POST OFFICE TELECOMMUNICATIONS
EDUCATIONAL PAMPHLET

LINES 1/7
DRAFT SERIES

SELF-SUPPORTING AERIAL CABLES

CONTENTS

INTRODUCTION

The high demand for telephone service and the continued rise in the price of engineering stores and labour led to a search for cheaper and where possible, better methods of subscribers' distribution.

The majority of subscribers' circuits include overhead construction, and this part of the distribution network presented some scope for savings in labour and materials. The problem was to find a method of increasing the circuit capacity of existing light overhead routes carrying a few wires without having to undertake extensive rebuilding and strengthening or alternatively to find a cable system that could be erected with less labour.

Aerial cables which are self-supporting have been introduced to satisfy these requirements. They are lighter and can be erected quicker and hence cheaper than the previous types of aerial cable which had to be fixed to a separate suspension strand by cable rings or by lashing.

STAINLESS STEEL SHEATHED AERIAL CABLE

Steel sheathed aerial cable was first erected on field trial in the B.P.O. during the early 1940's and was used to a limited extend for a considerable period. It was a standard method of construction where other types of cable would be likely to be damaged by gunshot, or where other special conditions obtain e.g. where the cable was the only outlet for U.A.X. junctions.

CONSTRUCTION

The core of the cable is made up of paper covered, soft-drawn copper wires, in twin or star quad formation. The core has a final wrapping of paper which is metallized on the outside to dissipate the heat developed in the sheathing process.

Issue 3.0, 6/68

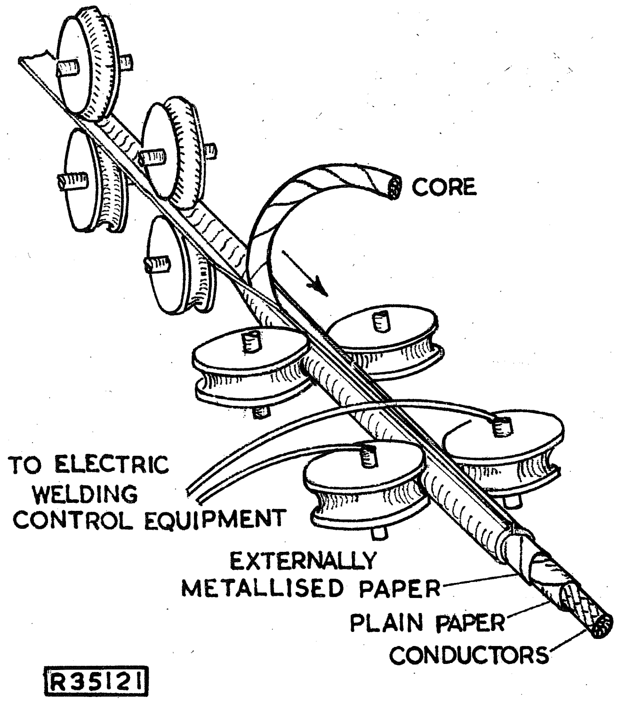


Fig. 1

The sheath is formed from stainless steel strip 0.031 in (31 mils) thick and has sufficient strength to support the cable without a separate suspension strand. The steel strip is passed through a series of four pairs of power driven rollers, the prepared core being introduced between the second and third pairs, as shown in Fig. 1. The first three pairs of rollers convert the flat strip into an unsealed oval tube having flanges located longitudinally on it. As the sheath, containing the core, passes through the last pair of rollers it is compressed into a round section, the flanges pressed together and electrically spot welded at approximately $\frac{1}{16}$ in. intervals to form a fin. The last two rollers are made of copper and are used as the welding electrodes. The spots are arranged to overlap so as to produce a continuous air tight seal down the whole length of the fin.

The latest pattern of this cable is sealed in a slightly different way. The flanges are smaller and are arc welded together in an atmosphere of argon gas, to produce a shallower fin than before.

The completed cable is immersed in water for several hours and subjected to an internal air pressure of 75 lb per square inch to ensure that the sheath is satisfactorily sealed.

The cable sheath is proof against puncture by gunshot but is liable to buckle if bent too sharply. Bending or straightening should be done gradually and any bends introduced should have a radius of not less than 12 inches.

The cable sheath is rather stiff and care has to be taken to prevent it being bent excessively otherwise it may crack or damage the core. For this reason it is supplied on large diameter drums (approx. 6 ft.), having an extra large barrel.

The cable was available in lengths up to 1000 yards and in the sizes ranging from 10 pr, $6\frac{1}{2}$ lb/mile to 38 pr 20 lb/mile.

ERECTION

Pole Lines

Existing pole lines are strengthened, where necessary; and new pole lines to support the cable are erected with reference to a tensioning table, which relates the wind pressure, in terms of 'sheltered', 'normal' or 'exposed' situations, to the permissible dips for given span length.

Note

The degrees of exposure are defined as:

(a) Sheltered, where nearby hills, building, etc. protect the line from high winds.

(b) Normal, inland situations where there is no shelter from the wind.

(c) Exposed, situations near parts of the coast, and over high ground, where winds of high velocity are known to occur.

Position on pole

The most convenient side of the pole to erect the cable is on the road side but an exception is made in the case of angle poles where the pull-on-pole is greater than 15 ft. At these poles the cable is placed on the inside of the angle so that it pulls away from the pole. This prevents the cable from binding on the pole and makes it easier to tension the erected cable.

When a second cable is erected it is placed 6 in. below the first, thus when considering clearances an allowance has to be made against this possibility.

Attachment to poles

The cable is attached to the poles by means of brackets or brackets and 7/14 stay wire slings. The fittings required should be fixed to the poles before the cable is erected.

There are three types of fixing which have to be considered:-

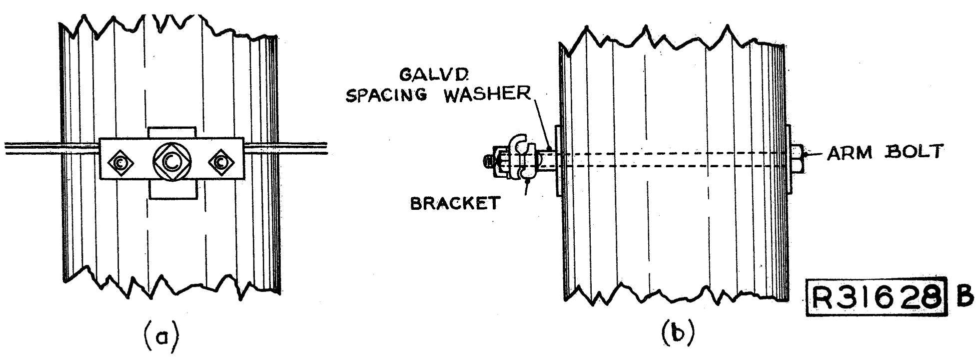


Fig. 2

At through positions: Where the pull-on-pole is less than 15 ft. the cable, after tensioning, is rigidly fixed in clamps which are bolted to the pole as shown in Fig. 2. Sketch (a) shows a side view of the cable fixed in the clamp and (b) shows an end view of the bracket fixed to the pole, before the cable is inserted.

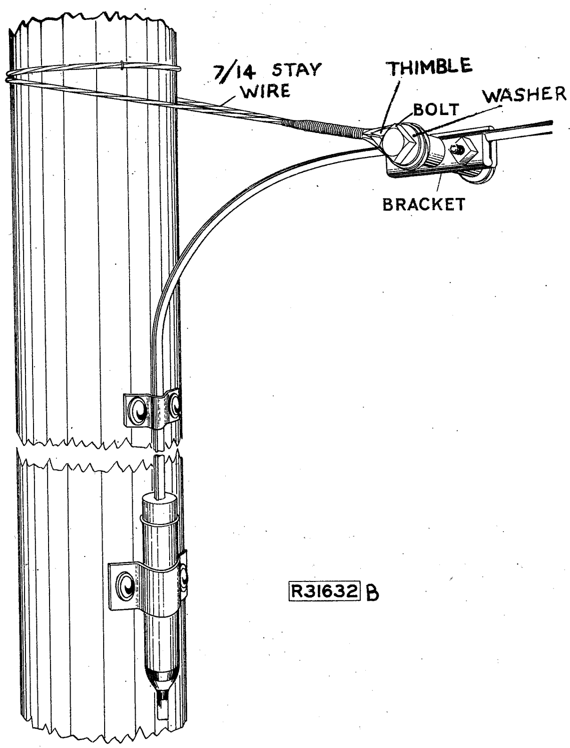


Fig. 3

At terminations: The cable is supported as illustrated in Fig. 3 at terminations. The ends of a 12 ft. length of 7/14 stay wire are made off on thimbles in the usual way which makes the effective length of the sling about 9 ft. 6 in.

The sling is passed around the pole so as to make $1\frac{1}{2}$ turns, without crossing, and is lightly stapled in position. The thimbles, each sandwiched between two flat washers, are bolted one either side the bracket which is in turn sandwiched between spacing washers as shown.

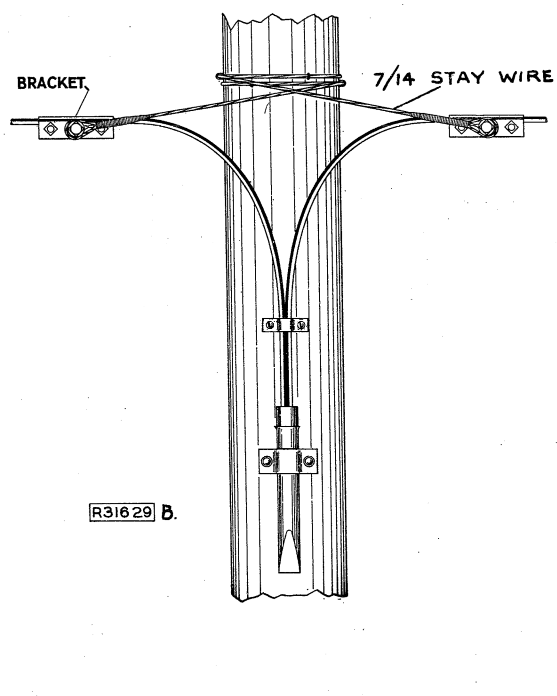
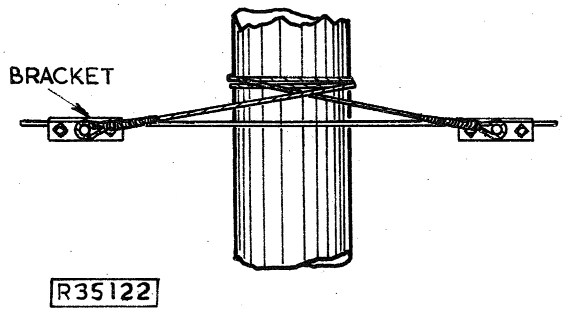


Fig. 4

At jointing points or at through positions where the pull-on-pole exceeds 15 ft. the cable is supported by a method similar to that at terminations, either side of the pole.

In the case of a jointing point the arrangement is as shown in Fig. 4 but for through positions the cable is continuous, as shown in Fig. 5, and stands away from the pole because of the pull-on-pole.



When attaching the slings to the pole the turns must not cross and each sling must be free to move in its own set of staples to facilitate subsequent tensioning.

Fig. 5

Pulling-in the cable

The cable is erected by setting up the drum on jacks at one end of the pole line and by means of a rope, pulling it through snatch blocks or aerial cable pulleys each attached at a suitable position near the top of the pole.

When the section has been drawn-in the cable is tensioned and firmly fixed at each pole.

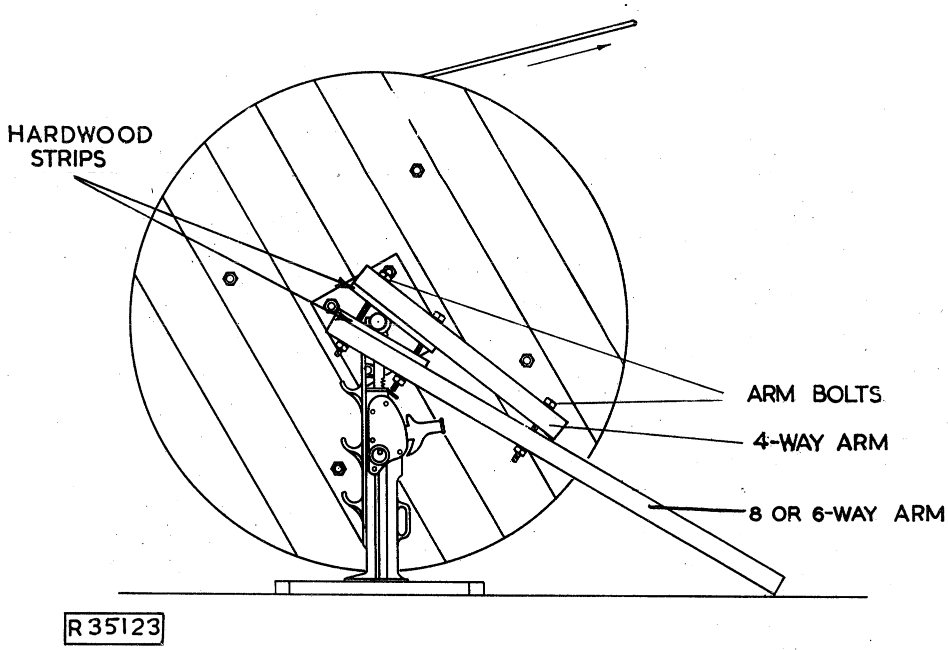


Fig. 6

The cable drum is set up on a spindle on jacks about 30 ft. in front of the first pole of the section to be cabled. To prevent the drum over-running and kinking the cable the spindle is firmly fixed in the drum, by wedges if necessary, and fitted with a wooden brake made with arms and arm bolts as shown in Fig. 6.

A conventional type cable grip is used on the end of the cable but the cable end has to be specially prepared to prevent the grip from slipping because of the fin and the fact that the stainless steel is very hard and smooth.

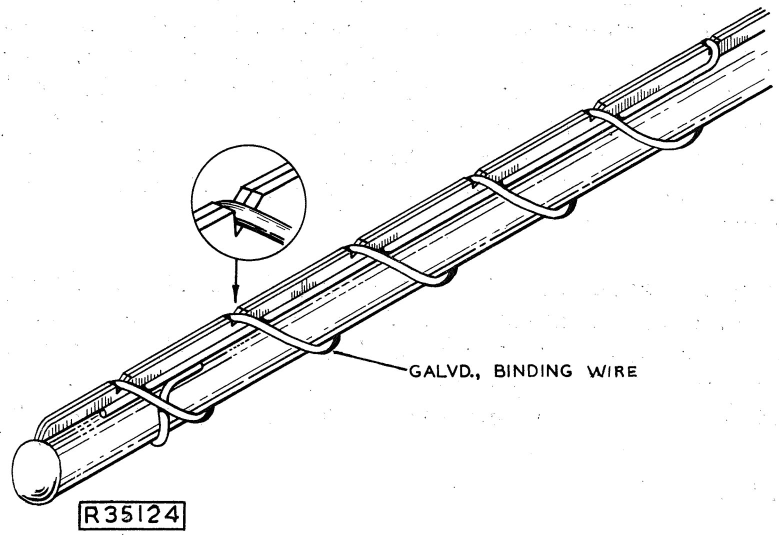


Fig. 7

The leading end of the cable is straightened for a length of approximately 6 ft. and notched with a file as shown in Fig. 7. The end of the fin is rounded to give a smooth lead. The six notches, beginning about 1 in. from the end are spaced at $1\frac{1}{2}$ in. intervals. The filing should not pierce the sheath. Approximately 30 in. of galvanized binding wire is then wrapped around the cable as shown.

The latest pattern of this cable cannot be prepared in this way because the fin is too shallow to allow filing. The end of the cable is prepared by denting or deforming with a hammer in order to give the grip a better bearing surface.

The cable grip is slipped over the prepared cable and the open end of the grip is bound tightly to the cable with tape or twine. The eye of the grip is attached to the cable draw rope with a swivel and keystone link.

A 3 in. rope, at least 60 yd. longer than the length of cable to be pulled in is laid out along the line and supported in snatch blocks or aerial cable pulleys fixed at the level of the cable supporting brackets on each pole. On straight sections of the line the blocks or pulleys should hang vertically; it is often convenient to attach them to existing arms. On angle poles care has to be taken to attach the blocks or pulleys so that the cable and rope ride on the sheave during pulling-in.

The pole at the pulling end is temporarily stayed if no permanent stay exists. The draw rope is passed through the block or pulley at the top of the pole and is attached to a motor vehicle of 30 cwt or greater capacity, as required. To enable the vehicle to move towards the cable drum end during pulling-in, the draw-rope is passed round a snatch block secured to the foot of the next pole beyond the section being cabled.

The cable is pulled-in at an even speed not exceeding 3 m.p.h. and throughout the operation the cable is kept under tension by regulating the rate of coiling off from the drum with the aid of the brake shown in Fig. 6. If this tension is not maintained the cable on the drum becomes loose and can become hopelessly tangled.

Pulling-in continues until only one turn of cable remains on the drum when the operation ceases until the end is released from the drum. When the end is free, a short length of rope is attached so that when pulling-in is resumed the movement of the end of the cable to the top of the pole can be controlled by hand. Pulling-in continues until the end of the cable is 4 ft. 6 in. from the pole when the terminating bracket on the opposite side of the pole is secured to the cable. When fixing the cable to the bracket the cable should be below the wire slings. This allows a sufficient length of cable for jointing and ensures that the cable is not subjected to unnecessary bending.

With the drum end secured, the cable is pulled at the far end to remove excessive sag. The cable draw-rope is then secured at the foot of a convenient pole so that it can be detached from the vehicle without allowing any increase in the sag of the cable. The evhicle is then taken to a point about 30 yd. beyond the tensioning pole where it is used as an anchorage for the tensioning equipment.

Tensioning the cable

The equipment required for tensioning is a dynamometer and a chain puller.

The chain puller is attached to the tow bar of the vehicle and the dynamometer to the chain puller as shown in Fig. 8. A length of 7/14 stay wire is connected

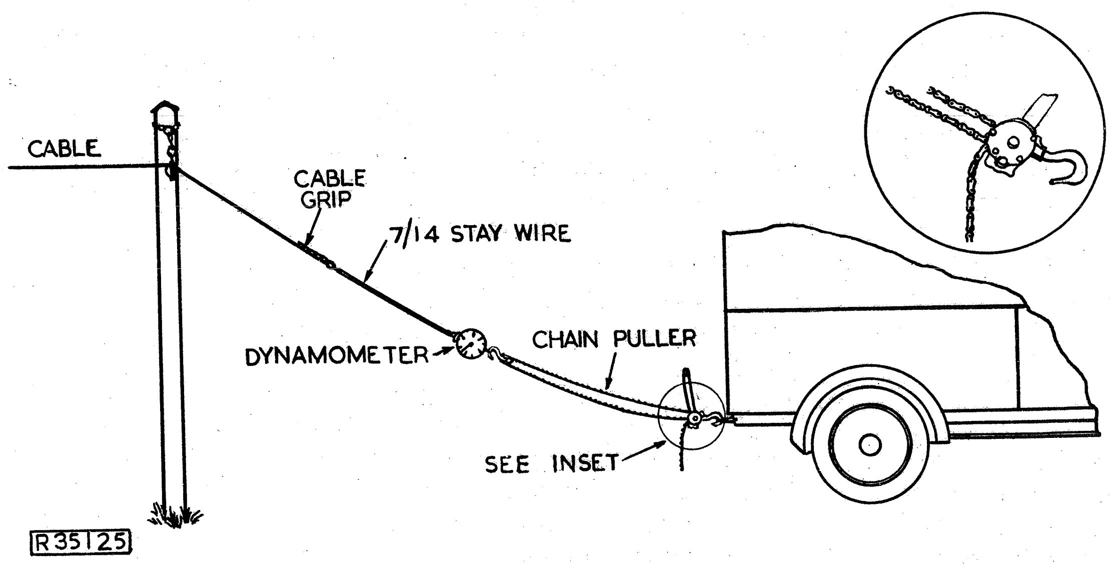


Fig. 8

between the eye of the cable grip and the dynamometer. Where the positions of the poles in relation to the road do not enable the vehicle to apply the tension in line with the cable the tensioning equipment should be anchored to the foot of the next pole or to three crowbars driven into the ground at an angle and lashed together by means of a sling chain.

The final tension to be applied should be as shown in Table I. The required tension is obtained by pulling up to a value equal to 50% above the final tension and gradually reducing to the value shown in the table. For example; a cable under 0.6 in. diameter is pulled up to 750 lb. at 70°F and then slacked off to 500 lb. which is the "final tension" shown in the table.

TABLE I

	Final tension (in lb.) to be applied to the cable								
Temperature °F	20	30	40	50	60	70	80	90	100
Cables 0.6 in. dia. and over	880	845	810	780	755	730	700	680	660
Cables under 0.6 in. dia.	630	600	570	550	525	500	485	470	450

On straight sections or where the angle poles have a pull-on-pole not greater than 15 ft. the cable is secured in its bracket at the tensioning pole while the required tension is maintained. With both ends secured, the cable can be transferred from the snatch blocks or cable pulleys to its brackets on the intermediate poles. The fin is placed in the gap between the two bracket plates but the bracket may be placed to suit the position of the fin i.e. with the gap above or below the arm bolt and towards or away from the pole. The blocks and pulleys can be recovered for use in other sections.

Where an angle pole having a pull-on-pole greater than 15 ft. exists, the bracket on the side of the angle pole remote from the tensioning end is attached to the cable while the tension is maintained. When this bracket is secured the tension is reduced by about 200 lb. and then the bracket on the other side of the angle pole is attached. After this the cable is retensioned to the 'final' value.

Where more than one angle pole has a pull-on-pole greater than 15 ft. the operation is carried out at the first angle pole from the fixed end of the cable and then repeated at each angle pole in turn, working towards the tensioning pole.

JOINTING

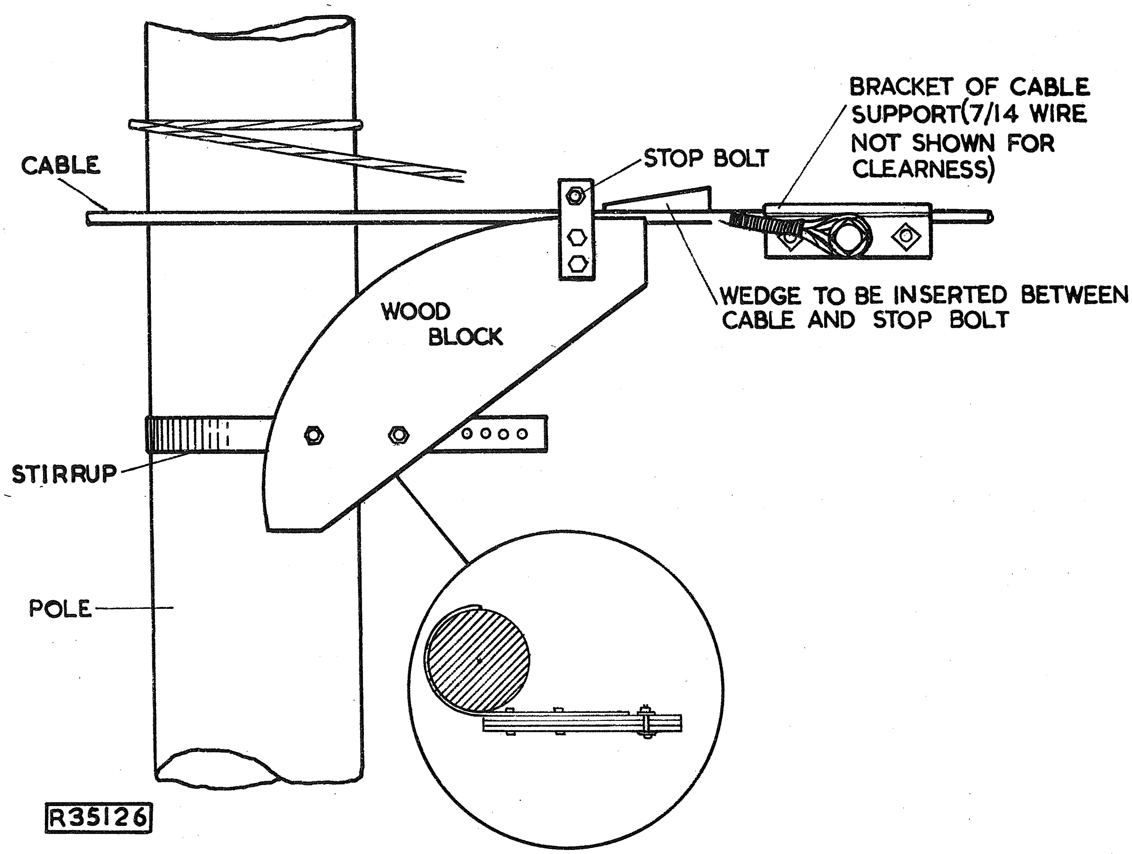


Fig. 9

When the cable has been erected, adjacent sections have to be jointed together in the following way.

The cable is bent carefully and smoothly through 90° so that the ends run side-by-side down the pole. The bends should have a radius of not less than 12 in. and are made round the bending tool shown in Fig. 9.

The tool is fitted to the cable so that the lower end of the wood block is in line with the final position to be occupied by the cable. The upper end is fixed to the cable with a hardwood wedge made locally. The stirrup which is reversible and of adjustable length is placed so that its curved end is in close contact with the pole. With the tool fixed in the required position, the end of the cable is pulled towards the ground so that the bend is made round the wood block.

With the cable ends running side-by-side down the pole a "plug joint" is made approximately 12 in. below the lower end of the bend as shown in Fig. 4.

Preparing the cables

At the point 12 in. below the lower end of the bend the sheath is cleaned, over a length of 2 in. with a clean file; particular attention being given to the fin. Where the weld is at the root of the fin, the latter is filed away until the weld is reached. Immediately the surface has been cleaned it is tinned using a special flux made up locally of:- 1080 gm. of zinc chloride and 340 c.c. of hydrochloric acid (concentrated) made up to 1 litre with water. The flux is corrosive hence all traces must be removed by wiping thoroughly after the tinning is completed.

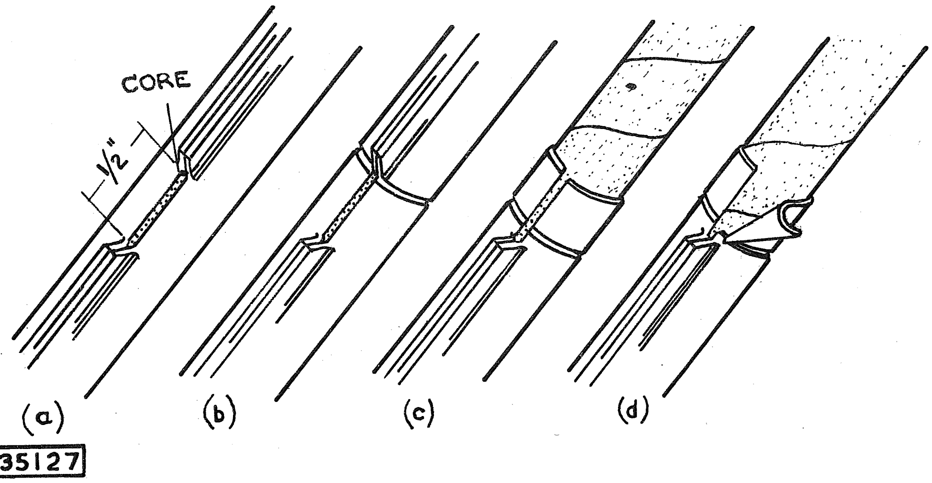


Fig. 10

The cable sheath is removed by filing away the fin over a length of $\frac{1}{2}$ in. commencing 2 in. beyond the end of the tinned portion.

The filing should continue until the core is visible as shown in Fig. 10(a).

The sheath at the end of the filed portion nearest the end of the cable is cut partially through with a three square (triangular) file all round the cable as shown in Fig. 10(b).

By carefully bending the end of the cable, the sheath will crack off at the cut and may be removed.

A second cut around the sheath and partially through it is then made about $\frac{1}{8}$ in. in front of where the fin ends (Fig. 10(c)) and with the aid of pliers the $\frac{3}{8}$ in. of sheath beyond the fin is peeled off as shown in Fig. 10(d). This should be done by gripping one of the corners of the piece of sheath and pulling towards the cable sheath so that a slight bell mouth will be formed where the sheath ends. A layer of insulating paper is then wrapped over the core and slipped under the end of the sheath and tied in position.

Making the joint

When the two cable ends have been prepared they are made into a plug with a 3 in. length of sleeve of the size to be used for the completed joint.

The plug is shown in section in Fig. 11.

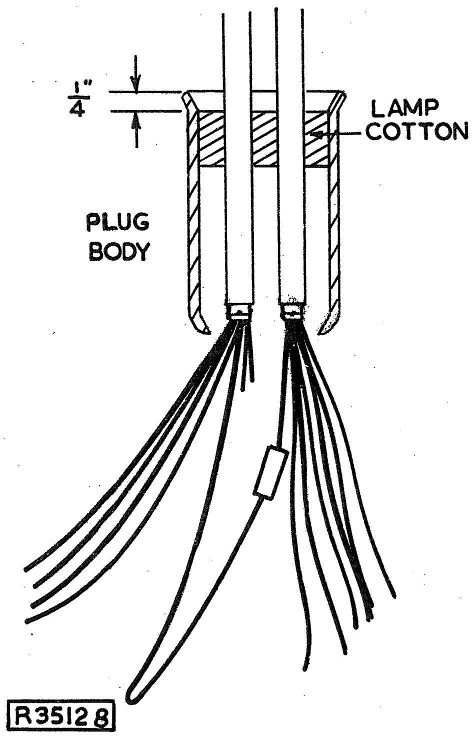


Fig. 11

The upper end of the plug body is belled out slightly and tinned internally to a depth of ½ in, and the lower end dressed slightly inwards and prepared for plumbing.

The cables are threaded through the plug body and packed in place with lamp cotton; a space of ¼ in. being left at the top to accommodate the solder.

The cables and the top of the plug body are heated with a blow-lamp whilst plumbers metal is poured in to fill the space above the lamp cotton.

The wires are jointed together in the usual way except that one of the two wires to be jointed is formed into a 'U' before the joint is made. The wire joints are located so that the sleeves form distinct banks either side the 'U'. The sleeves covering the joints in each pair should be in the same bank. The number of banks varies from two each side of the 'U' for cables up to 10 pair; to four for larger cables. Paper sleeves 2 in. long are used for all sizes of joints.

Pockets of Silica Gel are included in the joint, to maintain dryness, and the whole joint is wrapped with dry insulating paper. The paper is secured by a thread tie at the top of the joint.

Preparing the sleeve

One end of the sleeve is closed by dressing opposite sides together to form a flat seam as shown in Fig. 4. The seam is cleaned and sealed with solder using a blow-lamp and plumbers flux. A slight bell-mouth is made in the other end to accommodate the tapered end of the plug. The edge of the sleeve and the inside of the bell-mouth are cleaned and tinned for approx. ¼ in.

A cleat made from strip lead 2 in. wide, for securing the sleeve to the pole is soldered to the middle of the sleeve. The cleat is shaped to the sleeve and fixed so that when the sleeve is in position on the pole, the seam at the bottom is as near as possible, in line with the aerial cable.

Plumbing

The prepared sleeve is passed over the wrapped joint and positioned so that the cleat is ready to be attached to the pole. The plug is sealed into the sleeve by a $\frac{1}{2}$ in. finger wipe. Plumbing is proved by a local soap-suds test.

Fixing the joint to the pole

The cables are fixed to the pole at the ends of the bends by a conduit saddle flattened to fit over the two cables and fixed by two screws.

The joint is fixed by the cleat soldered to the sleeve and fastened to the pole with bonding nails and galvanised washers.

Connecting the cable to a terminal block

The lead covered cable is connected to the terminal block in the normal manner and led into the joint through the plug.

Connexion to an underground cable

The underground cable is taken to the top of the pole and jointed to the steel sheathed cable by a through joint made in a vertical position on the pole. The two cables should enter the main sleeve at opposite ends. (See Fig. 3).

STANDARD TYPES OF PLASTIC SHEATHED AERIAL CABLE

Several types of self-supporting plastic aerial cable have been used experimentally since the introduction of polythene and similar plastic materials, but at present, there are only two standard methods of providing self-supporting plastic sheathed aerial cable routes. One method employs polythene cable, as used for underground distribution, which is used on span lengths limited to 70 yards. The other method employs a cable which has a suspension wire as an integral part of the cable; this cable is known as self-supporting (combined) aerial cable.

POLYTHENE CABLE USED FOR AERIAL CABLES

CONSTRUCTION

The cable is manufactured in sizes up to 100 pairs in weights of $6\frac{1}{2}$, 10, and 20 lb. per mile. Each conductor is of annealed copper insulated by a covering of extruded polythene of radial thickness between 0.007 in. and 0.014 in. depending upon weight of conductor.

With the exception of the two pair cable, where four conductors are laid up as a star quad, the conductors are uniformly twisted together to form pairs. The pairs are then stranded in layers around either a 1, 2, 3, or 4 pair centre to form the cable; successive layers are stranded in opposite directions.

The polythene insulation is coloured for identification purposes. The identification scheme uses marker and reference pairs in each layer. The marker (first pair) is coloured orange-white, the reference (last pair) is coloured green-black, 2nd, 4th and other even pairs are red-gray, 3rd, 5th and other odd pairs are blue-brown, see Table II.

TABLE II

Pair number	1		2		3		4		5		Last	
Wire	A	B	A	B	A	B	A	B	A	B	A	B
1 pr centre	Orange	White										
2 pr "	"	"	Green	Black								
3 pr "	"	"	Red	Gray	Green	Black						
4 pr "	"	"	"	"	Blue	Brown	Green	Black				
5 pr cable	"	"	"	"	"	"	Red	Gray	Green	Black		
Layers	"	"	"	"	"	"	"	"	Blue	Brown		
			and so on with even and odd pairs to								Green	Black

In all multi-layer cables an open helical wrapping of polyethylene terephthalate tape is wound over each layer with the exception of the last. Tapes over centre and even layers are coloured blue and those over odd layers orange. For all cable sizes, the complete core is wrapped with two layers of paper tape. The cable is sheathed with an extrusion of polythene which contains carbon black, to minimize deterioration due to sunlight, and an anti-oxidant. The sheath thickness is between 0.04 in. and 0.1 inches.

RESTRICTIONS ON USE OF CABLE

The use of this cable for aerial work is permitted under the following conditions:

(i) Where the maximum span length does not exceed 70 yards.

(ii) Where the route is in a 'sheltered' or 'Normal' situation.

Within these conditions the following restrictions must be observed:

(i) At power crossings the cables must be lashed to a suspension wire.

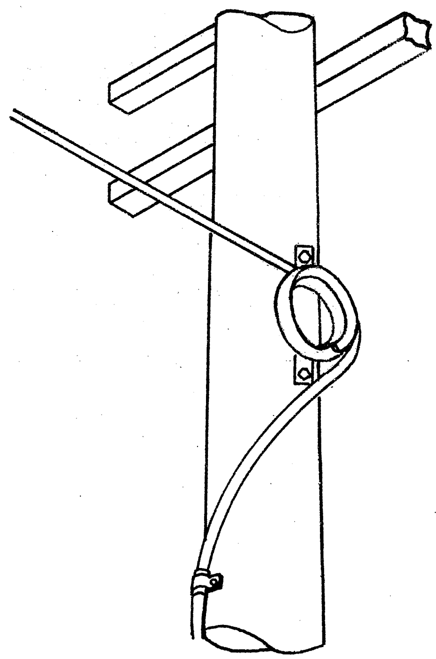
(ii) Joint Construction is prohibited.

(iii) Support must be provided at road and rail crossings.

ERECTION OF THE CABLE

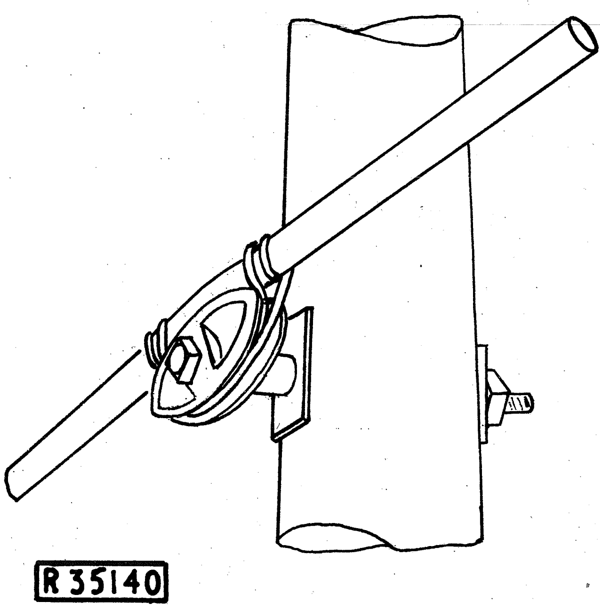
This type of aerial cabling uses pole attachments as shown in Figs. 12, 13, 14. At jointing points, a bollard type of support is used to terminate the cable, which is held by friction, in a helix of channel section. The cable is held by this friction alone. At through positions a channel support of light-alloy is used. This support is either bolted directly to the pole at straight through position, or secured by means of a shackle and eye bolt at angle poles.

The cable drum is set up on jacks in the usual way see Fig. 6 and the cable run out over the section to be erected. The cable is lifted and placed in position in the channel of the bollard nearest to the pole. The cable is then wound round the bollard. When coiling the cable round the bollard, the end of the cable is taken over the bollard and not looped over for each turn, otherwise a twist is put into the cable, which will tend to make the cable ride out of the channel on the end turn of the bollard. The cable is protected where it leaves the channel with split plastic tubing. Each end of the tubing is bound to the cable, and the cable is bound to the bollard as shown in Fig. 14.



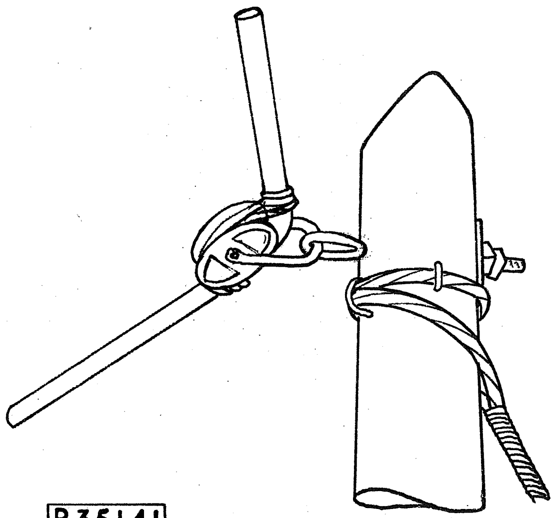
R35139

Fig. 12



R 35140

Fig. 13

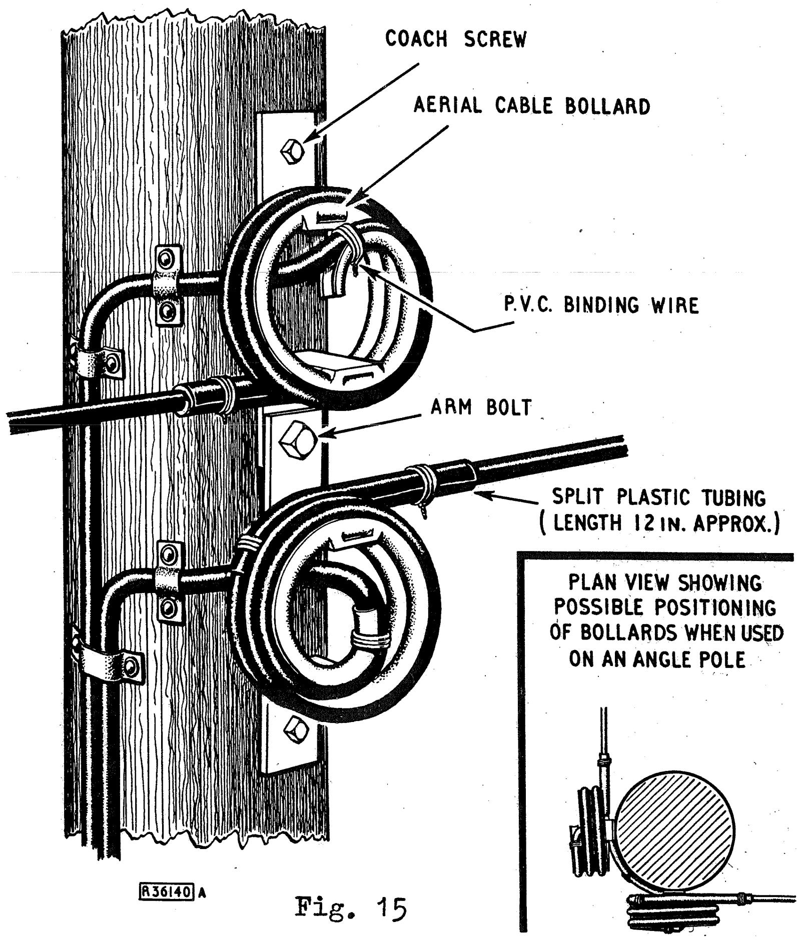


R35141

Fig. 14

At intermediate angle poles the cable should be lifted and placed in the channel of the cable support within the shackle. At intermediate poles on straight sections of the line the cable is laid over the pole bolt and the cable support rotated and fixed temporarily in a vertical position until the cable has been finally tensioned.

When coiling the cable round the upper bollard at a jointing point, the cable is passed from the span under, not over, the channel nearest the pole see Fig. 15.



R36140 A

Fig. 15

TENSIONING

After the slack cable has been pulled up the cable is tensioned. A snatch block is attached to the pole by means of a wire strop, with the top of the pulley of the block approximately level with the bollard. A cable grip is lashed in a suitable position on the cable and connected to the pulling wire, ensuring that the tension will be applied in line with the span. Before tensioning is applied, the cable and supports at angle poles are lubricated sparingly with glycerine.

The cable is first pretensioned, and then tension is reduced to its final value for the existing temperature. Whilst cable is being pretensioned all supports are inspected to ensure that tension has been equalized throughout the section. With cable held at the final tension the cable is terminated on the bollard. When terminating is completed tensioning gear is removed and cable placed in cable supports at through positions and bound in.

Before binding in at intermediate poles the cable is protected with a length of split plastic tubing. The cable is bound in using two 4 ft. lengths of P.V.C. binding wire. The middle of one length is placed across the cable, and three turns are made around the cable. The turns are pushed as close as possible to the cable support before being pulled tight. A similar binding is made on the other side of the support. The two pairs of ends are then pulled tightly, and taken along the channel of the cable support on the underside, and made-off on the cable. The two ends of each pair are passed round the cable, and are made-off in opposite direction. Finally, the P.V.C. is stripped from the ends of the binding wire, and wires twisted together see Fig. 16.

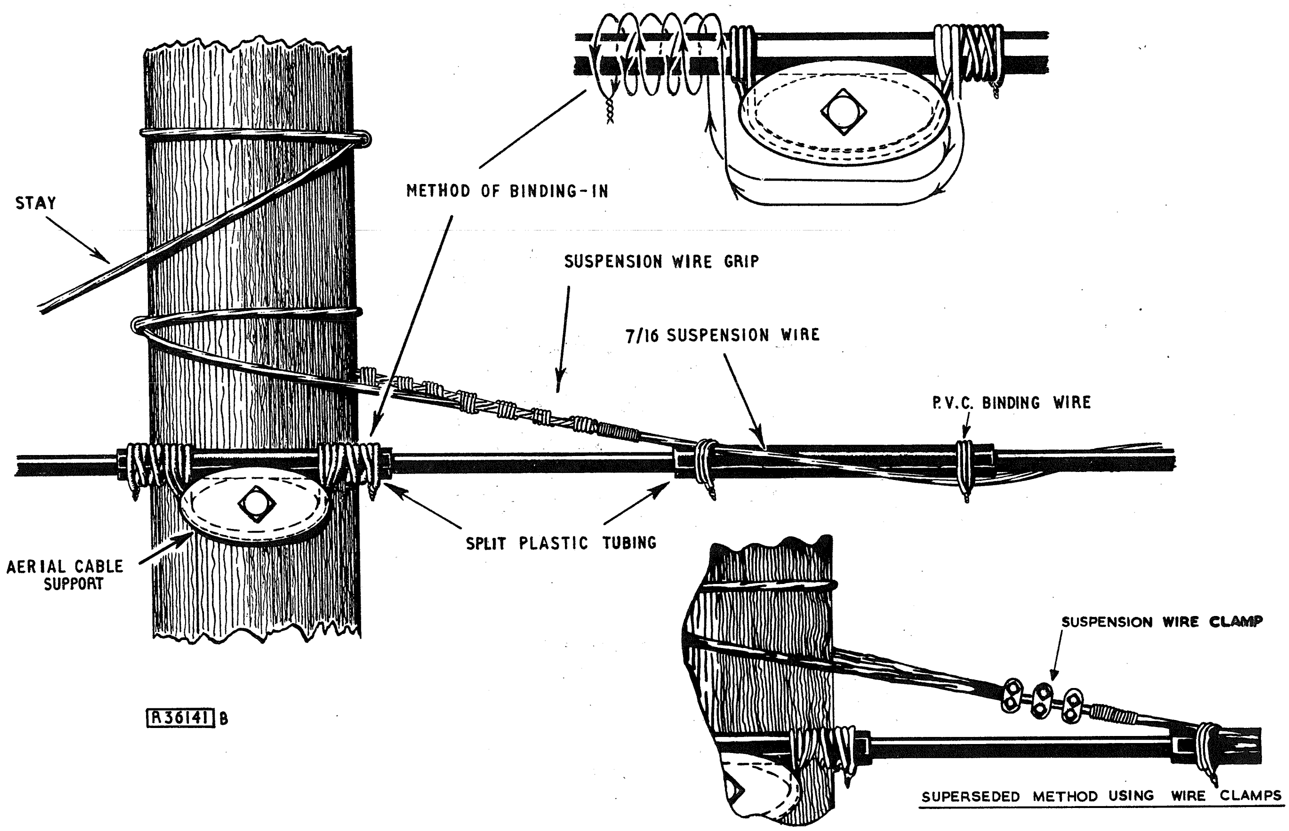


Fig. 16 Showing additional support at Road Crossings.

Road Crossings

At road crossings, and where cable overhangs a road, additional support is given to the cable by terminating a 7/16 suspension wire at one end of the crossing, and passing the wire around the aerial cable once for every three yards of run in the span, and terminating the suspension wire at the other end.

COMBINED SELF-SUPPORTING AERIAL CABLE

CONSTRUCTION

It is possible to manufacture any of the polythene local type cables as well as junction cables up to the largest size with an integral suspension strand. This suspension strand is laid up parallel with the core, and the whole enclosed within a black P.V.C. sheath to give a "figure of eight" cross section to the complete cable. Fig. 17 shows a side view and cross section of the cable; t_1 and t_2 are equal to approximately twice the minimum sheath thickness.

The following notes refer to the readily available size local cables which have a 7/16 (7/0.064 in.) suspension strand having a breaking strength of 3,520 lb. Larger cables have the following size suspension strands

Up to 1½ in. diameter	7/16
1½ to 2 in. diameter	7/14
2 to 2½ in. diameter	7/12
Over 2½ in. diameter	7/10

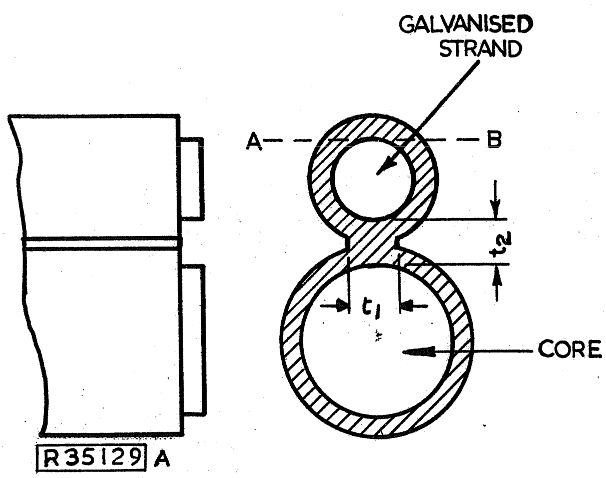


Fig. 17

Readily available sizes of cable vary from 10 pair 6½ lb. to 50 pair 20 lb. as shown in Table III.

TABLE III

Size of cable	Wind pressure lb./yd.			Dip in inches at 100°F for span lengths					
	Sheltered	Normal	Exposed	40–45 yd.	46–50 yd.	51–55 yd.	56–60 yd.	61–65 yd.	66–70 yd.
10 pr. 6½ lb.	0.58	1.37	2.41	6	8	9	11	13	15
15 " "	0.65	1.44	2.55	7	8	10	12	14	16
20 " "	0.69	1.51	2.70	8	9	11	13	15	18
30 " "	0.87	1.98	3.53	10	12	15	18	21	24
50 " "	1.07	2.30	4.14	12	15	18	21	25	29
75 " "	1.15	2.66	4.78	15	19	23	27	32	37
10 pr. 10 lb.	0.69	1.55	2.77	7	9	10	12	14	17
15 " "	0.72	1.66	2.95	8	10	12	14	17	19
20 " "	0.90	2.05	3.64	10	13	15	19	22	25
30 " "	1.01	2.27	4.07	11	14	17	20	24	27
50 " "	1.24	2.81	5.05	16	20	24	28	33	38
75 " "	1.33	2.84	5.15	22	27	33	39	45	53
10 pr. 20 lb.	0.90	2.05	3.64	10	13	15	18	21	25
15 " "	0.94	2.16	3.85	11	14	17	20	23	27
20 " "	1.05	2.37	4.25	13	16	20	23	27	32
30 " "	1.30	2.95	5.28	19	24	25	34	40	46
50 " "	1.51	3.45	6.16	26	32	38	46	53	62

ERECTION

Pole lines

The pole line should be constructed; or if it exists it should be strengthened, where necessary, with regard to the wind pressure values and dip given in Table III.

Position on pole

It is usually more convenient to erect the cable on the road side of the poles but at angle poles where the cable is not jointed and the pull-on-pole is greater than 5 ft. the cable is placed on the inside of the angle so that it pulls away from the pole. This facilitates the supporting and subsequent tensioning of the erected cable.

If a second cable is required it should be placed below the first cable and on the same side of the pole.

Before the cable is erected all fittings needed should be placed in position on the poles and all staying either of a permanent or temporary nature should be carried out.

Attachment to poles

There are three different methods of attaching the cable to poles depending on the line conditions:-

At terminations the suspension wire is extracted from its sheathing, taken twice round the pole and secured by a wire suspension grip, as shown in Fig. 19.

The cable is terminated at the beginning and end of each section, at poles where the pull-on-pole is 30 ft. or more and also at jointing points.

Before the termination is made the suspension wire has to be separated from the cable for a length equal to the length of the termination, plus the length down the pole sufficient to enable a joint to be made at 3 ft. 6 in. from the ground. A sharp knife is used to slice the top of the P.V.C. covering from the wire. The cut is made along the line AB shown in Fig. 17, care being taken to keep the knife flat so as not to damage the galvanized wire. The suspension wire is then pulled out of its sheathing which must not be trimmed off.

Several turns of binding wire are applied to the cable where the suspension wire leaves the sheath, in order to prevent the cable from tearing off the suspension wire at this point.

The suspension wire is wrapped round the pole (pole plates are used for 7/12 suspension wires and above), a staple being hammered into the pole to maintain the termination at the correct height. A grip is attached to the suspension wire in a similar manner to that adopted for the pole stay (see E.P. LINES 1/4). The grip, Fig. 18, is made up in three parts, a frictional gripping helex at each end and a close wound centre section. An 'O' ring is slid onto the grip to an indicating

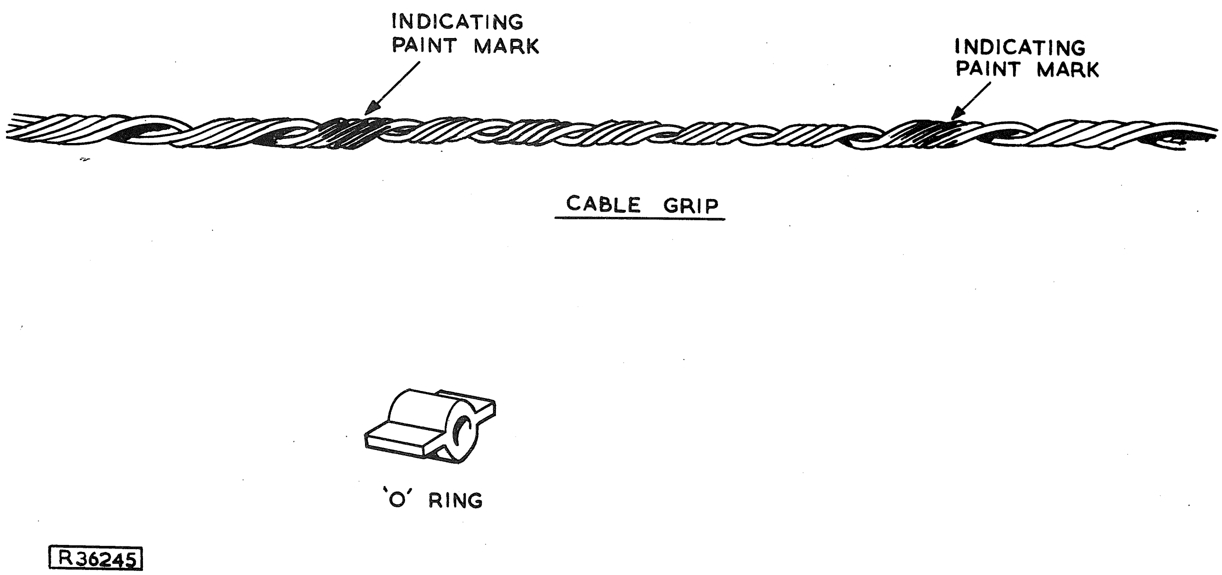


Fig. 18

paint mark the free end of the suspension wire placed within it and wound two or three times round the pitch of the helex of the grip. The 'O' ring is crimped with pliers so as to secure the suspension wire tó the grip, any surplus suspension wire cut off, and that part of the grip wrapped round the suspension wire back towards the pole. The other half of the grip is then wrapped round the suspension wire in the span, so that the finished termination appears as in Fig. 19. The grip is ever only used once, when it is discarded. This method of termination supersedes that where clamps are used, which is shown in Fig. 20.

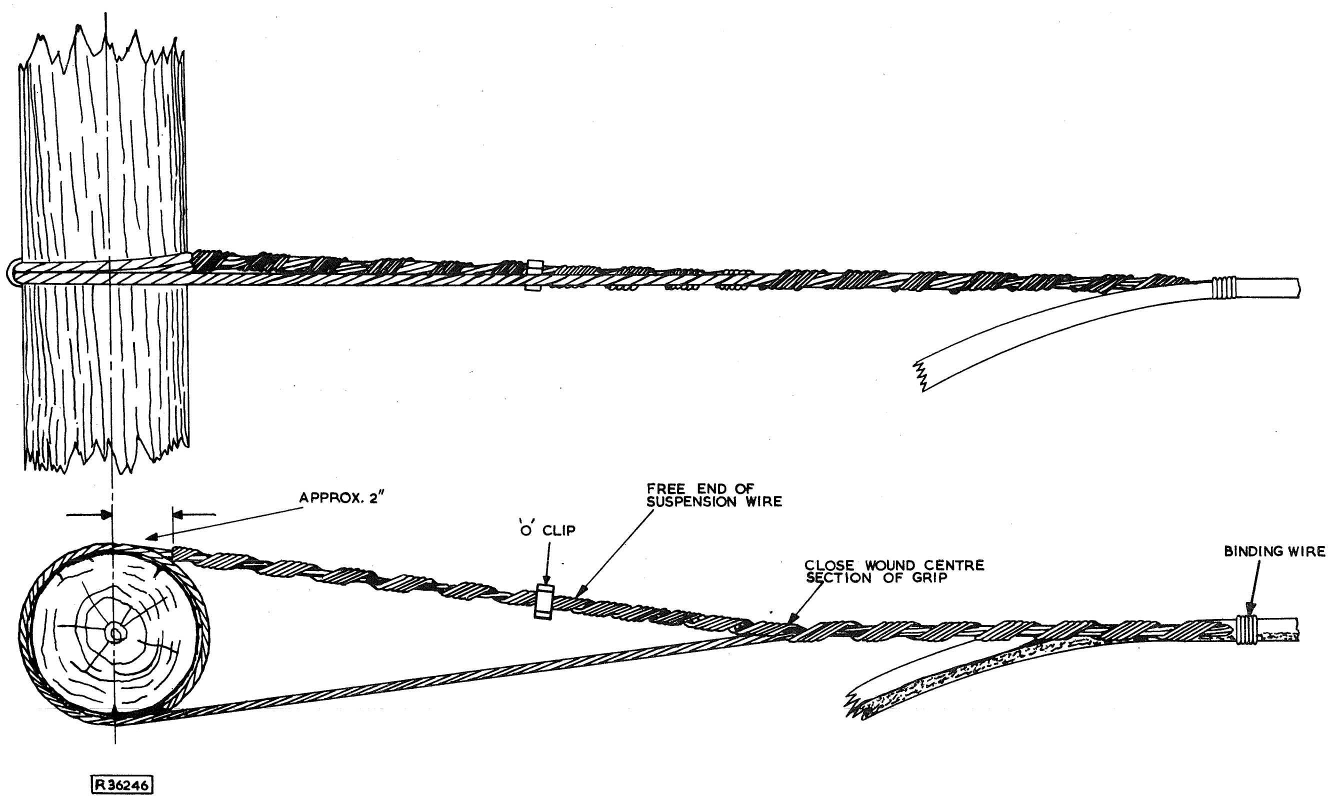


Fig. 19

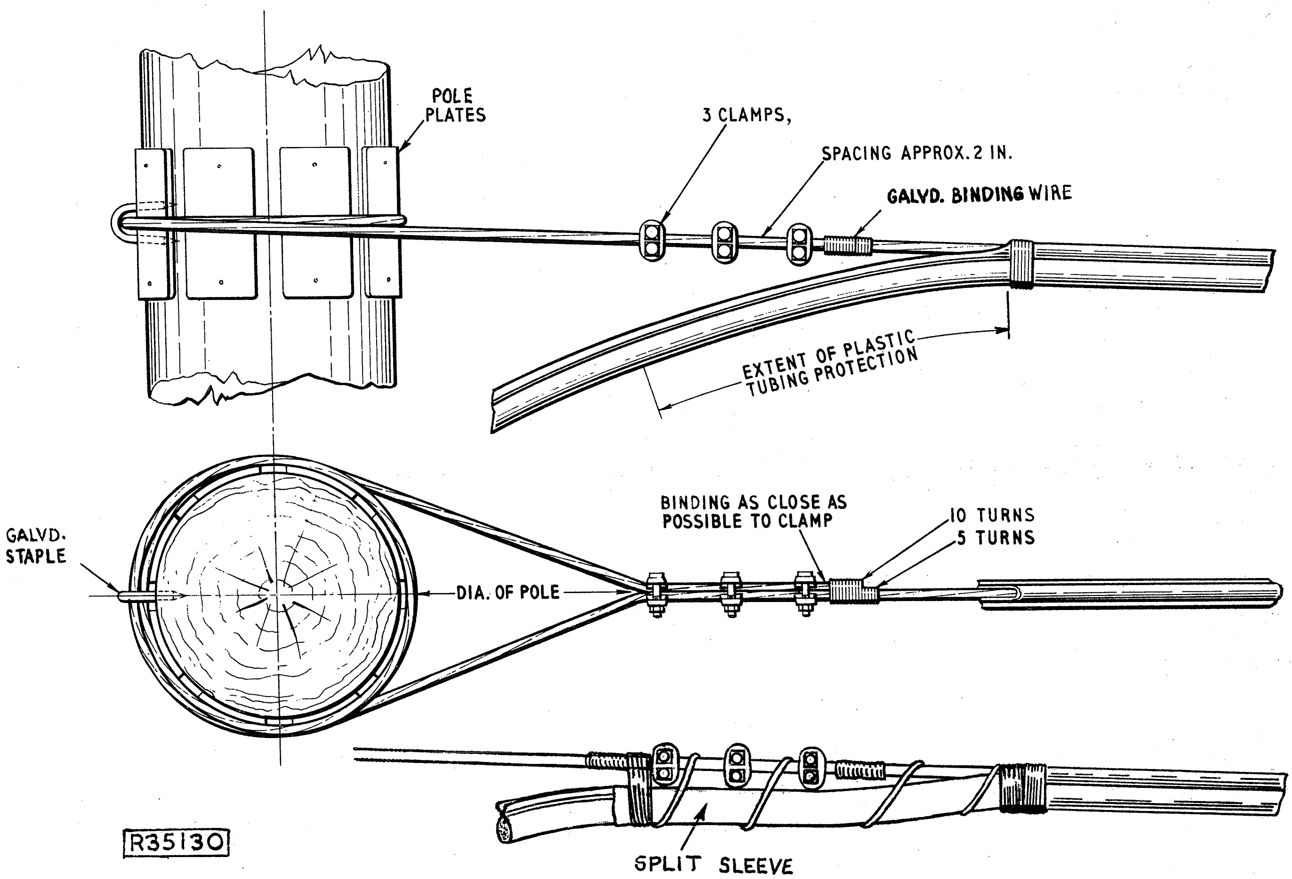

POLE
PLATES
3 CLAMPS,
SPACING APPROX. 2 IN.
GALVD. BINDING WIRE
EXTENT OF PLASTIC
TUBING PROTECTION
GALVD.
STAPLE
DIA. OF POLE
BINDING AS CLOSE AS
POSSIBLE TO CLAMP
10 TURNS
5 TURNS
SPLIT SLEEVE
R35130

Fig. 20

At angle poles where the pull-on-pole is between 5 and 30 ft., and at canal, building and road crossings the cable is bound-in to a circular flanged support as shown in Figs. 21 and 22.

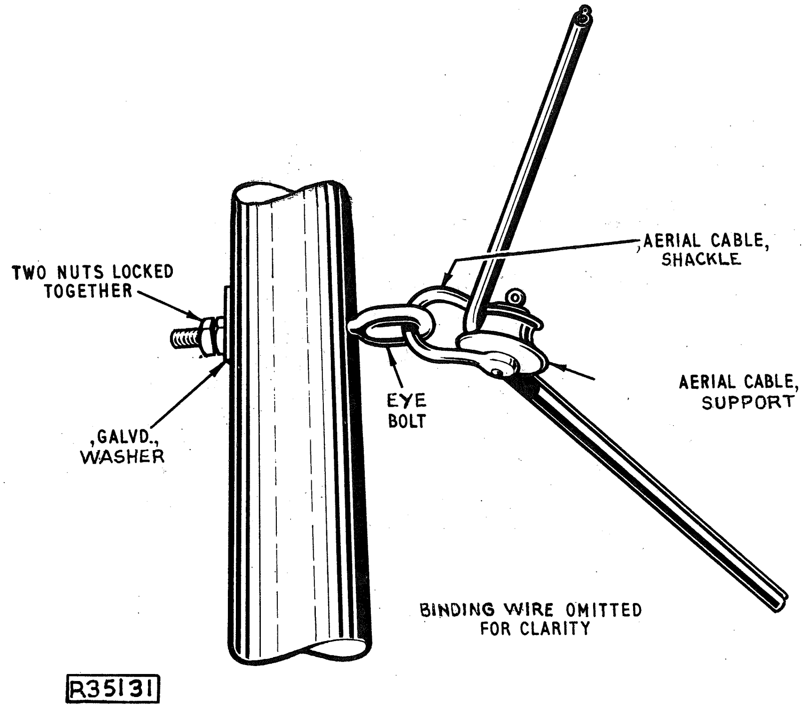


Fig. 21

The pole is bored for the eye bolt which is fitted with its eye in the horizontal plane. The shackle is assembled in the eye of the bolt with the cable support assembled on the shackle pin. The head of the pin and also the smaller flange of the cable support are uppermost as shown in Fig. 21.

After the cable has been erected and tensioned, as described later, it is firmly bound to the support with P.V.C. insulated binding wire as follows (Fig. 22):- With the cable laying snugly in the support (suspension wire upwards) the middle of a 4 ft. length of binding wire is laid across the cable to one side of the support. Three close turns of the wire are then made round the cable. A similar binding is made on the other side of the support.

Each set of turns is pushed as close as possible to the cable support. Each pair of ends is then pulled tight and taken round the cable support and made off on the cable. The two ends of each pair are passed round the cable and made off in opposite directions. Finally the P.V.C. is stripped from the ends of the binding wire and the wire twisted together as shown in Fig. 22.

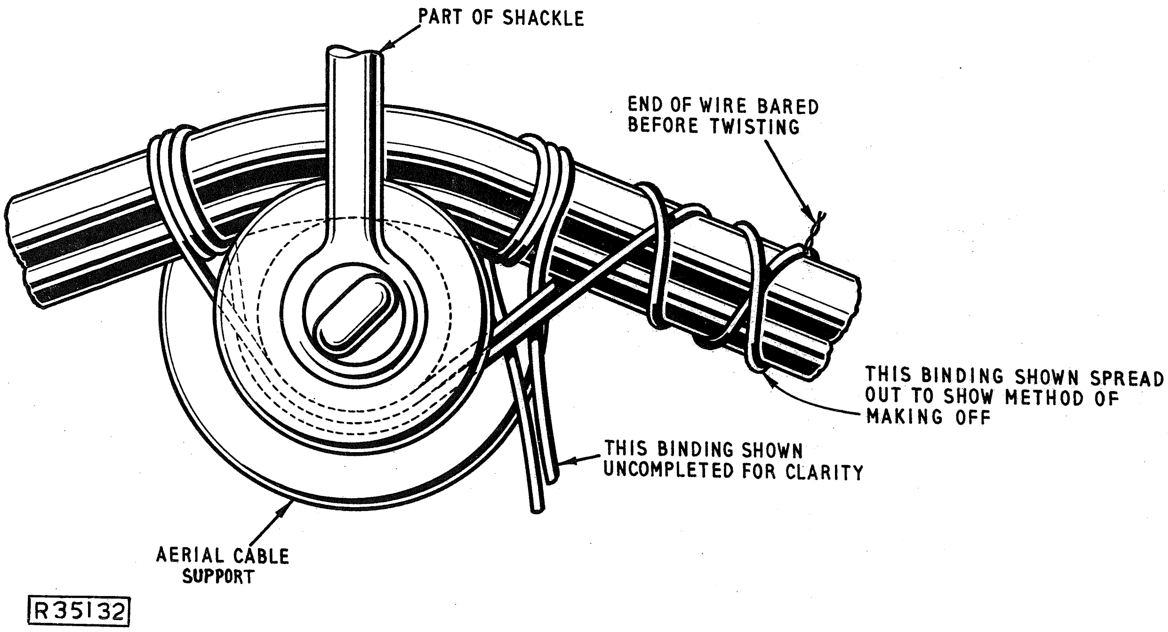


Fig. 22

At straight through positions where the pull-on-pole is 5 ft. or less the cable is secured to the pole with a bracket as shown in Fig. 23. The bracket has a groove along its length which accommodates the insulated suspension strand and clamps it tightly.

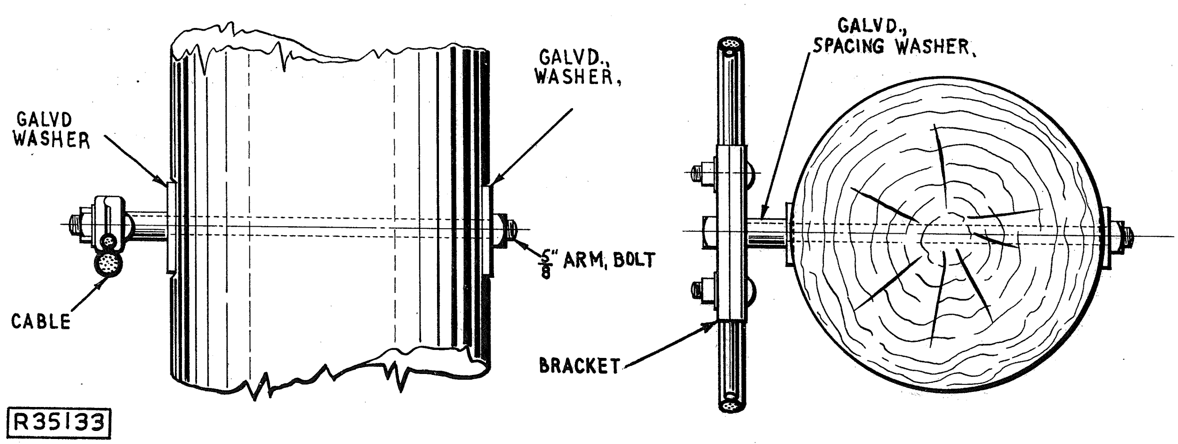


Fig. 23

Pulling-in the cable

The cable drum is set up in the usual way and the cable run out along the ground; care being taken to pass the cable on the same side of the pole as the fittings. If the poles are free from other plant, it is often more convenient to pay out the cable by means of a cable-drum trailer and subsequently pass the cable over the top of the pole where necessary.

Where there are road crossings, flagmen are posted to warn approaching traffic and other road users, until the cable has been tensioned and secured.

When the cable has been run out, one end is terminated as described. At intermediate poles on straight sections of the line the cable is lifted and laid over the spacing washers with the bracket secured finger tight in a vertical position. At intermediate angle poles the cable is lifted and placed on the support inside the shackle. The shackle pin is screwed down tightly using a spike or bar.

Unless precautions are taken when the cable is being erected, this type of cable is liable to high-amplitude low-frequency vibration known as "dancing" or "galloping". This occurs because of the shape of the cable. Cross winds acting on the cable set up lifting forces similar to the action of a propeller, on the surface of an aeroplane wing. Galloping is prevented by the insertion of at least six complete twists per span of cable. This tends to cancel out the wind effects in the same way that electrical induction is reduced (a) in a cable by having varying lays and (b) in overhead lines by having transpositions. The twists are inserted on straight through positions after the cable has been tensioned and before the cable is fixed in the bracket. Where two or more poles with shackle fittings are next to each other it is necessary to insert the twists at the time the cable is placed in the fitting and before tensioning, as it is difficult to twist a tensioned cable at an angle fitting. For odd end spans and single spans the cable is twisted before terminating.

Tensioning the cable

After the cable has been pulled in and twisted where necessary it is terminated at one end of the section and then tensioned.

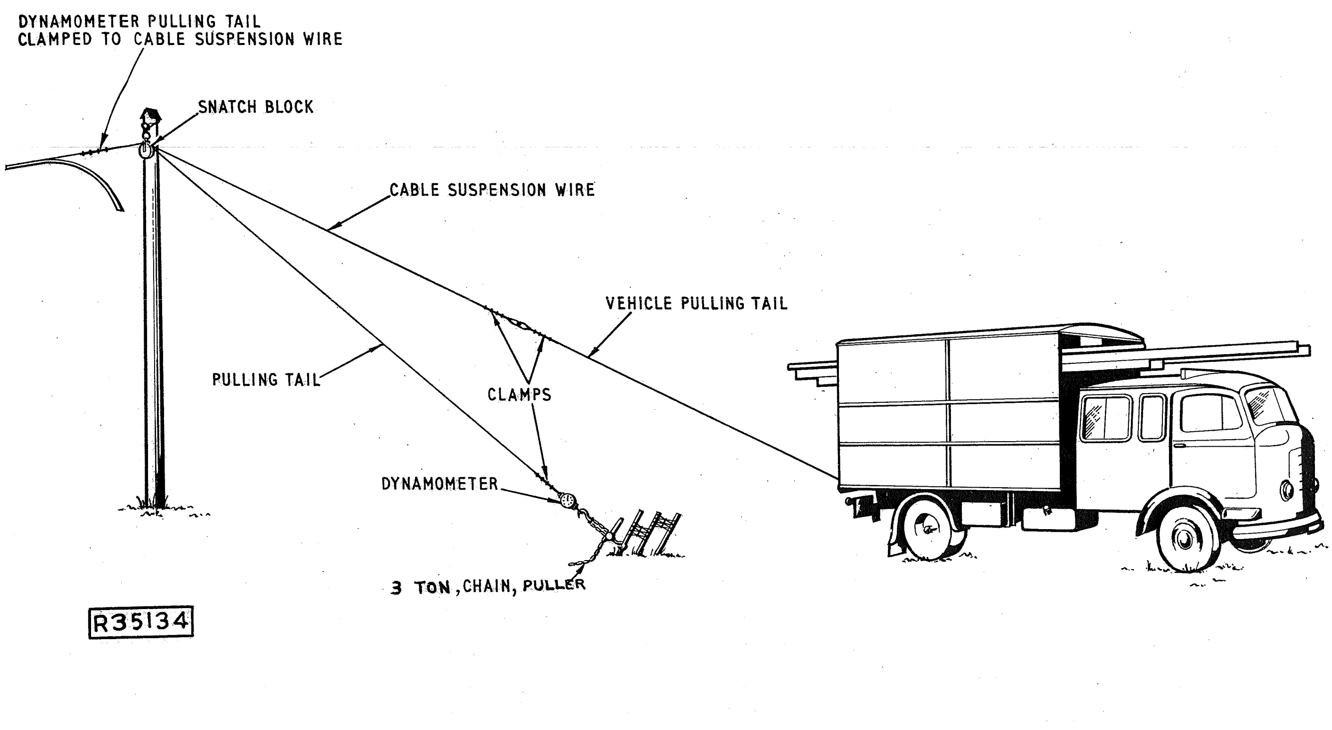


Fig. 24

The arrangement at the tensioning end of the section is as shown in Fig. 24. The suspension wire is extracted from the sheath as previously described for an amount approximately equal in length to the height of the termination above ground.

The suspension wire is turned back on itself to form an eye and secured with four clamps. A suitable length of suspension wire is fixed through this eye and connected to the pulling vehicle so that the slack cable can be pulled up. As the slack is pulled up it may be necessary to extract more suspension wire and an allowance has to be made to allow for the attachment of the dynamometer pulling tail in front of the termination as shown.

When sufficient suspension wire has been extracted, a pulling tail (1/12 or 7/16) is attached to the suspension wire by means of four clamps. The other end of the pulling tail is attached to the tensioning equipment as shown in Fig. 24. The cable is now tensioned according to the values given in Table IV, for spans up to 70 yds. in length. Lower tensions may be applied where sufficient headroom is available. When tensioning, a tension 200 lb. greater than the specified value is applied and left on unitl it has been ensured that the tension has equalized throughout the section. The tension is then reduced to the specified value. Special methods of construction are employed in the rare cases where spans greater than 70 yds. are essential.

TABLE IV

Size of cable	Tensions at temperature of				
	Up to 20°F (lb.)	21°-40°F (lb.)	41°-60°F (lb.)	61°-80°F (lb.)	81°-100°F (lb.)
10, 15, 20 and 30 pr. 6½ lb. 10 and 20 pr. 10 lb. 10 pr. 20 lb.	980	900	840	760	680
50 and 75 pr. 6½ lb. 30 and 50 pr. 10 lb. 15, 20 and 30 pr. 20 lb.	940	880	840	780	720
75 pr. 10 lb. 50 pr. 20 lb.	900	860	840	800	760

With the suspension wire held at the final tension the cable is terminated and the tensioning gear removed. The cable is then twisted and bolted into the bracket at through positions, and where the pull-on-pole is 5 ft. or less. At angle poles, where it has already been twisted, the cable is bound to the aerial-cable support as shown in Fig. 21.

Long-span construction

Long-span construction may become necessary when natural obstacles such as rivers are encountered, or in some joint construction cases. At the beginning and end of long-span sections the route should be longitudinally stayed.

JOINTING PLASTIC SHEATHED AERIAL CABLE

The jointing of both types of polythene sheathed aerial cable is similar. The cables are led down the pole, side by side and a vertical joint is made not less than 3 ft. 6 in. from the ground. The cables are fastened to the pole with lead cleats embracing both cables. The cleats are made from strip lead and attached to the pole by bonding nails and washers. Short pieces of scrap plastic sheath are placed over the cables for protection before they are cleated to the pole. When fixing the combined type of cable to the pole the remaining suspension wire sheathing is left intact except for a few inches where the cable enters the plug. To give a tidy appearance the cables are run down the pole with the surplus sheathings overlapping as shown in Fig. 25.

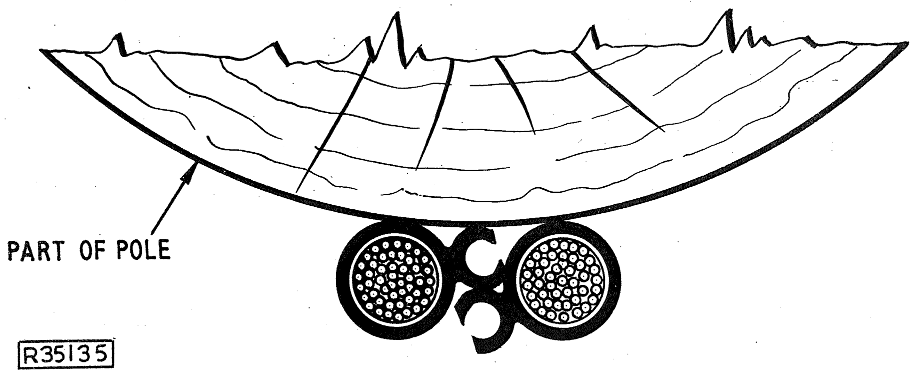


Fig. 25

The joint is contained within a cap-ended plastic sleeve which is sealed by means of an expanding plug.

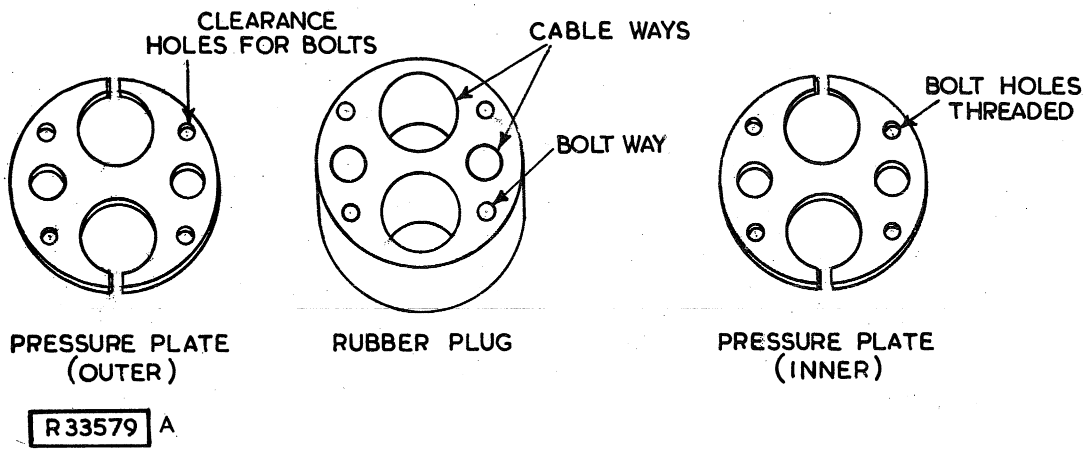


Fig. 26

The expanding plug consists of a cylinder of rubber 1 in. long, having longitudinal holes to accommodate the cables and the clamping bolts. In addition there are inner and outer brass pressure plates, $\frac{1}{8}$ in. thick of similar section to the rubber plug. Four brass bolts pass through the outer plate and rubber plug to threaded holes in the inner plate. When the bolts in the plug are tightened the inner and outer pressure plates come closer together, resulting in a radial expansion of the outer surface of the rubber, and at the same time the walls of the holes in the rubber are forced inwards. Thus the rubber is pressed tightly against the cables, bolts, and inner wall of the sleeve and an adequate seal to the cable joint is provided. Fig. 26 shows the main components of an expanding plug.

SLEEVES

Wherever possible cap-ended polythene sleeves are used to contain joints in polythene sheathed aerial cables. The use of expanding plugs for cable joints necessitates the use of sleeves with larger diameters than are normally required for plumbed joints of similar sized lead covered cables. Advantage can be taken of the increased diameter by using reduced jointing length. Generally the length of the cable joints should be such that they can be accommodated in sleeves 7 in. to 10 in. in length.

A plastic sleeve up to and including 2 in. in diameter will require no preparation, except that a brass reinforcing collar of suitable size is fitted over the open end. If the plastic sleeve has an internal diameter of $2\frac{1}{2}$ in. or greater, a 9/16 in. diameter hole is drilled 3 in. from the closed end and an air valve fitted.

Making the joint

A temporary support is set up to facilitate the doubling back of pairs for jointing and the depth of the "U" so formed should be approximately 6 in. measured from the sheathing butts. The doubling back of pairs allows the sleeves covering the conductor joints to lay along the length of the lead sleeve. This is clearly shown in Fig. 27 which shows a "U" joint in the course of preparation.

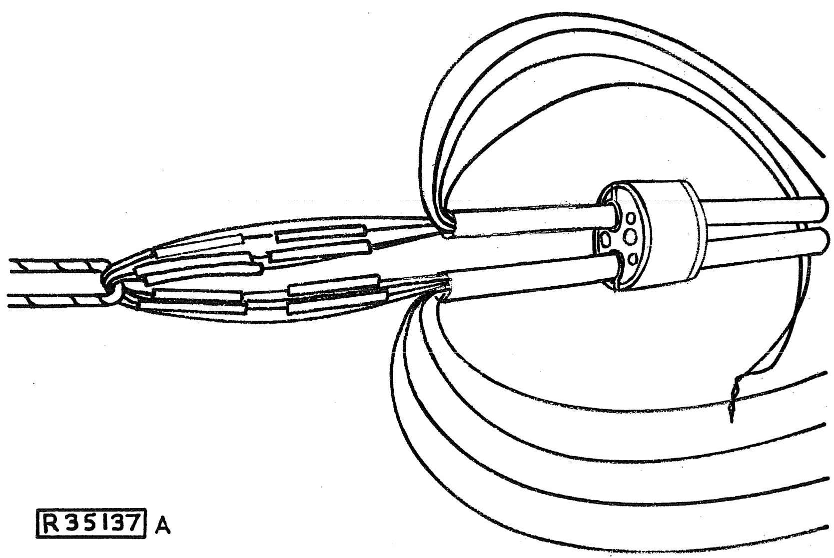


Fig. 27

The jointing sequence will normally follow the cable colour scheme in target rotation. The "crank-handle" method of twisting the stripped wires can be used, but the "finger and thumb" method may be found more practicable in some circumstances. No polythene insulation should be included in the wire twist and when cutting off the surplus wire the pliers should be taken through half a turn, leaving 1 in. of wire twist to be folded down. The twists are covered with polythene sleeves which are placed over the conductors before jointing commences. Banks of sleeves can be built up in the joint according to the jointing space available and then securely tied-in with thread.

If the joint is to be contained in a plastic sleeve up to and including 2 in. diameter one of the securing bolts in the expanding plug should be replaced by a bolt which contains an air valve for pressure testing purposes. The expanding plug is moved along the cables so that the inner pressure plate is flush with the end of the sheathing. The prepared polythene sleeve is then passed over the expanding plug until the outer pressure plate is flush with the sleeve end. Care should be taken to see that there is adequate clearance between the joint and the inside of the sleeve, as it is passed over the joint. If such a clearance cannot be obtained the joint is given two wrappings of dry insulation paper. The bolts in the expanding plug are then tightened until no slip can be detected as the cables are pulled by hand individually.

Pressure test

A local pressure test of 10 lb. per sq. in. is applied to the joint using the air valve in the sleeve, or the air valve in the securing bolt, whichever is provided. Particular attention should be given to expanding plug holes in which the cable diameter has been increased by using a packing of rubber tape. The joint and polythene cables should be wiped clean of all traces of soap, which has a bad effect upon polythene if left in contact with it for any length of time.

Fixing the joint to the pole

When the joint has been completed it is lifted to a height of 6 to 8 ft. and cleated in position. Where possible the joint is fixed on the opposite side of the pole to the cable as shown in Fig. 28.

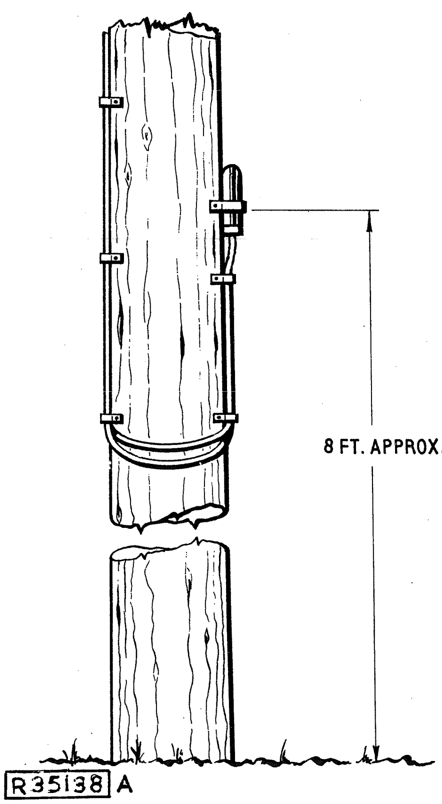


Fig. 28

END