protective cap fitted over the end of the conduit.

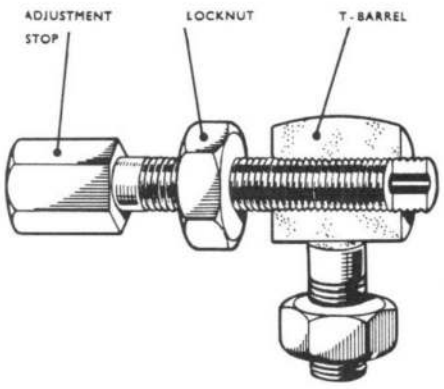


Fig. 4 Adjustment stop and T-barrel

16. The stop may be mounted in a T-barrel, which is fitted to a rigid member. The T-barrel must be securely fixed in position to prevent its swivelling out of alignment.

Double-ended stops

17. Where it is inconvenient, due to the inaccessibility of the components, to fit adjustable stops at the ends of the conduit, a double-ended stop (fig. 5) may be fitted in the length of the conduit. The minimum thread engagement may be checked by means of the small witness hole in the body of the stop.

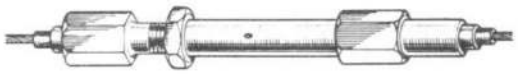
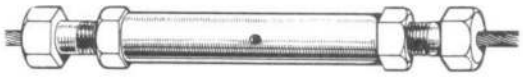


Fig. 5 Double-ended stop

Connectors

18. Connectors are used when it is necessary to uncouple a Bowden control at some point in the run of the cable, or when a Bowden control is used in conjunction with a different cable.

19. The connector shown in Sketch A of fig. 6 is used for joining two cables only, and cannot be employed where a conduit is fitted. It is also used for joining a length of Bowden cable to a cable of a different type, such as may be used for long straight runs. The connector shown in sketch B of fig. 6 is used for joining two Bowden controls.



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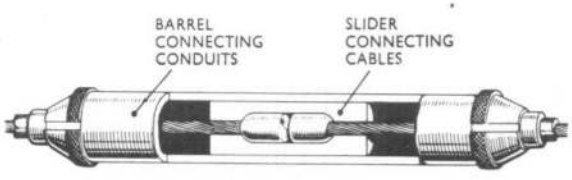

B

Fig. 6 Connectors

Junction boxes

20. Junction boxes are used for connecting a single cable to two others, where there are two components to be operated by a single control. The two types of junction box are shown in fig. 7.

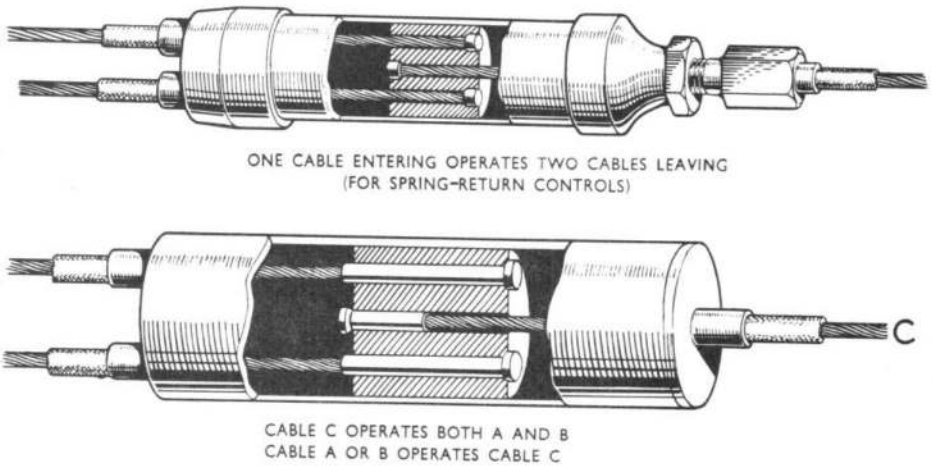

Fig. 7 Junction boxes

INSTALLATION

General

21. Particular attention must be paid to the axial alignment of all cables assemblies. Where the cable leaves the stop at which the conduit terminates, it must be kept in an absolutely straight line (fig. 8) as otherwise it will rub on the edge of the stop and gradually be worn away.

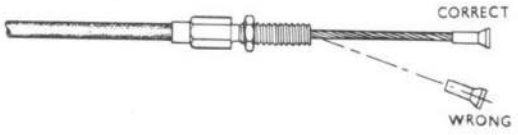

Fig. 8 Alignment of conduit and cable

22. Where the cable is connected to a lever the alignment should be such that the centre-line of the conduit is in a straight line through the mid position of the rise and fall of the arc of travel of the lever (fig. 9).

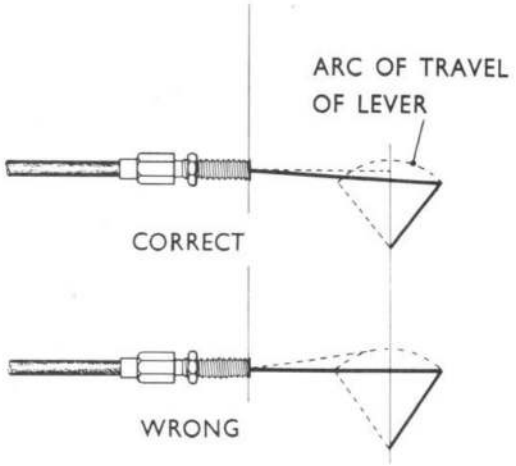

Fig. 9 Alignment of cable with a lever

Installation radii

23. Any bends in the route of the control should have as large a radius as possible. Where D is the overall diameter of the conduit, the minimum radius of bend permissible for Bowdenite conduits is 12 x D. The stresses induced by bends and pulleys vary directly with their radii. A small pulley may easily stress a cable so highly that it will fail on this account alone, irrespective of other loading. As a rough guide, pulley diameters should never be less than 20 cable diameters.

24. Changes in the direction of the control route should be kept to the minimum possible. On a normal bend through 90 deg., the loss in efficiency may be as high as 15-20 per cent. Where there are two bends of 90 deg. in the route, the loss of efficiency rises to about 30 per cent, on a long control.

Care in handling cables

25. Great care should be taken to prevent the cable from becoming kinked, because once it is bent, it does not readily straighten out again. If a distorted cable is assembled in a conduit, the control will not function efficiently, because a considerable proportion of the movement transmitted to the cable will be absorbed by the effort to straighten it. Lengths of cable should therefore be kept neatly coiled, and should always be handled carefully.

26. The cable should not be put on a dirty floor or bench where it may pick up particles of swarf or other foreign matter. The clearance between the cable and its conduit is comparatively small, and bits of grit or filings may cause faulty operation.

27. It should be noted that preformed cables are supplied with their ends lightly tacked in place with solder, while live-lay cables are soldered for about an inch at each end to prevent the wires from untwisting. Live-lay cables should never be cut unless the wires are first soldered in position. Preformed cables can be cut without being first soldered, but the cut ends should not be left free for any length of time, because they may unravel, especially if they are roughly handled. The free ends should be lightly tacked in position with solder.

Method of soldering the first nipple to the cable

28. The brass nipple should be soldered in position on one end of the cable as follows:-

(1) Make sure that the surfaces are clean, and free from oil or grease.

(2) Tin the cable thoroughly over a length at least 1½ times that of the nipple, using solder, Grade C (ref. 30B/9105038) for both the ordinary and non-corrodible types of cable.

(3) Apply flux over the tinned portion of the cable. Use ortho phosphoric acid (Ref. 33C/812) as a flux for both types of cable.

(4) Heat the nipple with a hot iron and slide it over the tinned cable, leaving about 1/16 in. of cable protruding beyond the end of the nipple. It is very important that sufficient heat should be applied at this stage to ensure that the solder runs freely in the joint, because cold joints are a frequent source of trouble.

(5) Hold the soldered nipple in a vice or a pair of pliers (fig. 10) and spread the protruding strands of the cable with a small ball pane hammer. Then finish the joint by applying a blob of solder over the end of the cable, so that the countersink in the nipple is filled with solder.

(6) Wash the soldered joint thoroughly in hot water to make sure that the flux residues are removed, then dry the components and apply a coating of rust preventive PX-1 Cat. No. C-614 (Stores Ref. 34B/9100478).

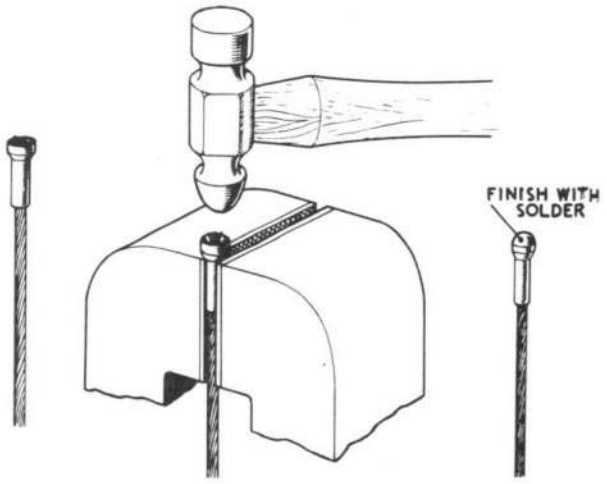

Fig. 10 Spreading the end of the cable

Lubrication

29. When the nipple has been soldered to one end of the cable, the cable should be thoroughly lubricated with graphitic grease Cat. No. G.357 (Stores Ref. 34B/9423151). The wax should be applied at room temperature, 60-70 deg.F., and should be rubbed well into the interstices of the cable.

Fitting the control

30. When a cable or conduit is to be renewed, the faulty component should be used as a guide to the length required for the new part. The conduit may be cut to the exact length required, but it is advisable to leave the cable rather longer than necessary, because it simplifies the soldering of the second nipple. Surplus cable can be cut off when the second nipple has been attached. After the cable has been lubricated, it should be fitted as follows:-

(1) Thread the adjustable stop over the cable (if a stop is to be fitted at both ends), and slide on the conduit, making sure that the protective caps are fitted at each end. Thread on the second adjustment stop, and also the shackle, if it is to be used.

(2) Fix the control temporarily in position on the aircraft along the route it is to follow.

(3) Make sure that the part to be operated is in the 'off' position, and slip the other nipple on to the cable. Pull the cable taut, and, with a lead pencil, mark off the correct position for the nipple.

(4) Solder the second nipple in position as described in para. 28.

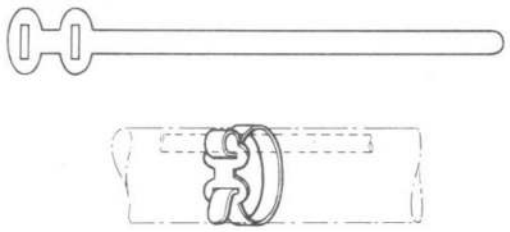

Fig. 11 Pliable clip

Fixing the conduit in position

31. The control should be attached to the airframe by pliable clips (fig. 11). For controls longer than 2 ft., the conduit should be supported every 12 in. Controls less than 2 ft. long should not require support except in special conditions such as a change of direction. The conduit of a Bowden control must never be in tension.

32. When the conduit has been correctly aligned, the T-barrels must be securely locked in position. If the T-barrel swivels, the stop will be forced out of alignment with the cable, and the control will be distorted. It is therefore most important that the T-barrel should be prevented from swivelling on its mounting.

SERVICING

Inspection

33. The control should periodically be inspected as follows:-

(1) Inspect the cable ends for fraying or any other damage.

(2) Inspect the conduit for kinks and signs of wear, especially at the ends, where the cable tends to rub on the edge of the stop or the cap unless the conduit and the cable are in a straight line.

(3) If there is any slackness in the cable, screw out the conduit adjustment stops until the slackness disappears (see para. 34 for twin runs). Make sure that all components are securely locked.

(4) Check that the control operates correctly, and is returned to position by the spring.

Adjustment of twin runs

34. When the twin runs are used, care should be exercised in the adjustment of the control. With the control in the 'no load' condition, the adjustment stops should be regulated to remove slack in the cables. Under no circumstances must any attempt be made to take up what appears to be slack in one or other of the runs when a load is being transmitted. This would inevitably impose high static loading in the control and would seriously affect its efficiency.

Lubrication

35. It should not normally be necessary to renew the coating of graphited wax on the cable. In tropical conditions, however, or where the control is subjected to high temperatures, the cable may require re-waxing after a few months. A sign of lack of lubrication is stiffness in operation; it may be difficult to start the control moving, and even when the initial resistance has been overcome, it moves jerkily.

36. When it is necessary to re-lubricate the cable, it should be removed from the conduit and wiped with a clean rag. Graphitic grease should then be applied as described in para. 29.

Removal of cable

37. If it is necessary to remove the cable for any reason, and it is intended to reassemble the same cable in the control, the following procedure should be adopted:-

(1) Slacken off all adjustment stops.

(2) Disengage the nipple from the component to which it is attached.

(3) Pull the cable through the conduit to its extremity so as to expose as much cable as possible behind the nipple.

(4) Solder the cable just behind the nipple. This is necessary to prevent the wires from untwisting when the nipple is removed.

(5) Unsweat the nipple from the cable, taking care not to melt the solder holding the wires in position. If any difficulty is experienced in removing a cable, it is preferable to scrap it and fit a new one.

Spare parts

38. Spare parts are listed in Section 29H of AP 1086. A cable or other component which is to be renewed must always be replaced by an identical part.

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