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TELEFLEX CONTROLS

GENERAL AND TECHNICAL INFORMATION

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AMENDMENT RECORD SHEET

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TELEFLEX CONTROLS

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Introduction

1. The Teleflex system of remote control is installed in aircraft to operate, from the pilot's cockpit, such components as engine and propeller controls, trimming controls, and fuel valves etc; the system can also be adapted to other uses such as the indication of undercarriage movements and the position of flaps. These control systems are not always Teleflex throughout, in many instances cable, chain or linkage is used for part of the control run in conjunction with Teleflex components for the initial or final part.

2. The principal of Teleflex system is a flexible transmitting cable operating in a rigid or semi-rigid conduit. The cable comprises an inner core wound with either a left-hand or right-hand helix wire. This helix wire engages with gear teeth of the lever mechanism at the transmitting end. The receiving end may engage with gear teeth or be threaded to one of the various types of end fittings in use.

3. In most installations a single length of cable is used, operating in a pull-push mode. The cable is housed throughout its length in closely-fitting conduit which can be led round bends of fairly small radii. In certain applications where short runs are used flexible, semi-rigid conduit may be used. This semi-rigid conduit will not stretch or compress when subjected to tensile or compressive loads.

4. Where it is necessary to reduce backlash to a minimum i.e. trim tab controls, a double length of cable forming an endless loop is used. In this

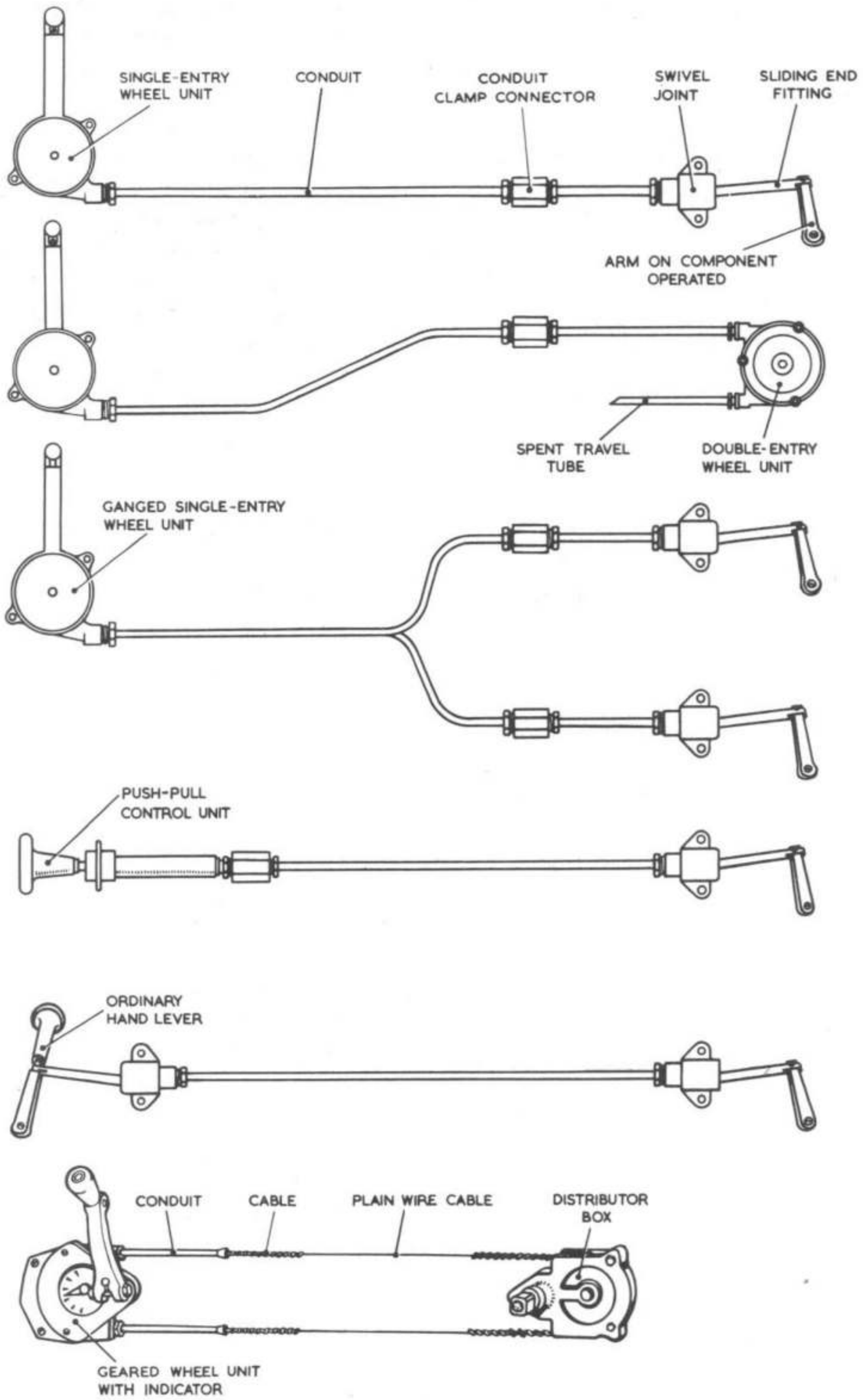


Fig. 1 Typical control runs

way the cables operate in tension only, eliminating the need for conduit and the inherent losses of motion that it imposes. This two-directional tension arrangement uses ordinary cable for the greater part of its run, with short lengths of teleflex cable being used at the ends for engagement with the gear wheels of the transmitting and receiving units.

5. The attachment to the actuating arm of a trimming tab often takes the form of a screw jack. This arrangement produces a powerful control, permitting a fine and positive adjustment of a heavily-laden component. Swivel joints are also provided to take up the angular movement of an actuating lever at the end of a control run, quick-break joints can be fitted at wing attachment points and bulkheads.

6. Various arrangements of control runs and end fittings are illustrated in fig. 1. The transmitting end of a control usually takes the form of a hand-operated gear wheel enclosed in a casing. Alternatively, where the control loading is light and the control run is fairly straight, a pull-push operating handle can be used. At the remote end of the control system the cable operates a wheel unit or is coupled, by an end fitting, direct to the actuating mechanism on the component being controlled.

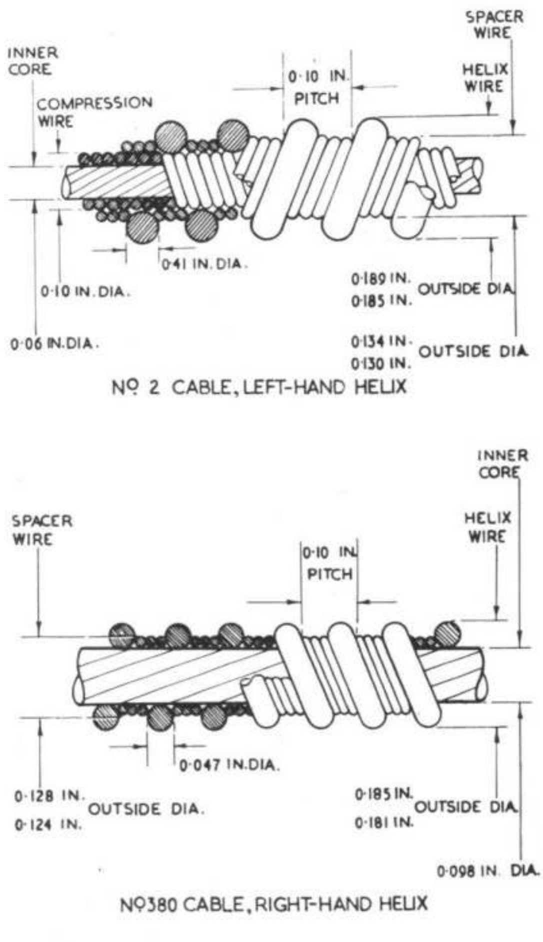


Fig. 2 Cables

DESCRIPTION

Cables (fig. 2)

7. Two basic cables are in current production for use in aircraft. Each cable is approximately, 3/16 in. dia. and weights 0·79 oz. per ft. The difference in construction is described in the following sub-paragraphs.

(1) The DS.23/2, or No. 2, cable is built up from a high-tensile wire inner core which is wound with a close-pitched compression wire. This is wound with the left-hand helix wire which is pitch-spaced by the spacer

wires. The cable thus formed has a minimum breaking load of 450 lb. and must be used with the DS.23/2 transmitting unit.

(2) The DS.380 cable is built-up from a high-tensile wire inner core which is wrapped direct with the right-hand helix wire and the spacer wires. By this construction there is improved efficiency and a reduction in backlash, particularly when the cable is under compression. The cable has a minimum breaking load of 1000 lb. and must be used with the DS.380 transmitting unit.

(3) The cables and the transmitting units are not interchangeable, as the cable wheels have the teeth cut to suit the left-hand or the right-hand cables.

TABLE 1

Teleflex cable sizes

Size No.	Nominal diameter (in.)	Actual diameter (in.)	
		Min.	Max.
2	3/16	0.185	0·189
380	3/16	0·181	0·185

Conduit

8. Under normal working conditions rigid metal conduit is used but where movement of the conduit is necessary, flexible conduit is used.

Rigid

9. The purpose of the conduit is to guide the cable and to enable compressive loads to be transmitted without the cable being buckled or kinked. Table 2 shows the size of the conduit and should be read in conjunction with Table 1. Two types of rigid conduit are used in aircraft systems, metal and metal lined with P.T.F.E. Metal conduit may be made from tungum, steel or light-alloy, the latter having been used extensively in older types of aircraft. Conduit made from aluminium lined with P.T.F.E. (D.S.431), has in most cases replaced the light alloy conduit, due to the reduction in friction resulting from the low coefficient of friction of the P.T.F.E. D.S.431 conduit, and is used for both numbers 2 and 380 cables, but has an o.d. which is greater than that of the metal conduit (Table 2) necessitating the use of the appropriate adaptors or fitting. ◀ P.T.F.E. lined conduit must not be used forward of the fire bulkhead, where tungum D.S.307/2 or steel conduit must be used. Reference is to be made to the appropriate aircraft Topic 3 for the specification of the steel to be used. ▶ The minimum bend radii for all types of rigid conduit must not be less than 3·00 in. radius.

TABLE 2

Teleflex conduit sizes

Size No.	Nominal size (in.)	Bore (in.) Min.	Bore (in.) Max.	Outside diameter (in.) Min.	Outside diameter (in.) Max.
2 and 380	3/16	0.194	0·196	0·270	0·273
D.S.431	3/16	0·192	0·194	0·342	0·345

Flexible

10. Flexible conduit (fig. 3) is used in installations to allow movement of components being operated, e.g. landing lamps, a short length of flexible conduit being interposed between the rigid conduit and the component. The length of flexible conduit should be kept to the minimum, as owing to the greater clearance in the bore, more backlash will occur over the run of cable. This conduit consists of a continuous winding of metal strip, over which is a cotton cover interspaced with fine wires running lengthwise, then the whole conduit is covered with an oil and damp resisting moulding. The ends of the conduit have permanently-attached ferrules swaged on as illustrated in fig. 3. This conduit must not be bent to a radius of less than nine inches, and is obtainable in lengths varying from six inches to fifteen feet, as shown in Table 3.

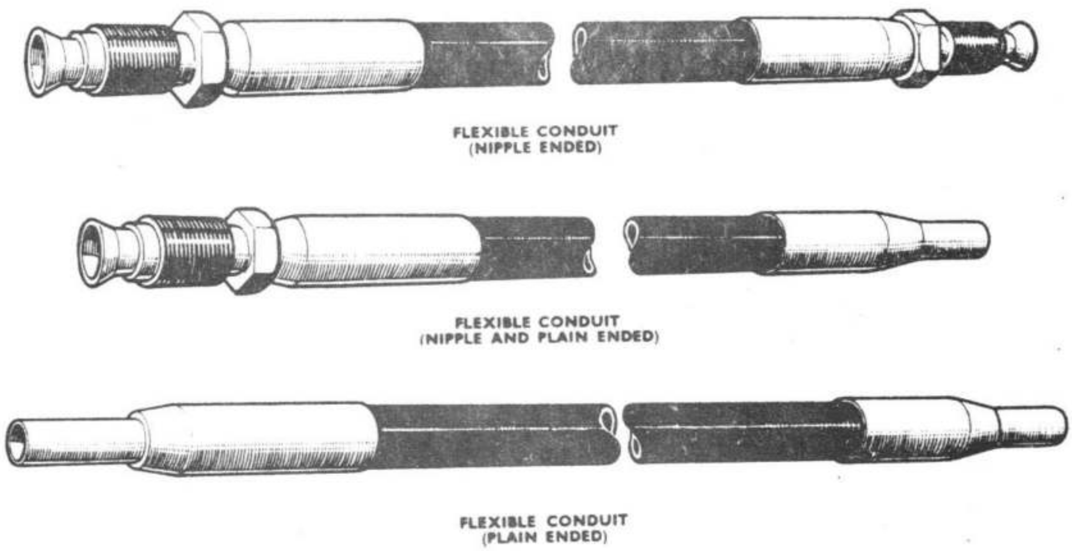


Fig.3. Flexible conduit

TABLE 3

Variations in length of flexible conduit

Range (ft.)	Variations in length (in.)
0·5 to 2·0	0·5
2·0 to 3·0	1·0
3·0 to 4·0	3·0
4·0 to 15·0	12·0

PSG/29113/176669/1125/AUG.74/1731

Wheel units (figs. 5 to 8)

11. The No. 2 and the No. 380 units are similar, but are handed by the left-hand or right-hand helical teeth on the wheels. Various types of wheel units are used at the transmitting and receiving ends, and intermediately on cables. At the transmitting end they are provided with a hand lever, with or without a damping device. At the receiving end they have a shaft suitable for coupling to the component to be operated. Multiple transmission units for controlling a number of components simultaneously or independently can be used. In all instances units consist of a light-alloy casing in which is housed one or more gear wheels having teeth cut on their periphery to suit the helical winding on the transmitting cable. The casing is machined so that the cable is kept in mesh with the teeth on the gear wheel or wheels.

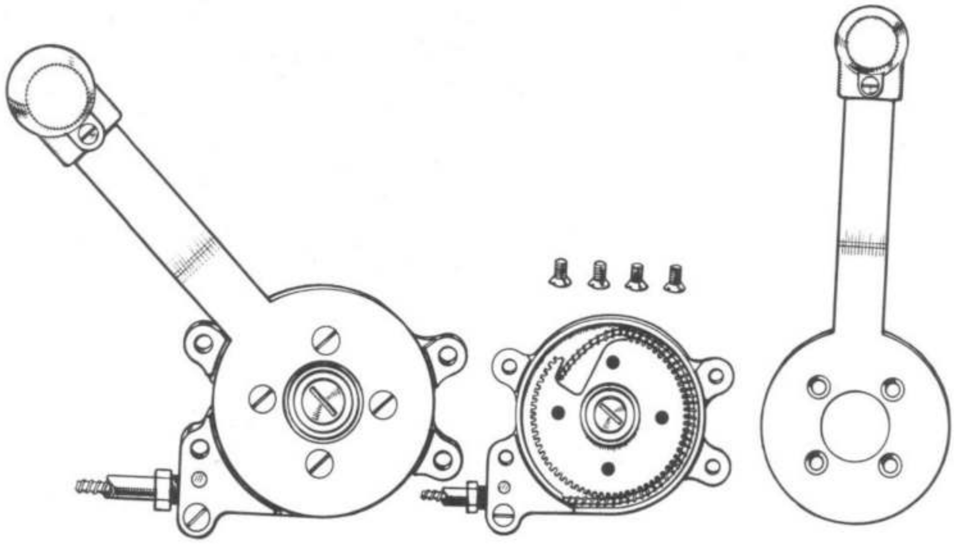


Fig. 4 Single-entry transmitting unit

Single-entry unit

12. The single-entry type of wheel unit is the type most commonly used at the transmitting end of a control. The cable enters the unit by a conduit connector and is led into a slot in the gear wheel (fig. 4). The rotary travel of this unit is limited to 270 deg. of travel of the gear wheel, as a minimum of 40 deg. engagement must be maintained between the gear wheel teeth and the cable, and at the extreme end of travel the cable must not foul the cable already wrapped round the gear wheel.

Double-entry unit

13. In the double-entry type the cable enters the unit by a conduit connector, and after wrapping round the gear wheel emerges via another conduit connector at a point 90, 120 or 180 deg. from the point of entry; these units are referred to as 90, 120 or 180 deg. wrap units, whichever is applicable (fig. 5). The correct direction of rotation to suit the installation can be obtained by choosing whichever lead-in is appropriate. The end of the cable that emerges from the unit is usually accommodated in a short length of conduit known as the spent travel tube (para. 19).

Straight-lead unit

14. In a straight-lead unit the cable passes straight through the unit and consequently engages on only a few teeth of the gear wheel. By virtue of this,

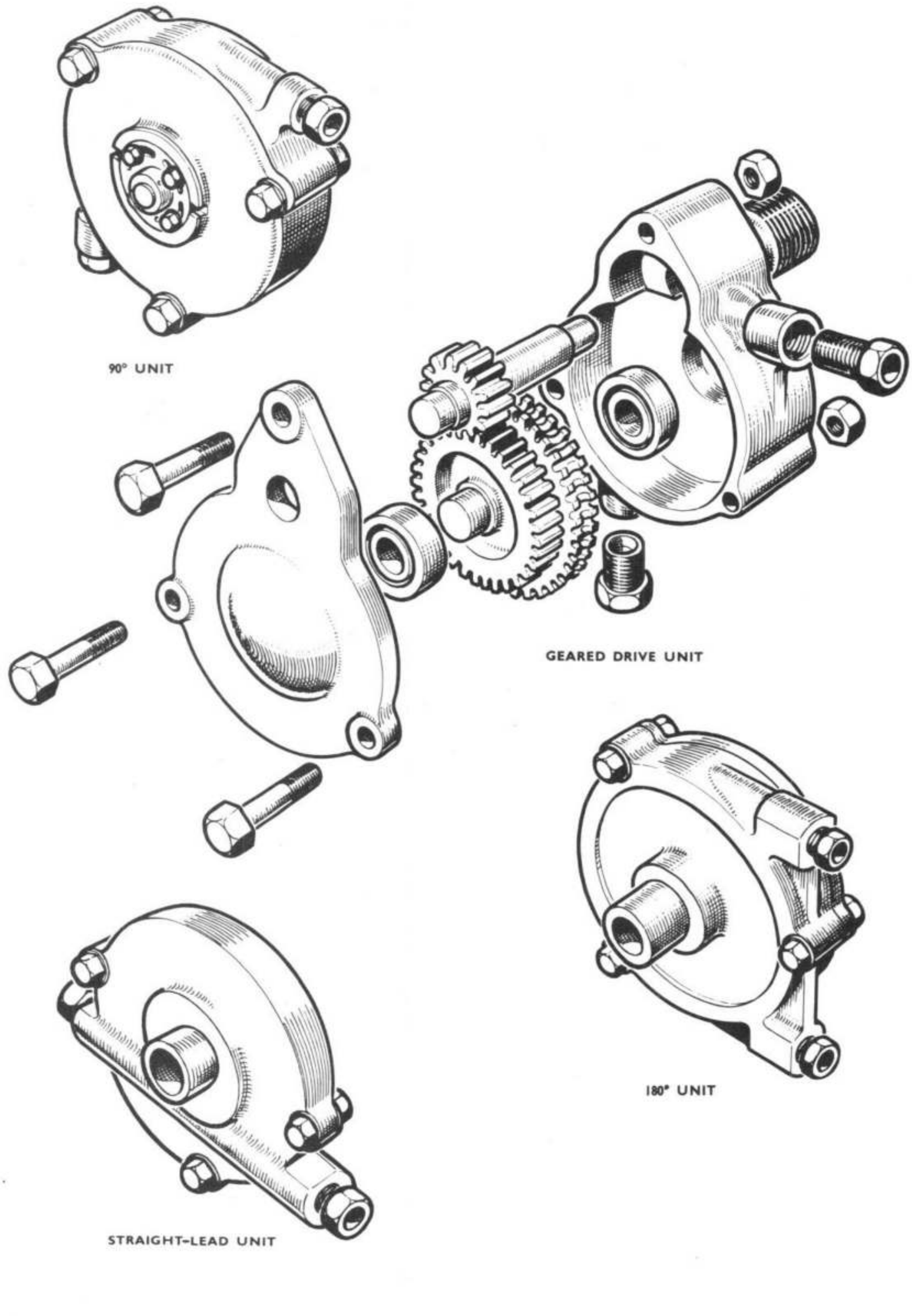


Fig. 5 Typical receiving units

these units are not suitable for heavily laden controls. They can be interposed in a control run without the necessity of breaking the cable, and they can also be fitted at the transmitting or receiving ends of a control.

Slotted-entry unit

15. Slotted-entry type units are installed when the greater part of the control run consists of plain control cable to which short lengths of Teleflex cable are connected for engagement on the wheel units.

Junction box unit

16. Junction box units are installed where it is necessary to reverse the direction of travel of the control cable, or to branch a run of cable so as to operate two components, e.g. on the port and starboard sides of an aircraft. In one type the box contains a gear wheel and provision is made for two cables to pass through the box on diametrically-opposite sides of the gear wheel. On cable operates the gear wheel, which in turn operates the other cable. Another type contains a double gear wheel and the cables pass through side by side; in this type, both cables travel in the same direction.

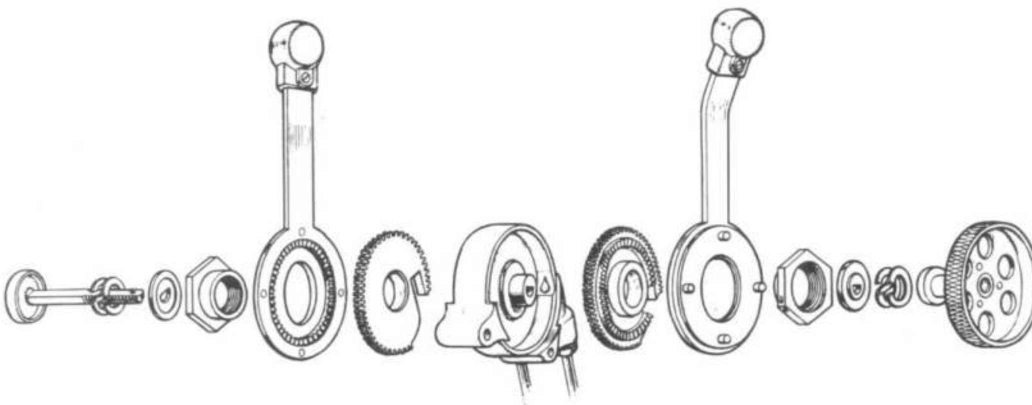


Fig. 6 Transmitting unit with face teeth adjustment

Damping device

17. Some transmitting units are provided with a damping device (fig. 6) which enables the friction in the control handle to be adjusted, so that control settings are not altered by vibration. Alternatively, when the damping device is slackened off, the control handle can be easily adjusted and then securely locked in position. This device consists of a spring-loaded friction plate pressed against the gear wheel. The load on the spring can be adjusted by a knurled hand nut on the spindle which is spring-loaded against the wheel unit cover.

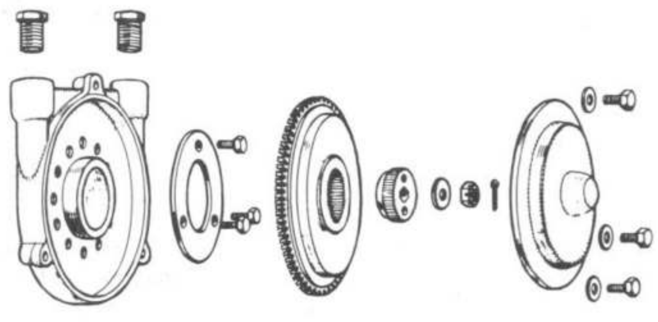


Fig. 7 Receiving unit with splined bush adjustment

Fine adjustment device

18. Some wheel units have provision for making relatively fine adjustments between the gear wheel and the operating handle or shaft without disturbing the cable. These adjustments are effected by one of the three following methods:

(1) A splined bush coupling the gear wheel to the shaft (fig. 7); there are 48 splines on this coupling thus providing an adjustment in increments of seven degrees thirty minutes.

(2) The gear wheel and the operating handle have face teeth on their butting faces (fig. 6). There are 72 teeth, thus providing adjustment in increments of five degrees.

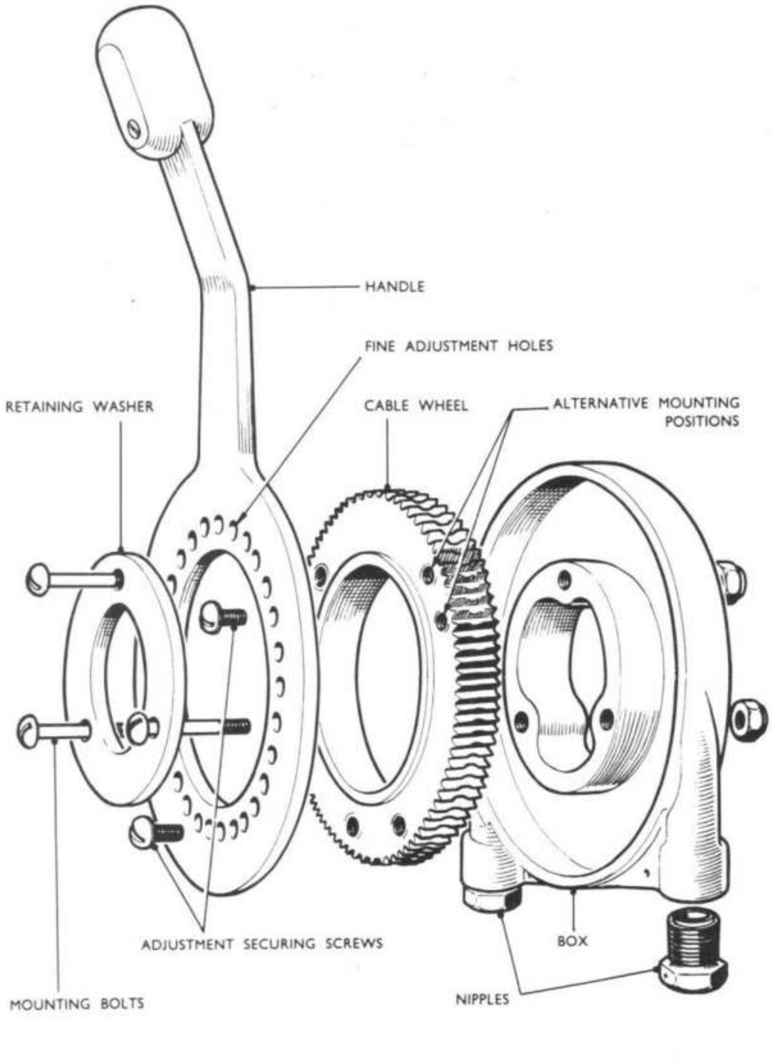


Fig. 8 Transmitting unit with attachment hole adjustment

(3) Another method of adjustment (fig. 8) is obtained by having 27 attachment holes drilled in the operating handle, and two alternative sets of three tapped holes in the gear wheel. One set of these holes is displaced relative to the other set by half the pitch of the 27 holes in the handle, thus providing an adjustment in increments of six degrees, forty minutes. The handle and the gear wheel are secured together by three setscrews.

Spent travel tube

19. The end of a control cable emerging from a wheel unit is accommodated in a short length of conduit known as a spent travel tube. This tube is fitted to the wheel unit by a conventional nipple, and has its end sealed to prevent the ingress of dirt.

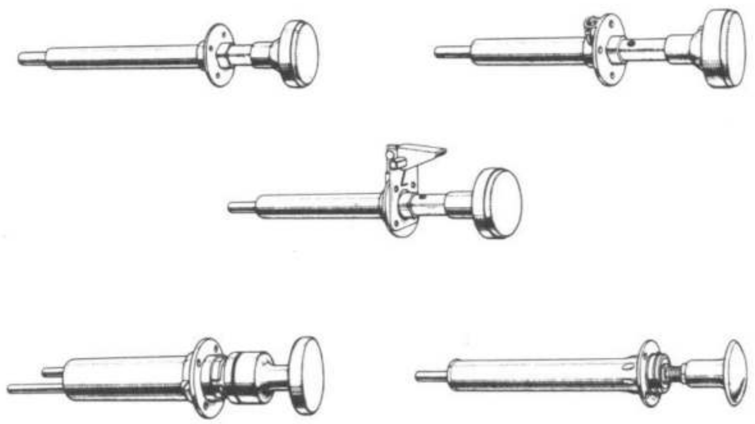


Fig. 9 Typical pull-push transmitting units

Pull-push control units

20. Pull-push control units are often installed in place of wheel units where the control is to operate against a light load, and where fine adjustment of the control is not required. The various types employed are illustrated in fig. 9. The cable is secured to the operating handle by

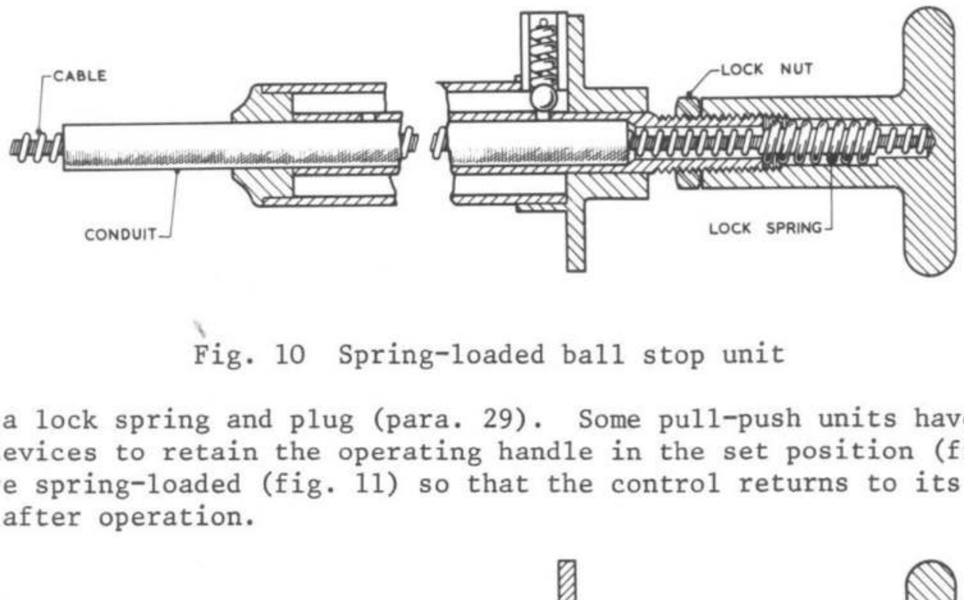


Fig. 10 Spring-loaded ball stop unit

means of a lock spring and plug (para. 29). Some pull-push units have locking devices to retain the operating handle in the set position (fig. 10); others are spring-loaded (fig. 11) so that the control returns to its normal position after operation.

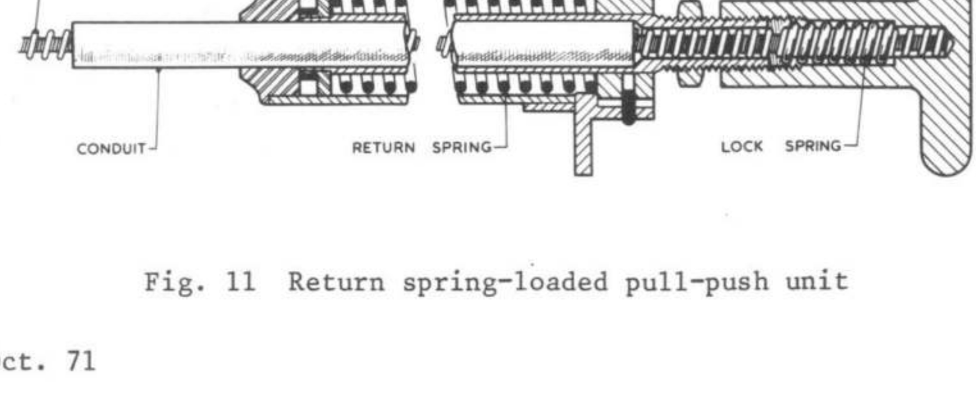


Fig. 11 Return spring-loaded pull-push unit

Sliding end fittings

21. When it is not necessary to convert the lateral movement of the control into rotary movement to operate a component, a wheel receiver unit is not required, and a variety of end fittings (fig. 12) are available for use, according to the method of attachment to the component. In each instance the fitting comprises a guide tube terminating in a fork eye, ball joint, or an external or internal threaded fitting. The guide tube is of such a bore that it forms a sliding fit on standard conduit or on the tube of a swivel joint. The cable is attached to the end fitting by means of a special collet attachment, or by means of a lock spring and plug as illustrated in figs. 13, 17 and 18.

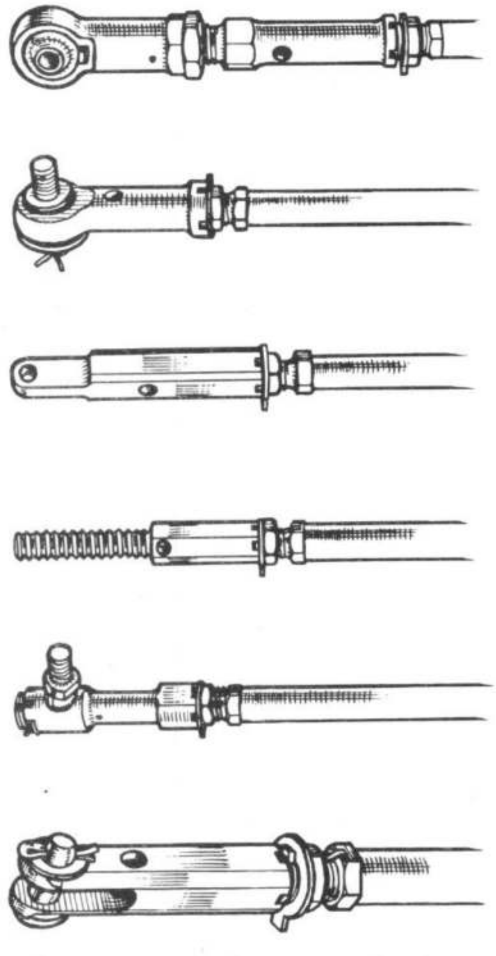


Fig. 12 Sliding end fittings

Swivel joints

22. A swivel joint can be installed in place of a wheel unit where the rotary movement imparted to the control mechanism lever at the receiving end does not exceed 90 deg. The control must be so adjusted that this 90 deg. movement is actually 45 deg. either side of the dead centre position. This adjustment is necessary as the angular travel of a swivel joint is limited to 8 deg. from the centre axis. This type of joint consists of a ball and socket connection inside a housing attached to the end of the rigid conduit in a control run; the housing must be rigidly secured to the aircraft structure. The ball is welded to a length of tubing of the same external and internal diameter as standard rigid conduit. A suitable sliding end fitting is attached to the end of the control cable so that the guide tube slides freely over the swivel joint tube. Typical examples of swivel connections are illustrated in fig. 14.

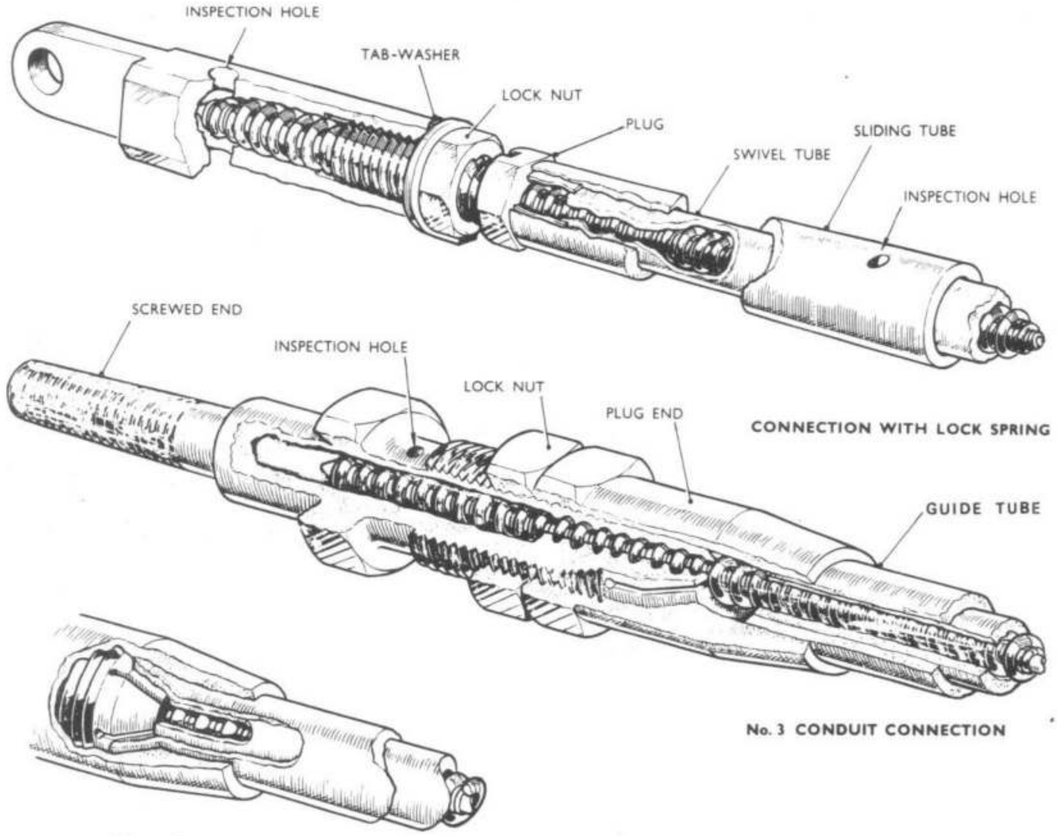


Fig. 13 Sliding end fitting attachment to cable

Torsion drive components

23. In certain installations the final movement in the remote control is rotary, so that the normal pull-push action has to be converted to rotary action. This is done by using a distributor box coupled to the component to be operated by a torsion drive similar to a normal flexible drive.

Distributor box

24. The distributor box is similar in construction to a normal receiver box wheel unit with a gear wheel attached to the face of the cable gear wheel. This gear wheel drives a pinion on a cross shaft, which can be coupled to a lever or torque shaft. Some distributor boxes may be chain driven, the ends of the chain being connected to the control as illustrated in fig. 1.

Screw jacks (fig. 15)

25. Screw jacks are used in installations such as trimming tab controls. The body of the jack accommodates a threaded spindle at one end and the other end is internally splined. The extending spindle of the jack is externally splined to fit the splines in the body, and is internally threaded to accommodate the threaded spindle.

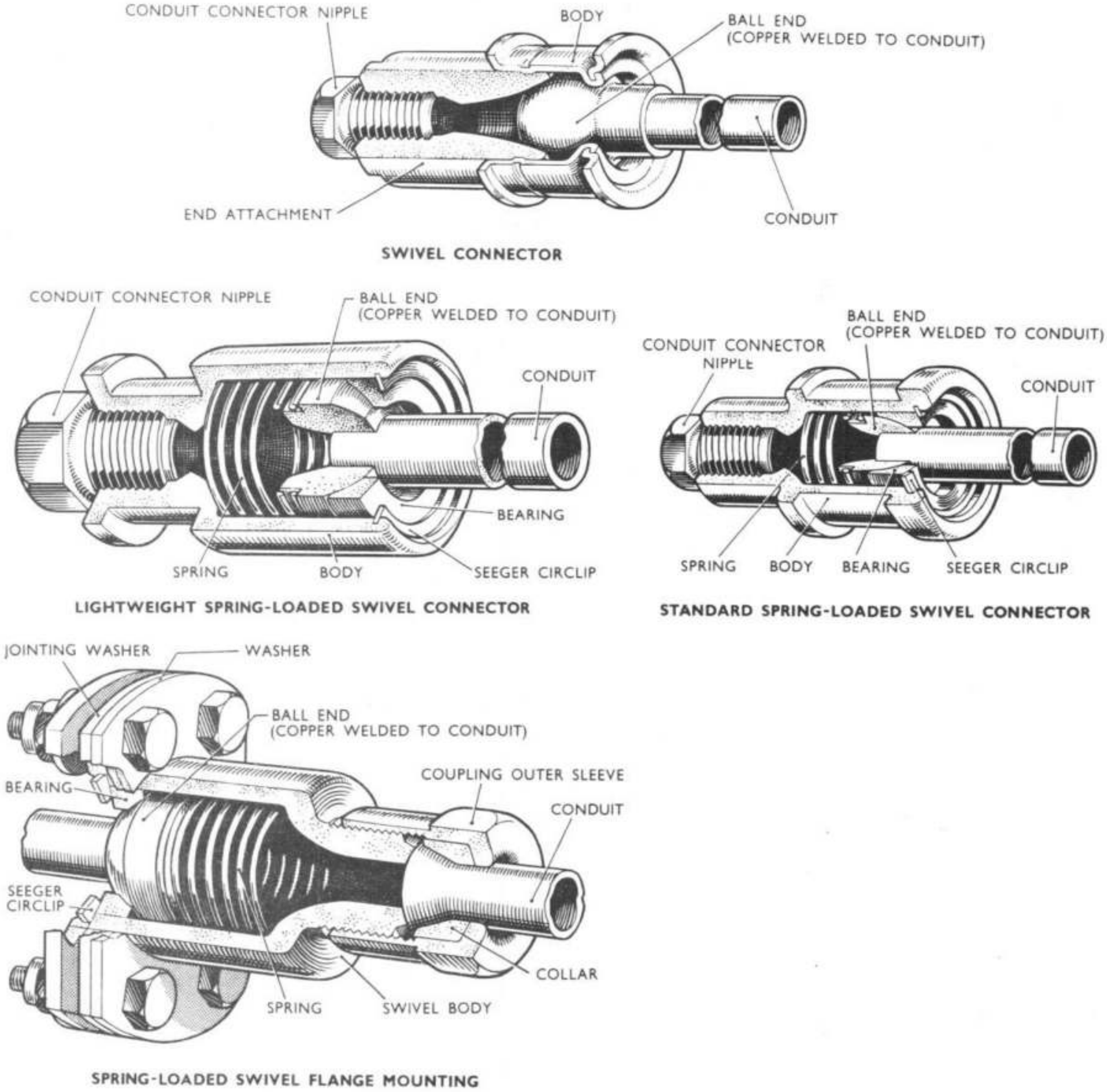


Fig. 14 Swivel connections

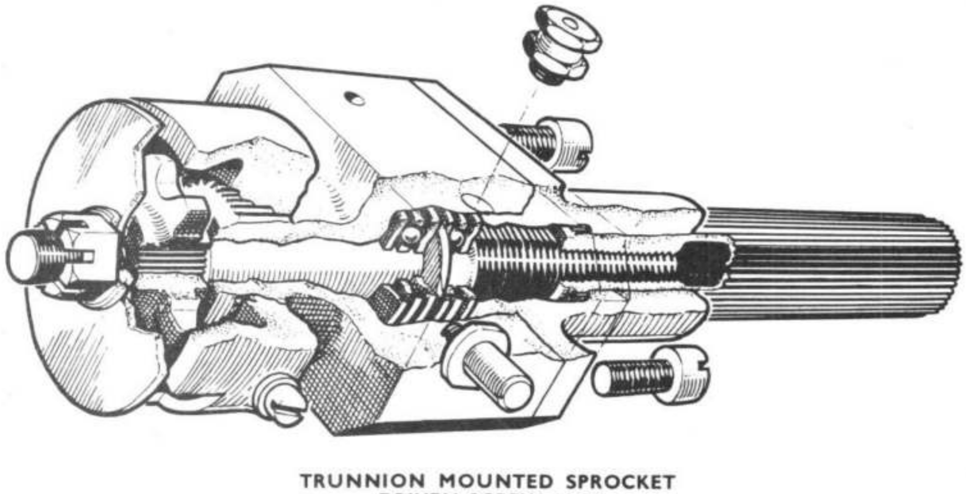


Fig. 15 Screw jack

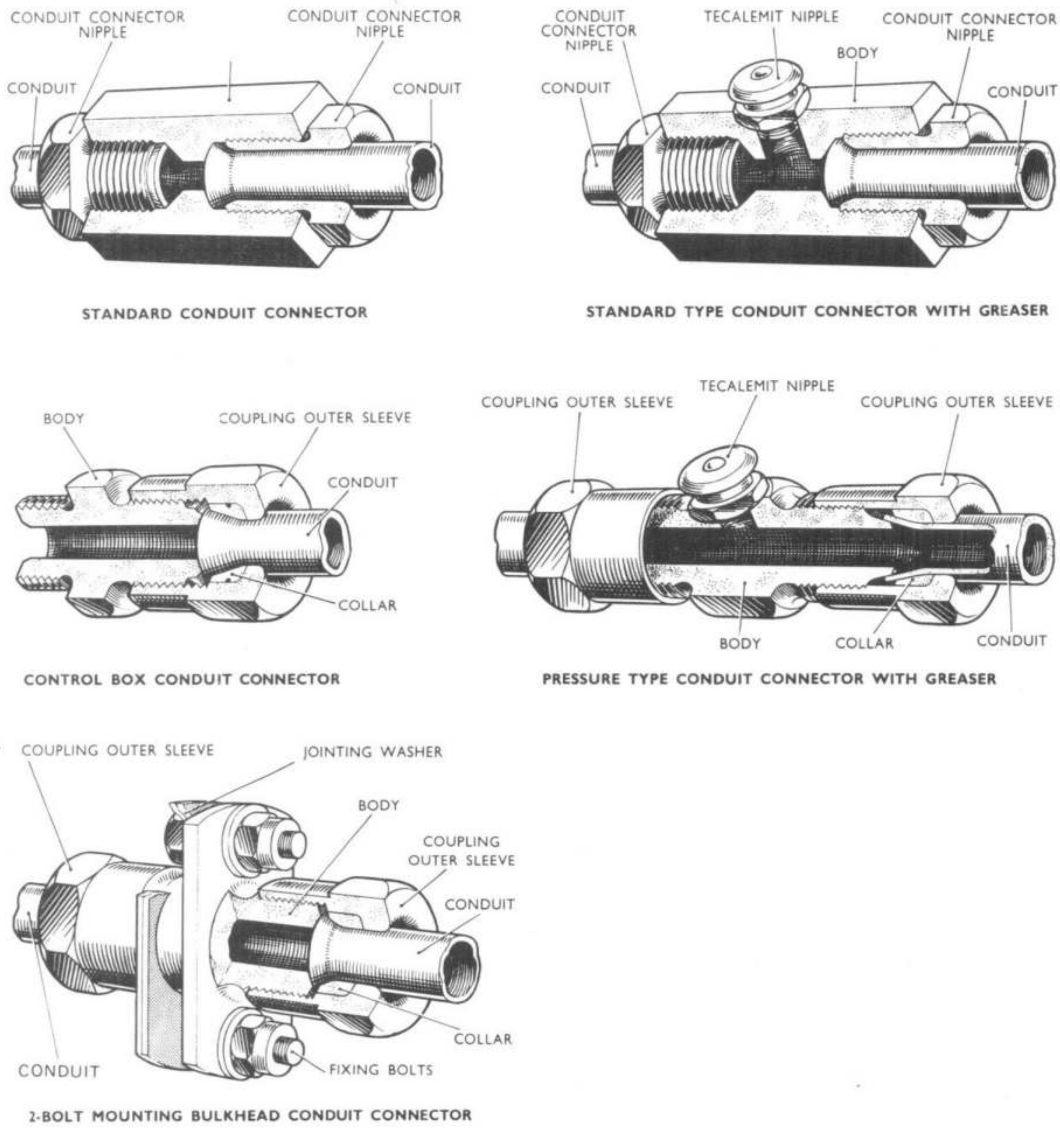


Fig. 16 Conduit connectors

<u>Conduit connectors</u> (fig. 16)

26. Conduit connectors are similar in construction to all-metal pipe couplings but without an olive. The standard conduit connection consists of a screwed nipple that is threaded on to a rigid conduit, before the end of the conduit is flared (belled). The nipple is then screwed into a wheel unit or conduit connector body, thus retaining the conduit secure against a shoulder in the internally-threaded connection hole. The pressure type is similar, except that the flared end of the conduit is tightened against a male conical seating instead of a shoulder, and a collar is inserted between the nipple and the flared conduit. Both types of connector can be obtained with a Tecalemit greaser (fig. 16) fitted into the body. The fittings used to mate P.T.F.E. lined conduit are similar to the types illustrated but have a larger bore to accommodate the greater o.d. of this conduit. A series of fittings are also

produced to enable the P.T.F.E. lined conduit, D.S.431, to be coupled to size 2 metal conduit.

Cable connectors

27. Two types of cable connectors, the screwed end split collet type and the lock spring type, are used to attach the end fittings quoted in para. 21 to the cable.

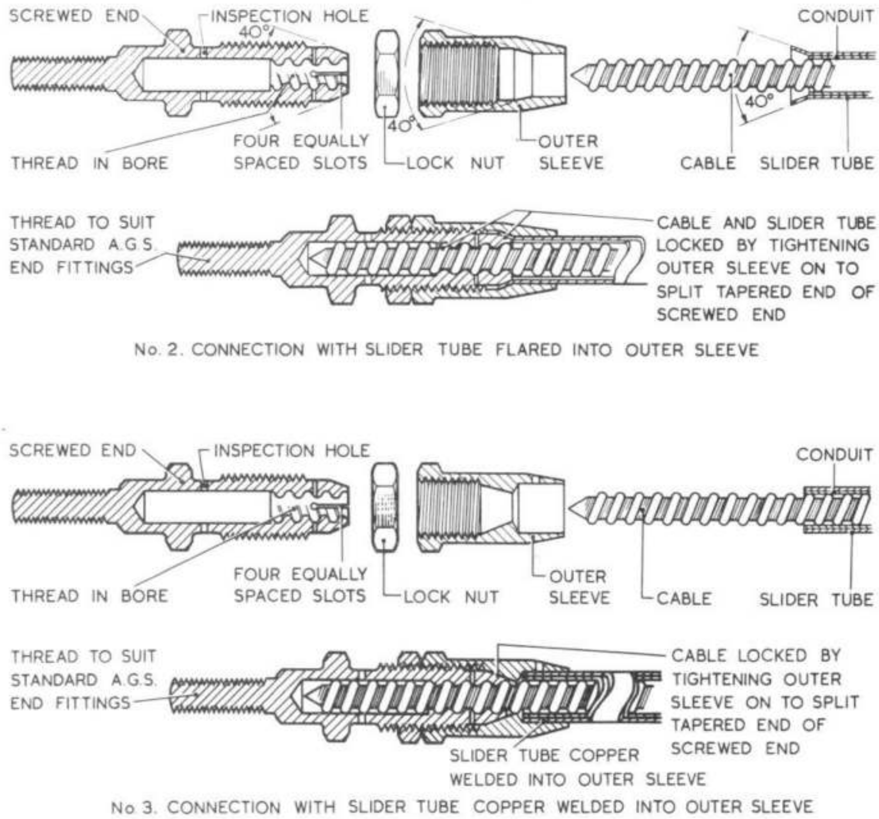


Fig. 17 Split collet type connector

Screwed end split collet type (fig. 17)

28. The screwed end type of connector consists of a body bored and threaded to fit the helical wire of the cable. One end is reduced and threaded to receive standard A.G.S. fittings, the other end is externally threaded to take the plug end and locknut. A hexagonal collar is machined on the outside of the body for the reception of a spanner when tightening the connection. An inspection hole is drilled through the body to enable operators to check that the cable is inserted correctly. The end of the body that receives the cable is tapered to an angle of 40 deg., drilled and slotted to form a collet for locking the cable when the connection is tightened. A nut or plug end, to which in No. 3 size of control the slider tube is copper welded, screws on the collet end. This plug end has a hexagonal collar machined on it for the reception of a spanner, and is locked by a locknut. In No. 2 size of control the plug end is internally bored to form a taper housing for the flared end of the slider tube, and when the connection is tightened the flared end of the slider tube is pressed against the collet on the body of the connection.

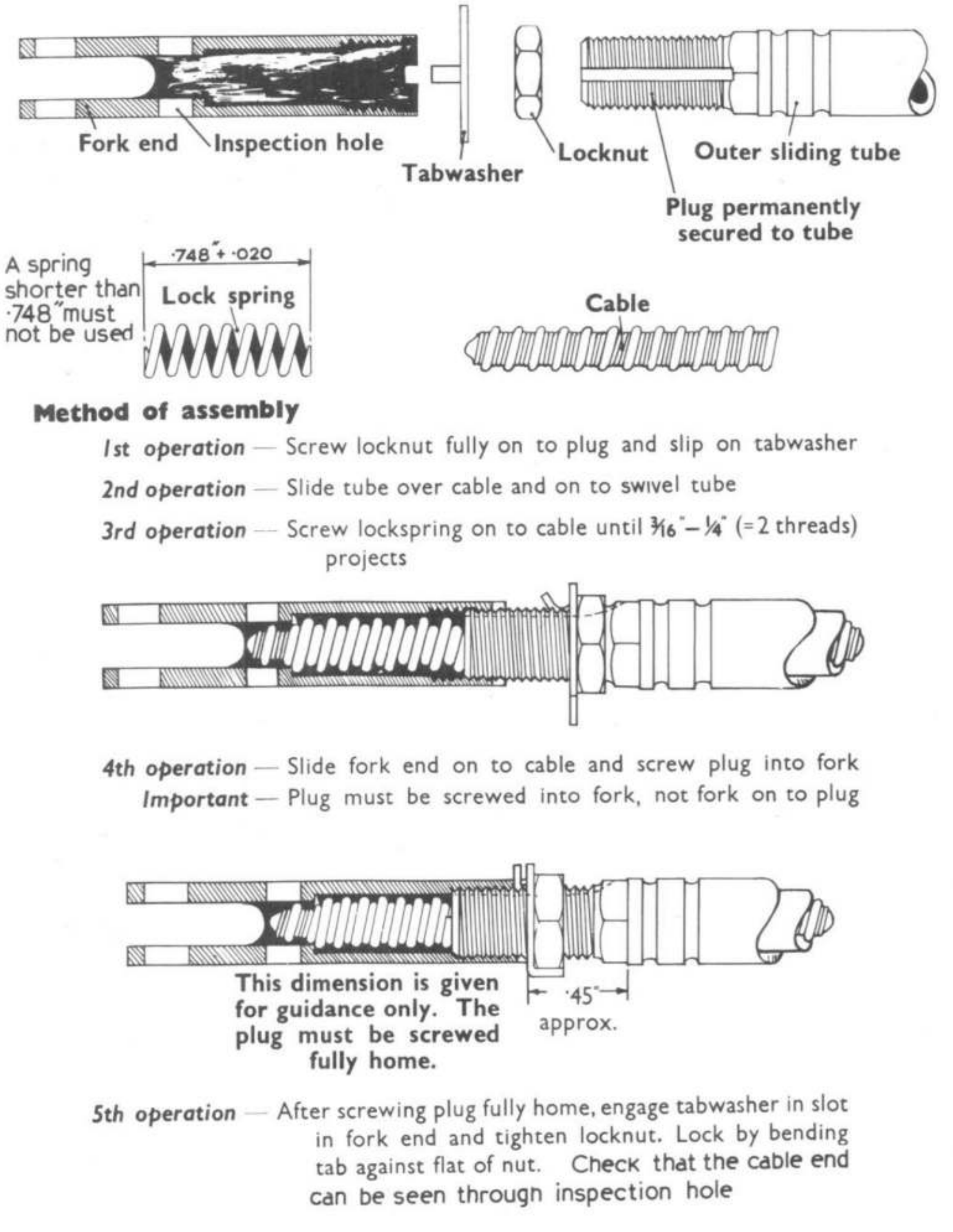


Fig. 18 Lock spring type connector

Lock spring type

29. Lock spring type connectors will be found in many aircraft for attaching sliding end fittings, and pull-push control handles, the principle used in each case is the same. A typical assembly is shown in fig. 18. The sliding end attachment fitting (para. 21) is internally threaded for approximately a fifth of its length, and then bored for approximately a further two-fifths of its length to house the cable locking spring; it is further bored to house the end of the cable. An inspection hole is drilled just beyond the

lock spring housing. The plug end is attached to the sliding tube and threaded externally to fit in the end attachment fitting and is locked by a locknut. The locknut is in turn locked by a tabwasher. The tongue of the tabwasher engages a slot machined along the plug.

Quick-break units

30. Quick-break units are installed in control runs to facilitate the dismantling of controls at bulkheads and break positions in fuselage and wing structures. A typical break unit is illustrated in fig. 19. The cable joining fittings are similar in all types of break units, and consist of rods machined with interlocking slotted ends attached to the ends of the cables.

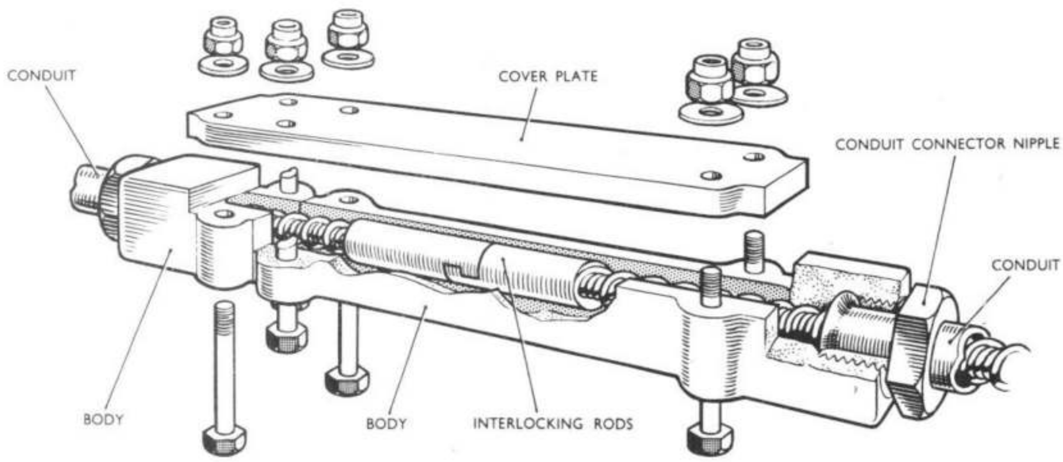


Fig. 19 Break unit, Type D

Break unit, Type D (fig. 19)

31. In this type of break unit the interlocking rods are housed in a divided box which is secured together when assembled by a cover plate retained in position by six bolts and nuts. The flared conduits are secured to the box by normal screwed nipples.

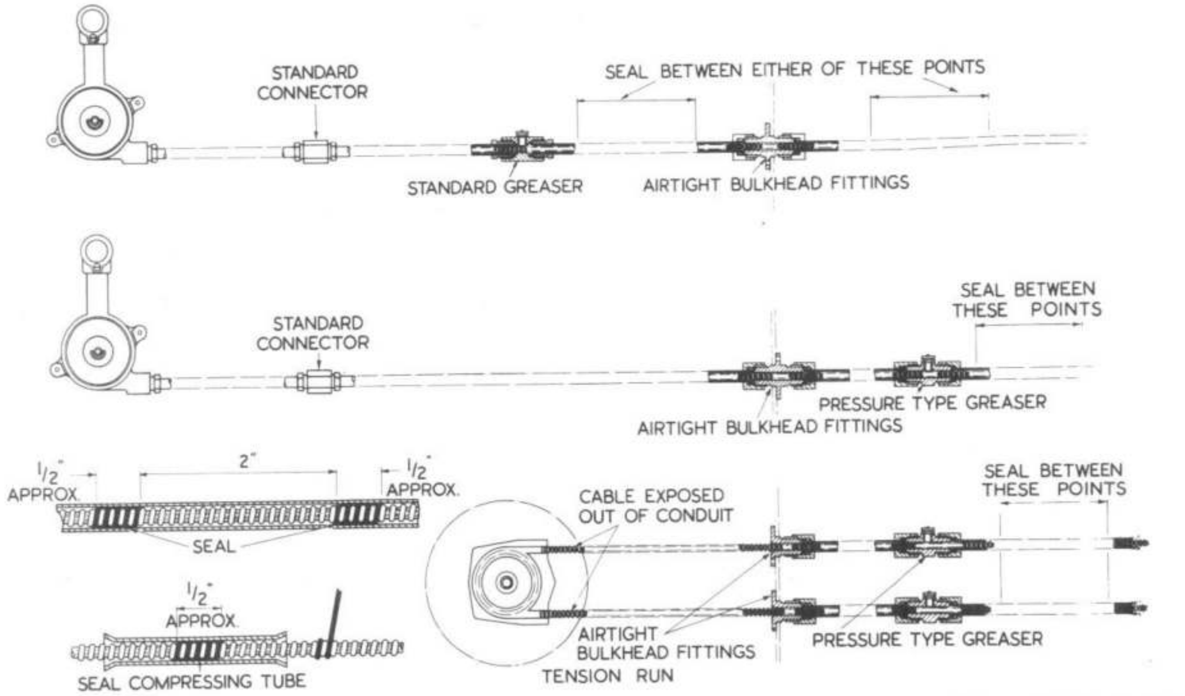


Fig. 20 Typical pressure cabin control runs

Pressure cabin control runs (fig. 20)

32. Typical pressure cabin control runs are shown in fig. 20. The seal is formed by two 2-inch lengths of one-sixteenth inch diameter asbestos string, two inches apart, wound round the cable between the raised helix wire. The seal packing is retained in position by the helix wire and forms a permanent seal between the cable and the bore of the conduit. The point of entry of the conduit can be made pressure-tight by means of a bulkhead connection as shown in fig. 20. A pressure type greaser connection is fitted on the pressure side of the bulkhead connection. When wrapping the asbestos string on the cable a short length of conduit, bell-mouthed at each end, can be used to reduce the outside diameter of the seal so that it will slide easily in the conduit, and bed well down within the helix wire spacing. This type of installation is only necessary at the airtight bulkhead; the remainder of the control run can be made up of standard fittings.

INSTALLING CONTROLS

General

33. The successful and efficient functioning of a control depends to a large extent on the care exercised during installation.

Note ...

> Cleanliness and careful handling of components is of prime importance, as the presence of foreign matter or superficial damage to components might jam the control, and will cause harsh operation and rapid wear.

Lubrication

34. When being assembled, all moving parts must be lubricated with grease. NATO No. G-354 (Ref. No. 34B/2241973).

Cable

35. Cable must be kept clean and free from kinks; if dirty, it should be cleaned in kerosine and wiped dry with a non-fluffy cloth. A cable that has been damaged, subjected to strain or heat, must be rejected. Wire cutters or end nippers may be used for cutting a cable and, after cutting, the rough end must be filed or ground, in the same direction as the lay of the cable, to a blunt conical shape. To prevent unwinding or splaying of the spacing wires during assembling, the free end of the cable should be tinned as follows:-.

(1) Using a soft wire brush, clean the cable thoroughly, then apply flux D.T.D.599A (Ref. No. 33C/9424968).

(2) Using solder B.S.219, Grade 'A' (Ref. No. 30B/2100) heat the cable in a small flame (Gas/Air torch) until the solder flows.

Note ...

> To permit the cable to flex during operation, the extent of tinning must not exceed 0·25 in. from the cable end, and only the thinnest coat possible should be given to enable the cable to be freely entered into the Teleflex wrapper box.

Flexible conduit

36. Flexible conduit must be clean, free from kinks, and internal and external damage. It must not be bent to a radius of less than nine inches.

Rigid conduit

37. Rigid conduit must be clean, free from dents or deformations, and reasonably straight. It is advisable to pass a cable through a length of new conduit to ensure that it is clear of any obstruction in the bore. Never use conduit that has been previously bent. Conduit should be secured to the aircraft structure at intervals of approximately three feet. Teleflex blocks or standard pipe clips of the correct size must be used. No supports must be secured to bends, no matter how slight the bend.

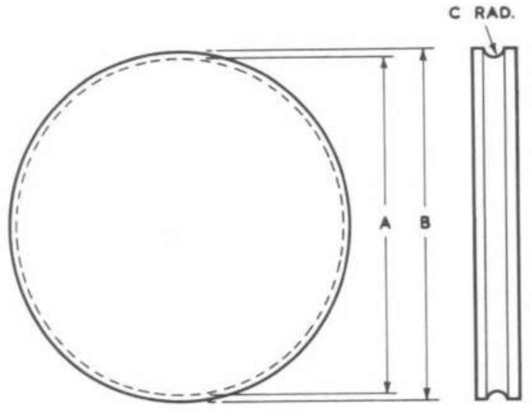
Cutting the conduit

38. Conduit can be cut to length with a hacksaw. The ends must be square and free from burrs. It is advisable to chamfer slightly the ends externally and internally to prevent splitting when the ends are flared. Any swarf or filings that enter the conduit should be blown out from the other end.

Bending the conduit

39. Conduit must be bent cold and to standard radii of not less than the following limits:-

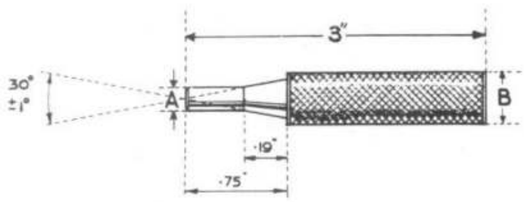
Conduit size	Minimum radius
No. 2 and 380	3·0 in.



CONDUIT SIZE	DIMENSIONS OF TOOL		
	A	B	C
No. 2	6·0 IN.	6·375 IN.	0·139 IN.

Fig. 21 Tool for bending conduit

A former as shown in fig. 21 should be used when bending conduit. The manufacturers recommend using a filler, such as 'Cerabend' before bending, but if this method is used careful control of the filling and cleaning methods is essential. If the conduit is bent without filling it is advisable to insert a length of cable to prevent distortion of the conduit. Large radius bends are not desirable and whenever possible standard radii should be used. It is advisable to keep the bends to a minimum, and in view of this it is often desirable to run the control diagonally from one point to another in preference to following the normal pipe and electrical lead runs in an aircraft.



Conduit size	Dimensions	
	A	B
No. 2	0·19 in.	$\frac{3}{8}$ in.

Fig. 22 Drift for flaring conduit

Flaring the conduit

40. When the end of the conduit is secured by a nipple type connector it is necessary to flare the end. The flare or belling must be of such a size that at least a sixteenth of an inch projects through the attachment nipple. The operation of flaring must be done cold. A drift similar to that shown in fig. 22 should be used. It is essential that the shank of the drift is a good fit in the conduit, and it should be smeared with lubricant before use. Before P.T.F.E. lined conduit can be flared the P.T.F.E. liner must be cut back from the vicinity of the flare using the P.T.F.E. cutting tool, fig. 23. The flare is formed by giving the drift a number of slight blows with a hammer; rotate the drift in the conduit between the hammer blows.

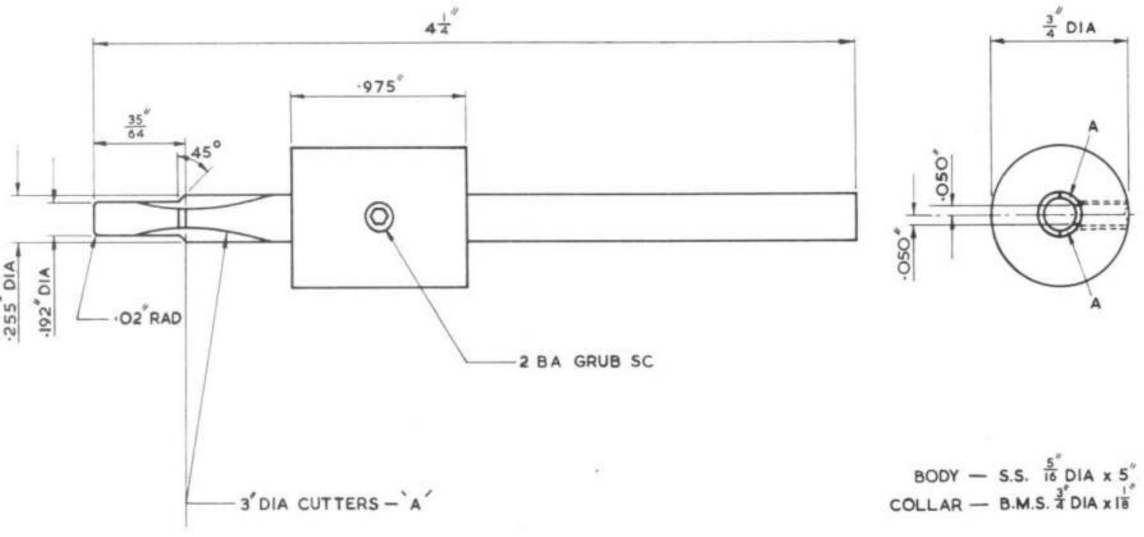


Fig. 23 P.T.F.E. cutting tool

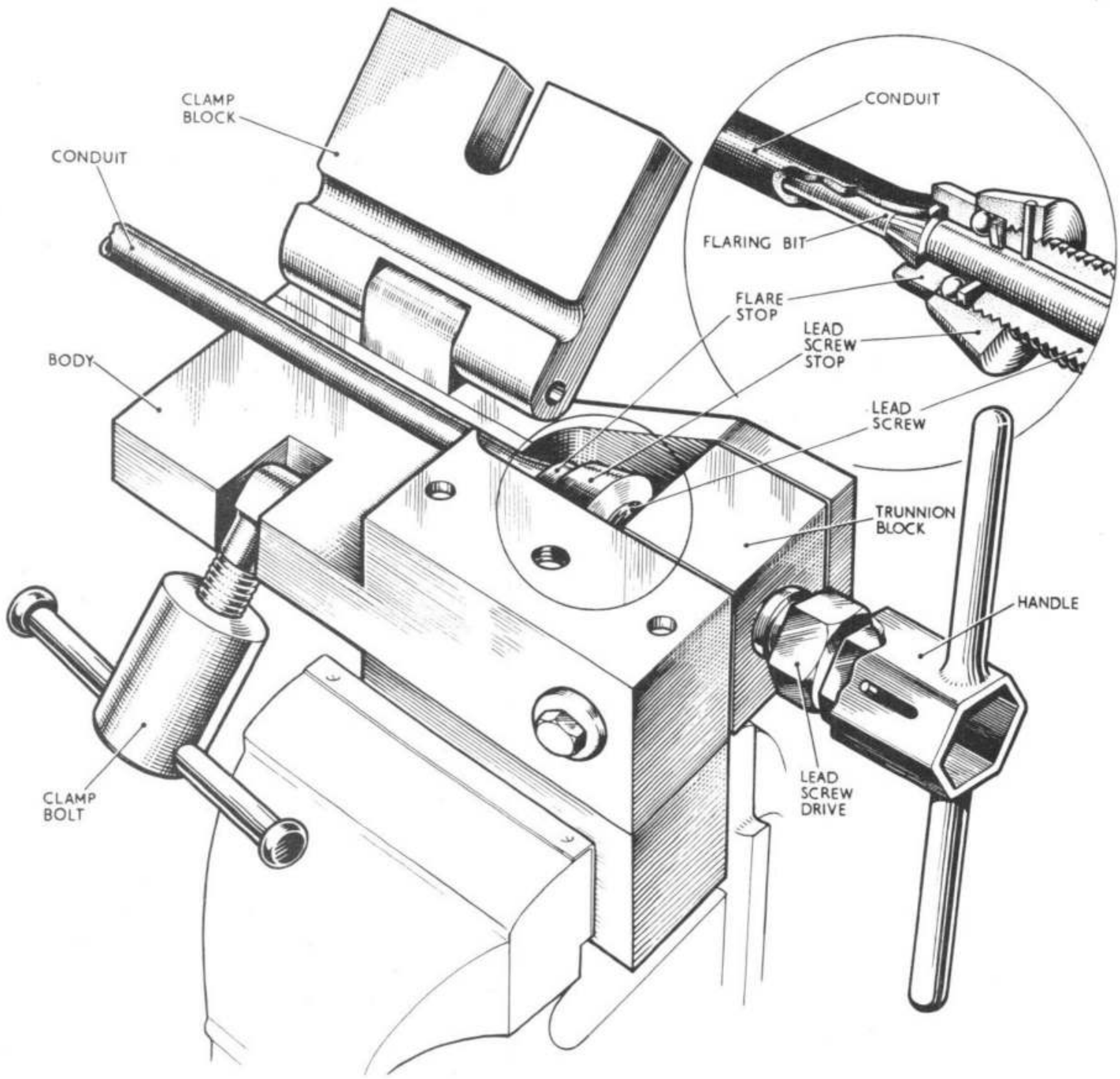


Fig. 24 Conduit flaring tool

Conduit flaring tool

41. The special flaring tool (fig.24) is designed to form a flare of 30 deg. and to allow a projection of 1/16 in. of flare through the attachment sleeve nut. This angle and projection applies to both No.2 and ◀ DS 431▶ conduits. The diameter at the top of the flare, if correctly formed, should be 0·34 in. to 0·35 in. for No.2 conduit and 0·44 in. to 0·45 in. for ◀ DS 431▶ conduit. The block provided underneath the tool should be gripped between the jaws of a vice so that the movement of the trunnion block is not restricted. The tool should be used as follows:-

(1) Unscrew the clamp bolt and hinge back the clamp block.

(2) Engage the handle and the lead screw nut, and unscrew the lead screw until the stop bears on the trunnion block.

(3) Thread the conduit to be flared over the flaring bit.

(4) Hinge down the clamp block and grip the conduit by tightening the clamp bolt.

(5) Screw in the lead screw and flaring bit until a stop is felt.

Note ...

This stop is caused by the flared end of the conduit butting against the flare stop (inset fig. 24).

(6) Disengage the handle from the lead screw nut, and turn it several times to finish and burnish the flared end of the conduit.

(7) Engage the handle and the lead screw nut, and unscrew the lead screw until the stop butts against the trunnion block.

(8) Unscrew the clamp bolt and hingeup the clamp block.

(9) Tip the trunnion block to disengage the conduit from the clamp block body.

(10) Slide the flared conduit from the flaring bit.

Conduit connectors

Standard type

42. When fitting standard type connectors the nipples must be threaded on the conduit before the flare is formed. When tightening the connection two spanners must be used. If there is any end play between the conduit and the body of the connector after tightening, dismantle the connection and enlarge the flare on the conduit.

Pressure type

43. When fitting pressure type connectors the outer sleeves and collars must be threaded on the conduit before the flare is formed, otherwise, the procedure is the same as for the standard type.

Standard connections to wheel units

44. Standard connections to wheel units are made in a similar manner to standard conduit connections.

Inserting cable into conduits

45. If the run of the conduit has been correctly installed, it should be possible to insert the cable through the entire length of conduit by hand, although some restrictions will be felt as the end of the cable traverses a bend in the conduit; once past the bend it should become quite free again. Great care must be taken not to kink the cable when inserting it in conduit. A thin film of grease NATO No. 6-354 (Ref. No. 34B/2241973) must be applied to the cable as it is fed into the conduit.

46. Where the length of control exceeds 30 ft. and there are several bends to be negotiated, it might be difficult to insert the cable without assistance. The cable can be assisted in some instances by attaching a double-entry wheel unit to the conduit and feeding the cable into the conduit by turning the wheel. Another method is to thread the outer tube of a sliding end fitting along the cable and on to the conduit; with one inch of the tube in engagement with the conduit, grip the cable and tube together and push them along the conduit as far as possible. Withdraw the tube to its original position and repeat the operation until the required amount of cable has been inserted. Normal gripping tools such as pliers must not be used to grip the cable to insert it into conduit, as this would damage the wire helix.

47. While it might be necessary to employ the method described in para. 46, or a similar method for inserting the cable into the conduit, it is important that in any length of installation it should be possible to work the cable backwards and forwards by hand when it has been completely inserted. If this is not possible, the run of conduit has not been installed to the required standard.

Screwed end connections

48. When assembling screwed end connections, thread the outer sleeve complete with slider tube, locknut, and screwed end over the cable; the outer sleeve and slider tube will fit over the conduit. Screw the screwed end in an anti-clockwise direction on to the end of the cable until the cable shows at the inspection hole. Continue screwing for a further two and a half turns, when the mean adjustment point will be reached. When final adjustment of the control has been made, the whole assembly can be locked by holding the screwed end stationary and screwing the outer sleeve on tightly. The locknut must be screwed tight against the outer sleeve.

Lock spring connections

49. When making lock spring connections (fig. 18), thread the sliding tube complete with outer sleeve on to the conduit, screw the lock nut as far as possible on to the plug, then screw the lock spring on to the cable until from three-sixteenths to a quarter of an inch projects through the lock spring (three-sixteenths of an inch equal two threads of the cable). Screw the end fitting on to the outer sleeve as tightly as possible. The sleeve will contact the spring when it is partially screwed in; the further tightening of the sleeve will compress the lock spring against the shoulder in the end fitting, thus tightening the spring on to the cable and ensuring a positive lock. Always hold the end fitting and tighten the sleeve; if the opposite method is

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adopted the fork will rotate the spring and alter its position on the cable. If the end fitting is not in exactly the correct position for coupling on the component to be operated, slight adjustment can be made by dismantling the connection and screwing the spring further on or off the cable. The cable must always be through the full length of the spring but the amount projecting must not exceed a quarter of an inch, because end fittings have blind ends and the cable will prevent the spring from being gripped against the shoulder in the fitting. A check should be made by inserting a wire in the inspection hole to ensure that the cable is located at the hole. In some instances the inspection hole has been drilled oversize so that it is possible to pass a wire straight through although the relative positions of the end fitting and cable are correct. In such an instance a visual check is satisfactory. When correct adjustment is obtained, tighten the locknut and bend over the tabwasher.

Note ...

> Adjustment must not be effected merely by screwing back the end fitting on the sleeve; the sleeve must always be screwed fully home in the end fitting.

50. A number of end fittings of two obsolescent types may still be found in service. One type has no provision for a tabwasher and the other type has neither a tabwasher nor a locknut. With both these types of end fittings the important points are that the lock spring must be fully compressed and the relative positions of the lock spring and cable must be correct. The type that has neither locknut nor tabwasher is locked by a split pin inserted through one of two holes drilled across the body and registering with a flat on the screwed outer sleeve.

Pull-push knobs with lock springs

51. Several types of pull-push units have the lock spring type of connection. In some of these control units the knob itself compresses the lock spring and in others the spring is compressed against a shoulder in the bore of the knob by a screwed plug. To assemble the type where the knob compresses the spring, unscrew the locknut and remove the knob from the threaded end of the sliding plunger; the knob has a left-hand thread. Pass the cable through the unit, screw on the lock spring until it protrudes between three-sixteenths and a quarter of an inch (two threads of the cable). Screw on the knob and tighten it fully to compress the spring on to the cable, then tighten the lock nut against the knob. In another type the knob and sliding plunger are integral, and the lock spring is secured to the knob and cable by a screwed plug that fits into the body of the knob.

Swivel joints

52. When installing a swivel joint it is important that the body is rigidly mounted as it takes all the reaction of the load and any movement of the fitting will result in lost motion in the control. Care must be taken that no foreign matter rests between the clamping block or strap and the body of the unit, as when it is tightened up the body will be distorted, resulting in harsh working of the ball joint. The swivel fitting is attached to the conduit in a similar manner to the attachment of a wheel unit. The swivel tube of the fitting carries a sliding end fitting; a check should be made to ensure that at least one inch remains in engagement with the swivel tube. An inspection hole is drilled one inch from the end of the sliding tube to allow this check to be made. Also a check should be made that the swivel tube can be rocked freely to the maximum deflection of eight degrees in any direction

from the centre line. It is important that the swivel joint be mounted in alignment with the component control to be operated, otherwise stiffness in the control and excessive wear will result.

Outer sliding tubes

53. The outer sliding tubes of sliding end fittings are supplied in one length only, and they may be cut to a length to suit the control to which they are fitted. A sighting hole must be drilled one inch from the end of the tube. When the control is at the limit of its movement the conduit should be visible through this sighting hole in the outer sliding tube.

Break unit, Type D

54. Before assembling this connection, the conduit securing nipples must be threaded on to the conduit before it is flared. Flare the two lengths of conduit. Thread the break unit body and end piece on to the two break rod cables, insert the break rod cable into the conduits and connect their slotted rod ends together in the body of the break unit. Secure the cover plate to the body and end piece by the six bolts and nuts supplied.

Inserting cable into wheel units (fig. 25)

55. It should always be possible to feed cable through a wheel unit freely although some resistance will be felt as the end tends to spring out and dig into the casing. When the cable has completed its travel round the unit, very little effort should be needed to push and pull the cable. It should be possible to push the unsupported cable from a distance of four inches from the wheel unit without it showing any tendency to bend. If the cable jams at any point, examine to see if all the coils of the cable are lying freely in the teeth of the wheel. If at any point the cable is riding on the teeth, the cable has probably been strained and is out of pitch, and should be rejected. Ensure that the interior of the wheel unit is clean and free from swarf of any kind. The cable must not be wound into engagement with the toothed wheel by a hand brace or any similar method as this will distort the lay of the windings on the cable. On final assembling the wheel must be packed with grease NATO No. 6-354 (Ref. No. 34B/2241973).

Single-entry units

56. When threading cable into a single-entry unit proceed as follows:-

(1) Detach the handle from the unit or, when fitting a driven unit, disengage the wheel from the component operated, so that the wheel can rotate freely.

(2) Position the wheel so that the slot is facing the conduit attachment hole and feed in the cable until it enters the slot.

(3) Rotate the wheel a minimum of forty degrees and refit the handle or, in a driven unit, engage the unit to the component to be operated so that the control and the component are in their relatively correct positions.

Note ...

It is important that there is not less than forty degrees engagement between the cable and the wheel in the 'cable out' position. It is equally important that at the other extreme of travel that movement is

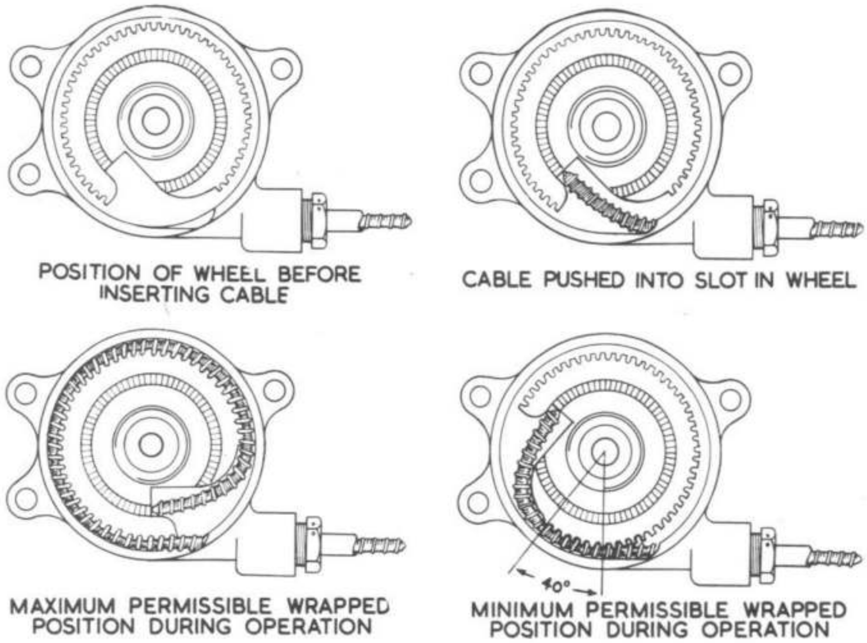

Fig. 25 Method of inserting cable in a wheel unit

governed by the stops in the wheel unit and not by the cable jamming against cable already on the wheel.

The number of teeth equivalent to forty degrees are given in Table 4.

Double-entry units

57. When threading cable into a double-entry unit proceed as follows:-

(1) Detach the spent travel or anti-torsion tube, if fitted, from the wheel unit; detach the handle if it is a transmitting unit or uncouple the wheel from the component if it is a driven unit.

(2) Feed the cable into the unit, either by direct pushing if the conduit is not attached or from the remote end if the conduit is fitted, until the cable end emerges from the spent travel hole in the unit. If it is not already attached, connect the conduit to the unit.

(3) Manipulate the wheel until the cable projects at least half an inch from the spent travel hole. In a driven unit ensure that the component control is at the extreme end of its travel equivalent to the 'cable out' position, and couple up the wheel to it. In a transmitting unit, attach the handle in the position it should occupy when the cable is 'out'.

(4) Operate the control of the other extreme position and measure the length of cable emerging from the spent travel hole in the unit. Check that the undistorted part of the spent travel or anti-torsion tube is at least half an inch longer than the cable. The ends of these tubes are usually sealed by being squeezed flat to prevent the ingress of dirt; it is essential that the cable cannot jam in the distorted portion of the tube. If necessary a longer tube must be fitted, under no circumstances must the cable be shortened.

(5) Secure the spent travel or anti-torsion tube to the wheel unit.

Note ...

The end of the cable must not have to negotiate a bend in the spent travel or anti-torsion tube. If the layout is such that the tube cannot extend straight out from the wheel unit, it must be bent as necessary and continued in a straight length sufficient for the extreme end of the cable to travel.

TABLE 4

Teeth engagement limits

Diameter of wheel (in.)	Number of teeth on wheel	Minimum number to be engaged
2·5	76	9
3·0	97	10
3·5	112	12
4·0	128	14

Adjustment of controls

58. Great care must be taken when installing or servicing controls to ensure that the remote receiving unit is in-phase with the transmitting unit, otherwise a dangerous condition might arise, such as a fuel cock being OFF when it should be ON. The correct procedure is to select one position of the transmitting unit, say ON, and determine whether the cable will have to be pushed or pulled when the control lever is moved to this position. Next examine the remote receiving unit, determine which will be the ON position when the cable is pushed or pulled as already decided, then engage the receiving unit to the component to be operated. Where double-entry wheel units are employed, the correct direction of rotation will have to be arranged in the design of the control by using the appropriate lead-in. Always make a final check after completing an installation.

59. If in any installation no provision has been made for rotating the wheel relative to the component to be operated, the control can be set by trial and error. To do this, set the transmitting unit to ON, feed the cable through the remote receiving unit, which must be disengaged from the component to be operated, then engage the unit to the component. Determine how many degrees the unit is out of its correct position, and whether it required turning clockwise or anti-clockwise. Calculate the number of teeth on the wheel that will correspond to the angle required for adjustment. Disengage the receiving unit from the component and withdraw the cable until only one helix is left in engagement with the wheel. Disengage the last helix and turn the wheel the number of teeth in the direction required to make the necessary adjustment. Feed the cable back into the receiving unit and couple up to the component. If necessary repeat the operation until the correct setting is obtained.

60. If the component to be operated has a spindle which is free to rotate through unlimited travel, it will be possible to mount the wheel unit first, the wheel and component spindle being rotated together when inserting the cable. To adjust the control, proceed as described in the preceding paragraph but the wheel can be rotated without disengaging it from the component.

61. Where a straight lead-in unit is used, fine adjustment can be effected by detaching the unit from the component, slackening the unit from the component, slackening the conduit attachments, and turning the complete unit bodily round the cable.

62. In all instances where a wheel unit is used at one end of a control and a sliding end fitting at the other, it is advisable to assemble the wheel unit first and make any adjustment required at the sliding end fitting, either by means of the lock spring within the limits, as previously described in this chapter or, if this does not give sufficient adjustment, the cable can be shortened. Final adjustment can also be made at the wheel unit end by alteration of the attachment devices as described in para. 18.

63. To adjust a control incorporating screw-jacks, it is only necessary to uncouple one end of the cable, rotate it in the required direction by operating the transmitting control lever, and recoupling the cable. Correct adjustment can be obtained by trial and error. Where two jacks are operated from the same distribution box, they can be adjusted independently.

64. End play can be eliminated from screw-jacks by the removal or addition of shims according to the type of jack. After dismantling, determine whether the thrust is taken by a plain thrust washer or a thrust-type ball bearing. In jacks with a plain thrust washer, end play can be adjusted by removing shims; in jacks with a thrust race, shims must be added between the race and the housing. The shims provided for this purpose are 0·002 in. thick. When the jack is assembled after adjustment, the spindle must be free to rotate, the spindle and threads must be free from damage, and the whole assembly must be clean and well lubricated with grease NATO No. G-354 (Ref. No. 34B/2241973).

65. If the adjustment using shims does not have the desired effect the jack must be rejected. Normally 0·007 in. end float is permissible, but when the jack is used to operate a spring-assisted trimming tab, the end float in all parts must be kept to a minimum and the end float in the jack itself must not exceed 0·002 in.

SERVICING

66. The following paragraphs give possible defects resulting in inefficient working of controls and appropriate remedies.

Damaged conduit

67. Damage to conduit will result in stiffness in a control, or in the case of severe damage, complete jamming. The damaged portion of conduit should be cut out and replaced by new conduit joined by conduit connectors.

Worn wheel unit casing

68. Wear on a wheel unit casing will increase the backlash in a control. Excessive wear may cause the cable to override the teeth on the gearwheel. This defect will be more pronounced in a push operation of the control. The gearwheel should be examined for worn or damaged teeth. It is advisable to renew the complete unit in preference to renewing only the casing.

Lack of lubrication

69. Lack of lubrication will result in excessive wear in the bore of the conduit. Remove and thoroughly clean the cable; clean out the bore of the

conduit. To clean the bore of the conduit an old length of clean cable, wrapped with asbestos string, can be used as a pull-through. The bore of the conduit should be cleaned length by length and not as a complete run. When assembling, lubricate the conduit and the cable with grease NATO No. G-354 (Ref. No. 34B/2241973). In applications where the cable and fittings are subjected to exposed conditions likely to cause corrosion, regular greasing is required.

Distorted or damaged sliding end fitting guide tubes

70. Sliding end fitting guide tubes that are damaged or distorted will result in stiffness in the control. This defect can be checked by uncoupling the fitting from the cable and testing for freedom of movement between the conduit and the guide tube. If the tube is defective, it must be renewed.

Fouling of end fittings

71. Fouling of end fittings against the aircraft structure due to faulty assembly or misuse can be rectified by resetting the assembly.

Damaged flexible conduit

72. Damage to flexible conduit will result in stiffness in the control or excessive backlash. The damaged conduit must be replaced by a new one.

Misalignment between a wheel unit and a component

73. Misalignment between a wheel unit and a component will result in stiffness in the control and excessive wear on bearing surfaces. The remedy is to correct the alignment.

Excessive backlash in a control

74. Excessive backlash in a control may be due to any one of the following defects:-

(1) Conduit connectors incorrectly assembled and so allowing end movement of the conduit.

(2) Excessive end play in screw-jacks.

(3) Cable in a double-tension run incorrectly adjusted.

(4) Swivel joints not rigidly mounted.

(5) Incorrect assembly of lock springs in end fittings.

(6) Excessive wear in the wheel units.

(7) Unnecessary lengths of flexible conduit.

(8) Damaged flexible conduit.

Note ...

After any adjustment has been made or parts renewed a functional check of the control must be made.

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