CONSTRUCTION OF OVERHEAD ROUTES

CONTENTS

EXCAVATION OF HOLES

The depth at which a pole should be set in the ground varies with the character of the soil. Under average conditions, poles up to 50' in length should be set to a depth of from 4' to 6' according to their length, and poles over 50' in length at depths up to 8' for the largest sizes. It must be remembered that soils which appear hard and satisfactory in hot dry weather may be very treacherous in winter. In "made ground", or where the soil is exceptionally loose, increased depths should be allowed.

Increased depths should also be allowed where poles are set in banks, since the side of the bank would be liable to give way under exceptionally heavy stresses. In such cases the depth should be measured from the lower side of the hole.

Distribution poles which have to remain unstayed should be set from one foot to two feet deeper than normal. In rock or ground where blasting is necessary poles should be set at one foot less depth than indicated above.

Cylindrical pole holes, excavated by the "bar and spoon" or "earth auger" methods, generally suffice for extra light poles, or for light or medium poles up to and including 30' in length. These holes are at least 6 inches greater in diameter at the ground line than the foot of the pole to be erected and are slightly tapered, to enable the butt of the pole to fit tightly at the bottom of the hole. A small channel is cut outward from the edge of the hole to facilitate the erection of the pole. The pole and channel are illustrated in Fig. 1.

The earth auger cuts holes 10" in diameter, and no larger size is available. Holes for heavier poles must therefore be dug with spades. The best that can be done is to leave three sides of the hole nearly vertical, the earth being undisturbed, and cut the fourth side in steps. The fourth side must be cut in steps, (see Figs. 11 and 12 to allow the hole to be dug at all. The top edges of the long sides of the hole thus formed are supported by 6 in. x 3 in. lengths of timber. Such a method has the incidental advantage that it facilitates the erection of the pole.

In the case of through poles the greatest width of the hole should be in the direction of the wires, whenever possible, as it is important to get the solid earth against the direction of stress on the pole. This stress will be lateral, owing either to a slight change in direction of the route, or to the effect of cross winds, or both.

In the case of terminal poles the constant end-pull due to the line wires is best met by a hole at right-angles to the direction of the line.

As little ground as possible should be disturbed during excavations. On country roads, the turf from grass margins or hedge banks should always be taken off carefully and laid away from the earth excavated. Large stones should be placed separate from the soil, so as to be available for packing at the butt of the pole and round the top of the hole when filling-in later. The turf should be replaced neatly when the pole has been erected.

Methods of excavation

(i) Digging Bar and Spoon

The top soil is excavated to a depth of 18 inches by means of a pick and shovel, and the remaining soil removed to the required depth by means of the digging bar and spoon which are shown in Fig. 2. The pointed end of the bar is used to loosen the soil. The bar is not driven into the soil with great force, as it will then compress the soil and render it difficult to withdraw the bar and to break up the soil. If allowed to fall under its own weight, it will penetrate ordinary soil to a depth sufficient to enable the soil to be levered away easily. The loosened soil can then be removed easily by means of the spoon. On reaching the required depth the bottom of the hole is well punned to ensure that the pole stands on firm soil.

(ii) Earth Auger

In loam or clay soils the earth auger is found to be effective for excavating cylindrical holes. An illustration of the tool is given in Fig. 3. The top soil is removed as described in the preceding paragraph, by the use of a pick and shovel. The lower soil is then excavated by inserting and rotating the auger. Care is taken not to exert too much pressure and in no circumstances is the auger allowed to tighten in the soil. The auger is withdrawn as soon as it is filled with loose soil, and the operation repeated until the hole is sufficiently deep. In loose soil the auger is operated by one man, but it is usually necessary to employ a second man when the soil stiffens as in the case of clay. If large stones are encountered the auger is withdrawn and the stones removed by using the 'digging bar and spoon'.

(iii) Rabitting Spade

A long-handled rabbitting spade can often be used to advantage in conjunction with the bar and spoon or the earth auger when pole holes are being excavated, and improved results can be obtained in the following and similar circumstances.

(a) When wet clay is to be excavated for a pole hole, the cutting edge of the rabbitting spade is more efficient than the chisel end of the bar and it loosens more soil for removal at each effort.

(b) When the earth auger is being used, small stones and obstructions can be cleared by means of the rabbitting spade without the auger being removed from the pole hole.

(c) The sharpened blade is useful when tree roots have to be cut through during the excavation.

The rabbitting spade is 7 feet long overall, and has a narrow spoon-shaped blade, ground sharp at the end, and is fitted with a long straight ash shaft.

(iv) Blasting

Increasing use is being made in the B.P.O. of blasting, in the preparation of pole holes, stay holes and trenches in all types of soil. Blasting is confined mainly to rural areas where there is little likelihood of damage being caused to buildings, walls and underground services. Special precautions are taken to ensure that the area affected by the explosion is clear of all persons and animals before a charge is fired. The explosive generally used is Polar Ammon Gelignite; this explosive is fairly resistant to water and can, therefore, be used in damp situations provided it is not exposed to moisture for long periods. The charge is fired by means of a detonator and a length of instantaneous fuse, the detonator being set off either electrically or via a length of safety fuse, which burns at the rate of 1 yard in 90 seconds.

A hole should be made whose diameter is only slightly greater than the diameter of the charge to be inserted. In hard rock the hole is drilled to a depth of 2 ft. and all loose material removed from the surface surrounding the hole. In other soils a hole is formed by driving a bar to within 9 in. of the required depth or, if this is impracticable, the bar is driven for a sufficient depth to allow about 2 ft. of cover over the charge. A length of instantaneous fuse, sufficiently long to reach a short distance out of the hole, is attached to the charge which is normally placed at the bottom of the hole. In soft soils, where the borehole is 3 ft. or more, a "decked" charge is often used. This consists of a main charge at the bottom of the borehole and a smaller charge some 12 in. nearer the surface.

When the charge has been placed in position the hole is filled and, in all but light soils, the filling is tamped down. The detonator is connected to the exposed end of the instantaneous fuse and sufficient length of safety fuse is added, if electrical firing is not being used, to ensure an adequate time margin after the fuse is lit. The present practice of keeping the detonator above ground lessens the chance of premature detonation during tamping operations and of misfires.

Before the charge is fired, the hole and ground for a few feet round it should be covered with wire netting, brushwood, matting or other suitable material, heavily weighted, to prevent damage or injury by flying fragments of stone. In the event of a misfire the hole should not be approached within 10 minutes of firing when electrical detonation is used, or within an hour when a safety fuse is used.

The effect of explosion is to disintegrate the ground immediately surrounding the explosive, and the resulting fragments of rock or loose soil may be easily removed, with a digging bar and spoon for example, to leave a hole approximately cylindrical in shape.

Blasting in the vicinity of houses, boundary walls etc., should only be undertaken when absolutely unavoidable, and notice should be given to the occupants of houses before the charge is fired.

(v) Portable Petrol-driven Road Breakers and Rock Drills

These machines are available for use on short lengths of underground work, such as road crossings and trenching sections, and for the exvavation of pole-holes. They are primarily intended for use on minor work for which the employment of an air-compressor unit is not justified on account of its higher standing charges and cost of transport to the site.

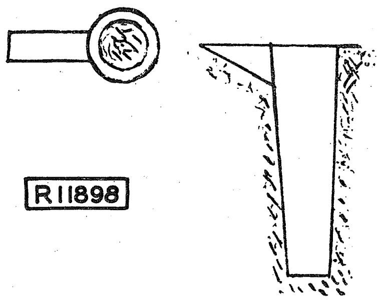


Fig. 1

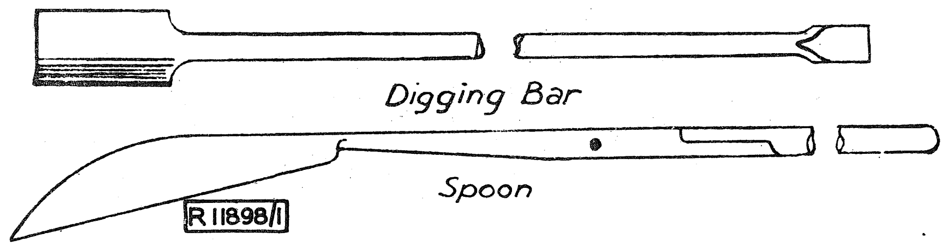


Fig. 2

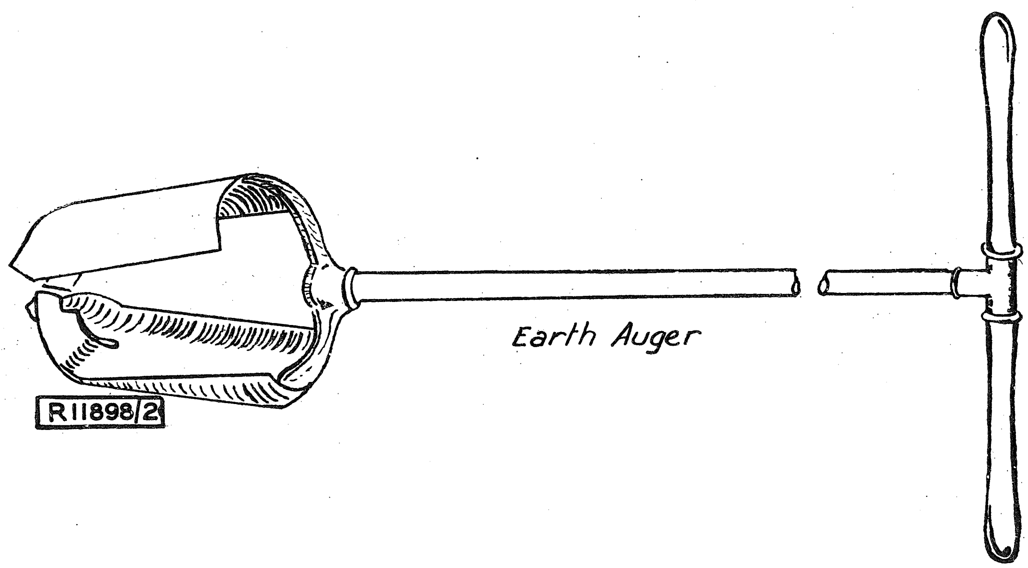


Fig. 3

(vi) Hand-operated Percussion Pick

For work of a lighter nature where the use of power-driven picks is not justifiable, a hand-operated percussion pick may be used. This tool is especially suitable for breaking light concrete, loosening setts and flags, splitting sand-stone and soft rock in excavations, cutting tar-macadam and making holes in walls for leading-in. Details of its construction are shown in Fig. 4.

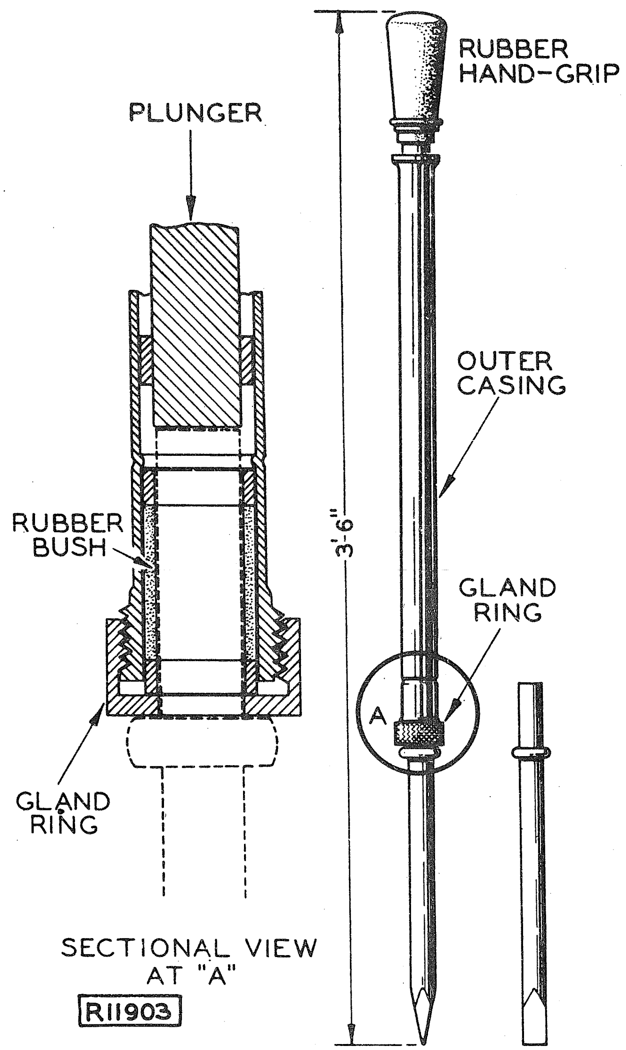


Fig. 4

The hand operated plunger guided by the outer casing of the pick is made to strike the top of the bit at the lower end of its stroke. A diamond-pointed bit or a chisel-pointed bit may be used. The top portion of the bit fits into a rubber bush within the pick and the bit is gripped firmly when the rubber is compressed by tightening the gland ring.

The tool has a total weight of approximately 12 lb. and it has the advantage of being easier to manipulate and less susceptible to damage than the power-driven tool previously mentioned.

MANUAL ERECTION AND RECOVERY OF POLES

Tools

(i) Pole Sliding Boards

These facilitate the erection of poles in stepped holes. They act as a guide and provide a smooth surface down which the butt of the pole slides without displacing soil, etc., into the bottom of the hole. They are made of pitch-pine, elm or ash and may be reinforced by strips of 1" diameter half-round wrought iron placed length-ways, for use with heavy poles. The usual dimensions are 7' x $10\frac{3}{4}$" x $1\frac{3}{8}$".

(ii) Pole Lifters

These consist of a two-pronged fork on a tubular-steel shaft which is fitted with a handle at about 2' 3" from the lower end. They are made in four lengths of 10', 12', 14' and 16' and are used in the erection of poles in cylindrical holes and in the earlier stages of the erection of heavier poles.

(iii) Ladders

If preferred, stout ladders of suitable length may be used instead of the pole lifters, the latter being entirely dispensed with. Stout ladders are provided with a wire rung at the top and bottom.

(iv) Sash Line and Ropes

Sash line is normally used for guy lines. Sash line should not be relied on if its failure would cause injury or damage. In addition to its use as a guy line, a rope secured to the head of the pole is, on replacement work, often helpful in raising the pole. A length of rope is often helpful in twisting poles of medium weight.

(v) Pole Twisters

These consist of a length of $\frac{1}{2}$" wrought-iron chain, with a claw at one end and a large link at the other. They are used in conjunction with a crowbar when it is necessary to twist a heavy pole after erection and before filling-in begins.

(vi) Pole Carts

A pole cart may be used for moving a pole to the pole hole and can be employed to assist in its erection. A pole cart is illustrated in Fig. 5.

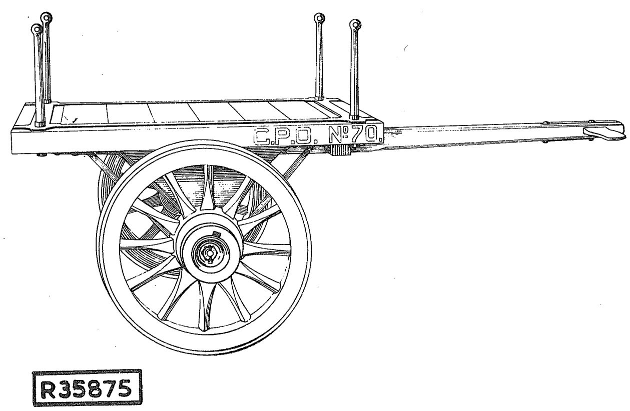


Fig. 5

(vii) Pole-raising Shearlegs

These may be used to erect 28 ft. to 34 ft. poles. The shearlegs are portable and consist of two light metal tubular legs, to which are attached pulley blocks and tackle with a 4 to 1 ratio. The pulley blocks are attached to the pole with a chain hitch, and the tackle is a wire rope of high tensile steel. The pulley blocks and wire rope are attached to a winch, which is mounted on one of the legs and is operated by a long cranked handle. A ratchet is fitted to the winch to sustain the load and may be released for unwinding the wire rope. Spikes are fitted on the end of the shearlegs to prevent slipping.

(viii) Miscellaneous

Other tools necessary are crowbars, shovels, spades, bass brooms, wood or iron punners and pulley blocks. Sling chains, which are always used in conjunction with the latter, have a small ring at one end and a larger ring at the other. The smaller ring passes through the larger one, no hook being required.

Fig. 13 shows one use of such a chain.

Erecting poles in cylindrical holes

Medium and light poles up to 30 ft. in height present little difficulty in erection and the work is carried out satisfactorily by the use of pole lifters. When a cylindrical hole has been dug, the digging bar is placed in the hole to act as a slide for the butt of the pole.

After placing the butt in position in the channel cut from the edge of the hole, the pole is raised to a vertical position by two men who place themselves one on each side of the pole, in such a position that when the pole is lifted it will over-balance towards the butt. A third man assists and takes the weight of the pole as required, by using a pole lifter. In cases when a number of poles are erected in cylindrical holes, the holes are filled-in to a depth of 12 inches, as the poles are erected. This ensures the safety of the poles until the route is aligned, after which the filling-in operations are completed. An illustration of this method of erection is shown in Fig. 6.

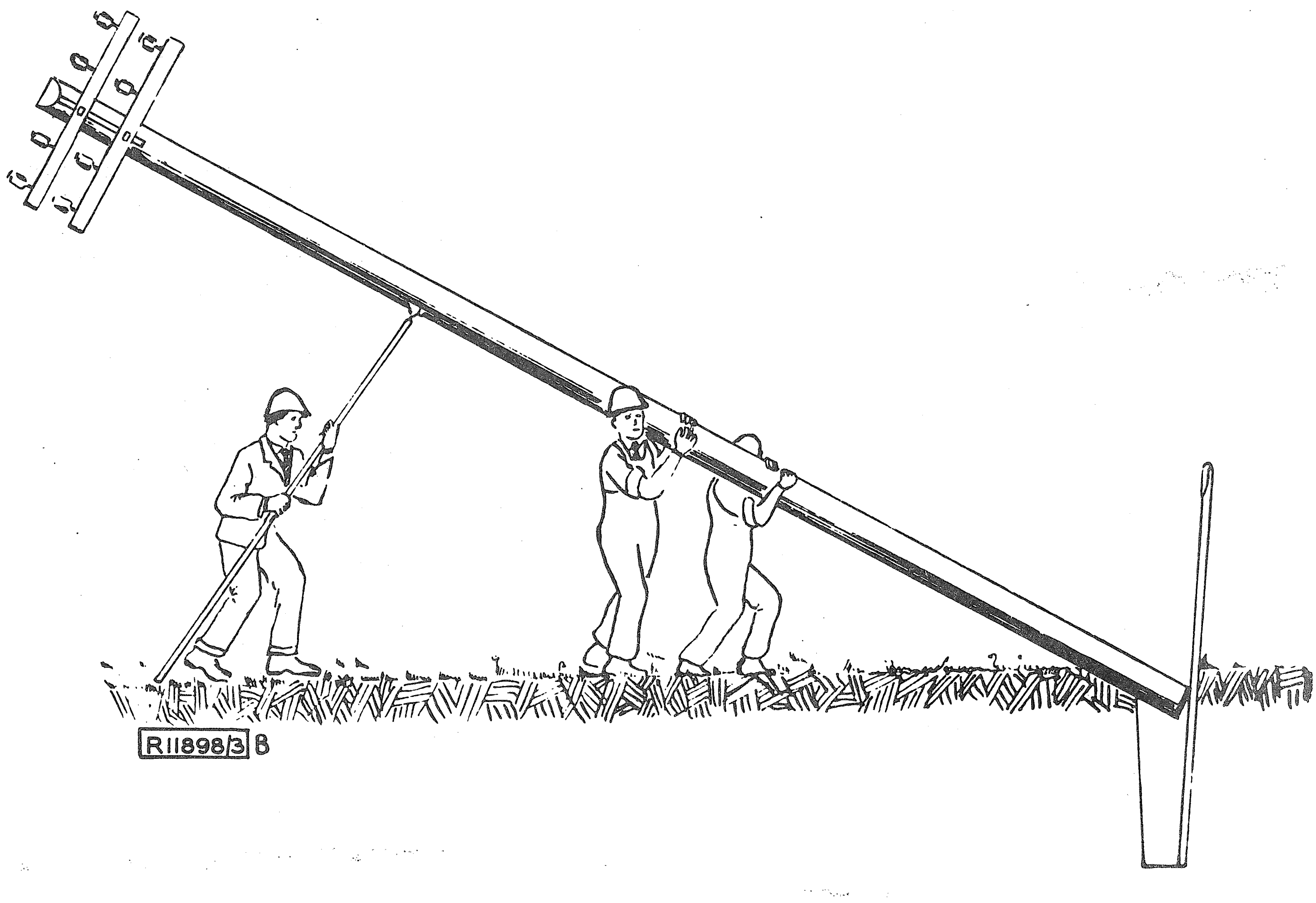


Fig. 6

Erecting Poles Using Shearlegs

A pole sliding board, or digging bar is placed in the hole, and the butt of the pole set against it so that the pole cannot slip as lifting commences. The shearlegs are laid along the pole with the apex at the butt end, one leg each side of the pole, and each foot about 5 ft. from the pole see Fig. 7. The centre of gravity of the pole will thus be on the butt side of the hitch.

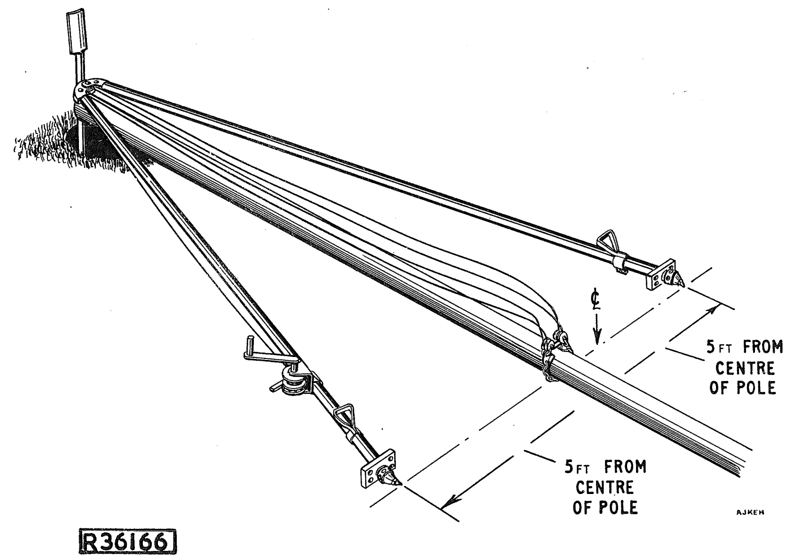


Fig. 7

The hitch must be fitted on the pole at a point on the line between the feet of the shearlegs, otherwise it is difficult to keep the shearlegs upright when raising the pole. The pulleys are set about 2" apart to make sure that the steel rope runs clear of the pole, see Fig. 8.

The shearlegs are then raised to the vertical position. With the spikes firmly based in the ground, the pole is raised by operating the winch. As the pole rises the shearlegs lean towards the pole, see Fig. 9, and when the top of the pole is high enough the butt slides gently into the hole. The handles at the bottom of the shearlegs can be used to hold the pole straight during filling in the hole see Fig. 10.

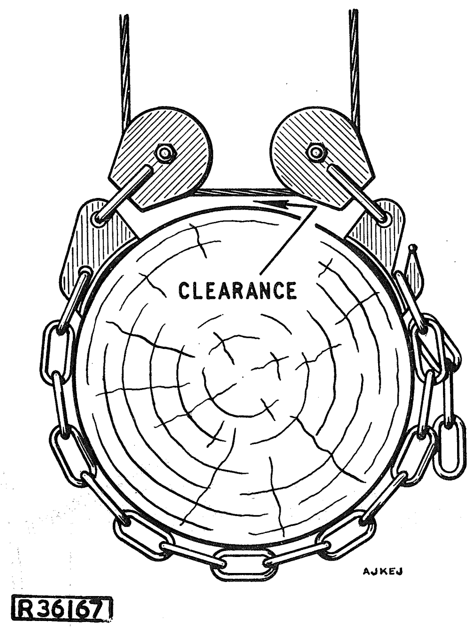
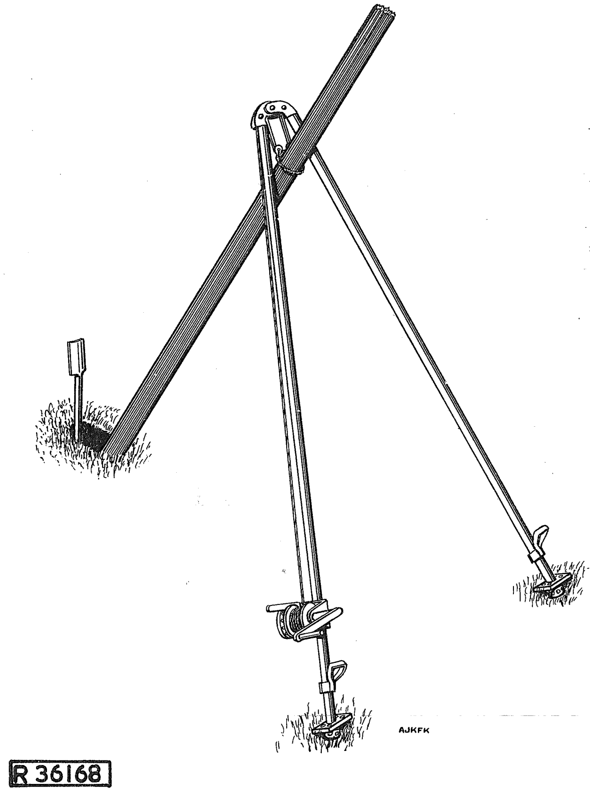


Fig. 8



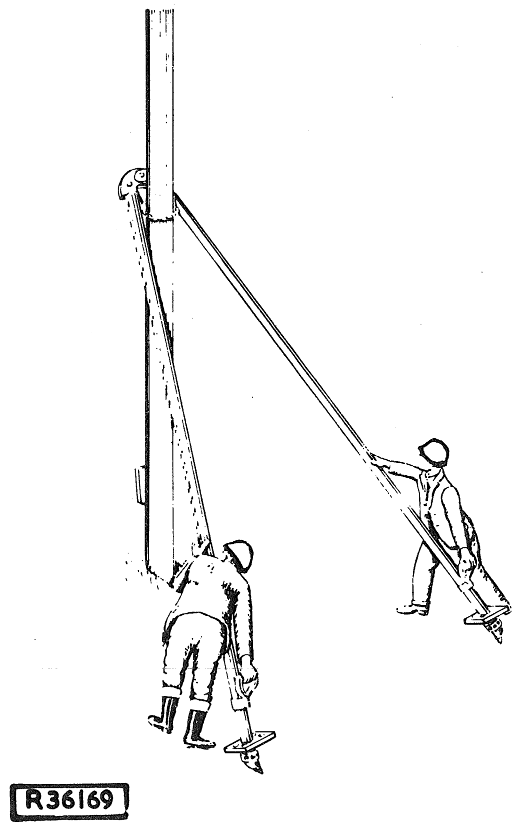


Fig. 9

Fig. 10

After the pole is erected, the winch is slackened off, and when the shearlegs have been lowered to the ground, the hitch on the pole will loosen itself and slide down, where it can be removed.

Filling-in

The earth is thoroughly punned as it is filled into the hole. When the cylindrical type of hole is used the space between the pole and the wall of the hole is necessarily small and, when filling-in, an ordinary punner is of little use except near the surface. The flat punner end of the digging bar is therefore used to consolidate the soil replaced in the cavity of the lower section of the hole.

Methods of erecting heavy poles

When heavy poles are erected it is necessary to use a derrick. For this purpose a sound stout or medium pole, slightly longer than half the length of the pole to be erected, is used; for example, a 36 ft. derrick suffices for a 60 ft. pole. The derrick pole is set in the ground to a depth of at least 3 ft. If the ground is inclined to be soft, the derrick should rest on a block of timber at the bottom of the hole, the depth of the hole being increased so that the bottom of the pole is at least 3 feet below the ground line.

Guy ropes or stays in three or four directions should be attached to the derrick pole. If more suitable facilities for attachment are not available, the guy ropes or stays should be secured to crow-bars or short lengths of pole fixed in the ground, or to temporary stay rods and blocks.

Two methods of erection are available, known as the 'middling' method and the 'end-on' method. The method adopted is dependent upon the space available for the operation, but the former is preferable where circumstances allow, as the stresses imposed upon the derrick pole are not so severe.

(i) Middling method

This method is illustrated in Fig. 11. The main pole is laid with its point of balance or centre of gravity close to the derrick pole. A treble pulley block is attached by means of a sling chain to the top of the derrick pole. An arm on this pole prevents slipping. Another sling chain is used to attach a double pulley block to the main pole in such a position that when the pole is raised from the ground it will be slightly 'butt heavy'. Three or four lines are attached to the main pole for the purpose of steadying it during the course of erection. A guy line attached near the butt of the pole is found useful for controlling the butt whilst the pole is being raised. The pole is gradually raised until the point of balance is sufficiently high to enable the pole to be swung into a vertical position with the butt end just clear of the ground. The butt is then guided into position over the hole by the guy lines, and the tackle run out to allow the pole to drop into position. A board is placed at the back of the hole to prevent disturbance of the soil by the butt of the pole during the operations. For specially heavy poles, a luff tackle consisting of single and double blocks is employed in addition to the main tackle.

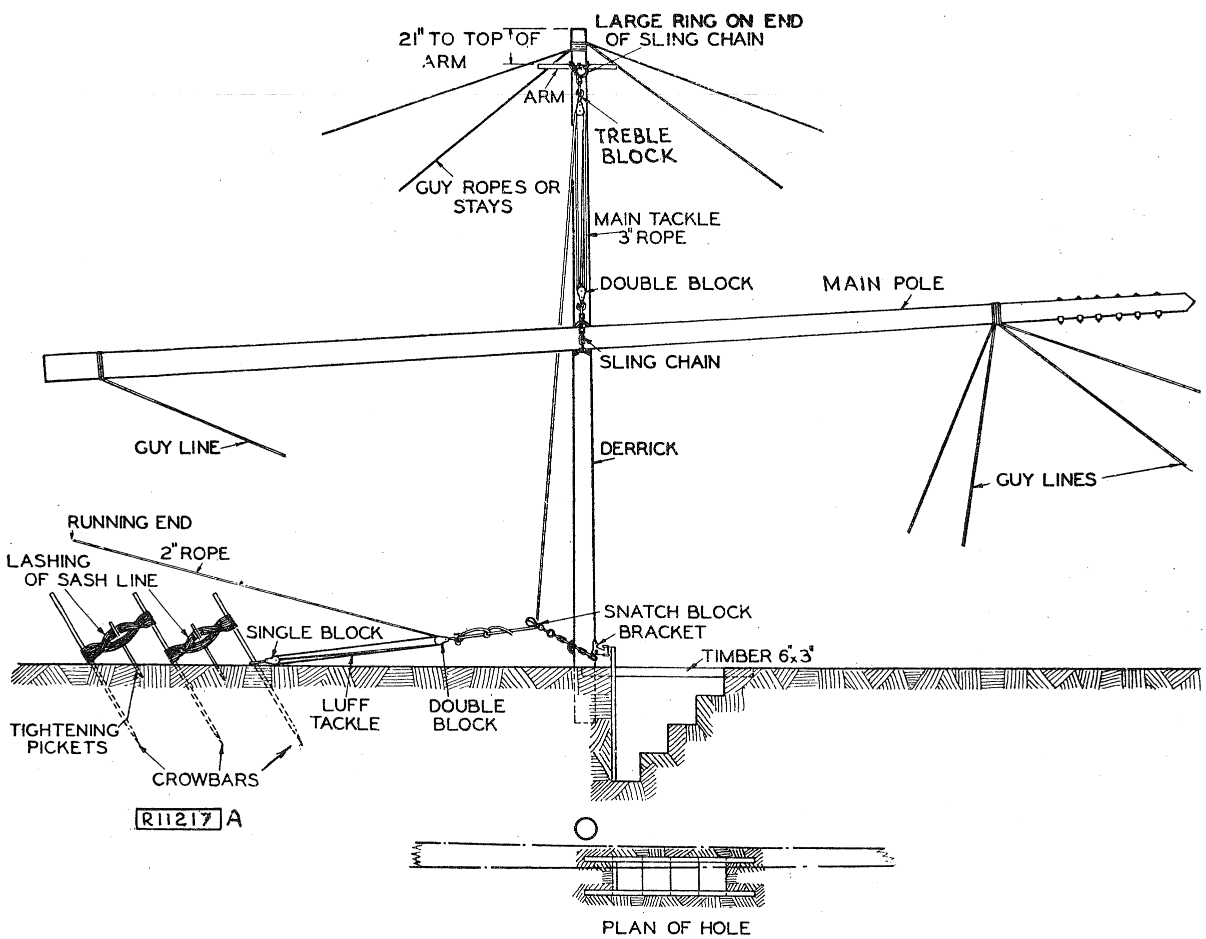


Fig. 11

(ii) End-on-method

The main pole is placed with its butt against the sliding board with its weight still resting on the pole-cart. A sling chain is attached at a point slightly nearer the top of the pole than its centre of gravity. The main tackle is the same as that described in the previous method, and is attached to the derrick in the same manner, luff tackle being used when required. The pole is then gradually raised into the vertical position, the butt end being assisted to slide down the board. The precautions enumerated under the previous method also apply, and in addition, as the pole approaches the vertical position two guy lines are held tightly against the pull of the tackle to prevent the pole from being pulled over beyond the vertical. The method and tackle is illustrated in Fig. 12.

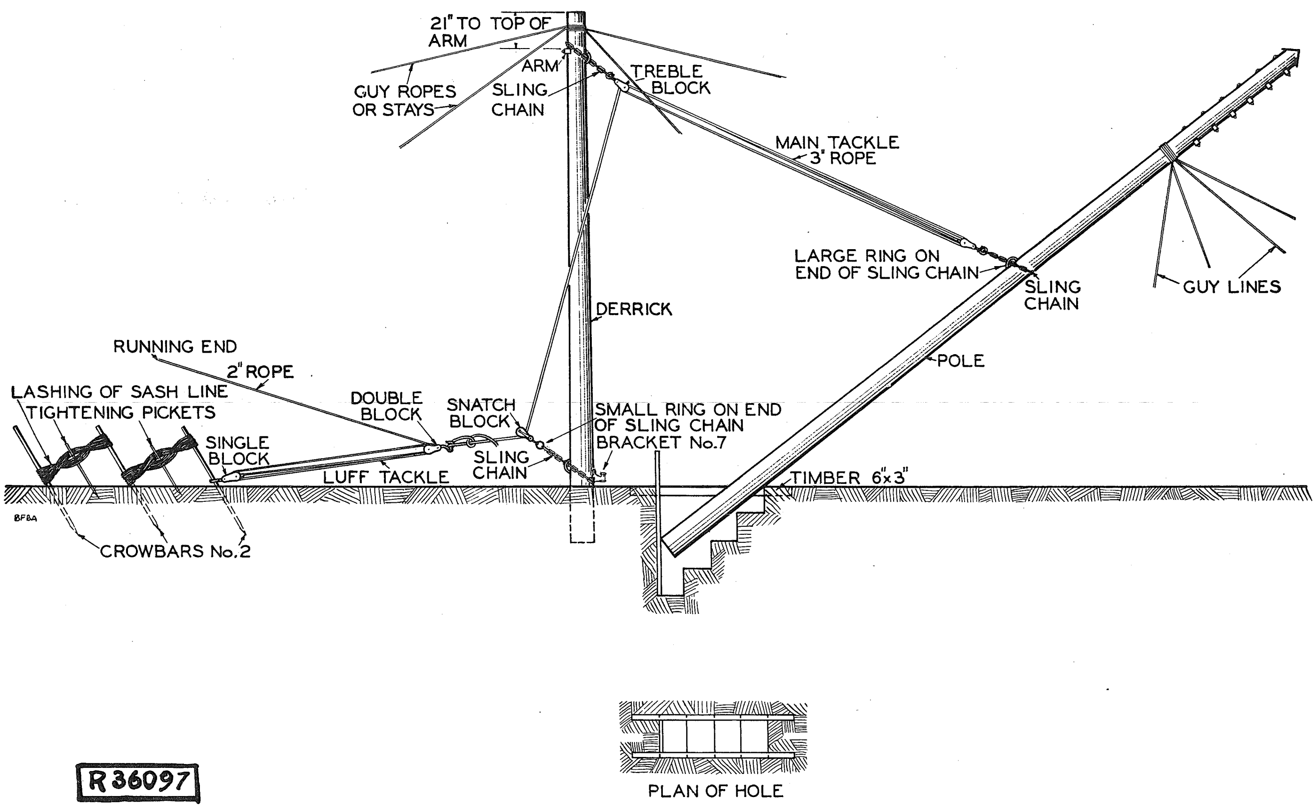


Fig. 12

A winch is sometimes used in place of the luff tackle; when this is done, great care is taken to anchor it securely to the ground.

When the pole is placed in position pole twisters are used to twist it slightly, if necessary, before filling in the earth.

The disadvantage of this method is that it causes greater stresses to be placed on the derrick than those due to the 'middling' method.

Lifting heavy poles over buildings

Two derricks are necessary to lift a heavy pole over a building - one in the front and one at the back of the building. The height of each derrick is greater than the height of the part of the building over which the pole is to pass. The general arrangements at each derrick are similar to those described above, but the two derricks should be stayed with stranded iron wire to increase their rigidity. The first operation is to raise the pole, in a horizontal position, to such a height that it will clear the highest part of the building. Extreme care is necessary in steadying the pole, and at a suitable moment when the pole is suspended over the building a man on the roof attaches the double block of the second derrick.

The pole then is gradually guided into position by easing the tackle on the first derrick and hauling on the second derrick. When the pole is in the position to be lowered and the second derrick tackle has taken the whole weight of the pole, the tackle of the first derrick may be removed with safety.

All pulley blocks are attached to the pole or crow-bars by the means of sling chains.

Removal of poles

This operation can be carried out with the aid of a pole-lifting jack. A stout chain is placed around the base of the pole and over the top of the lifting jack. Operation of the jack lever gradually lifts the pole out of the ground by a direct vertical pull, thus saving the labour of excavation (see Fig. 13). It cannot, of course, be employed in cases where blocks are affixed to the butt of the pole. The pole is stayed during the operation and is then either lowered gradually or permitted to fall according to the requirements of the situation. This tool is also used, where conditions permit, to move poles to a new position on a grass margin.

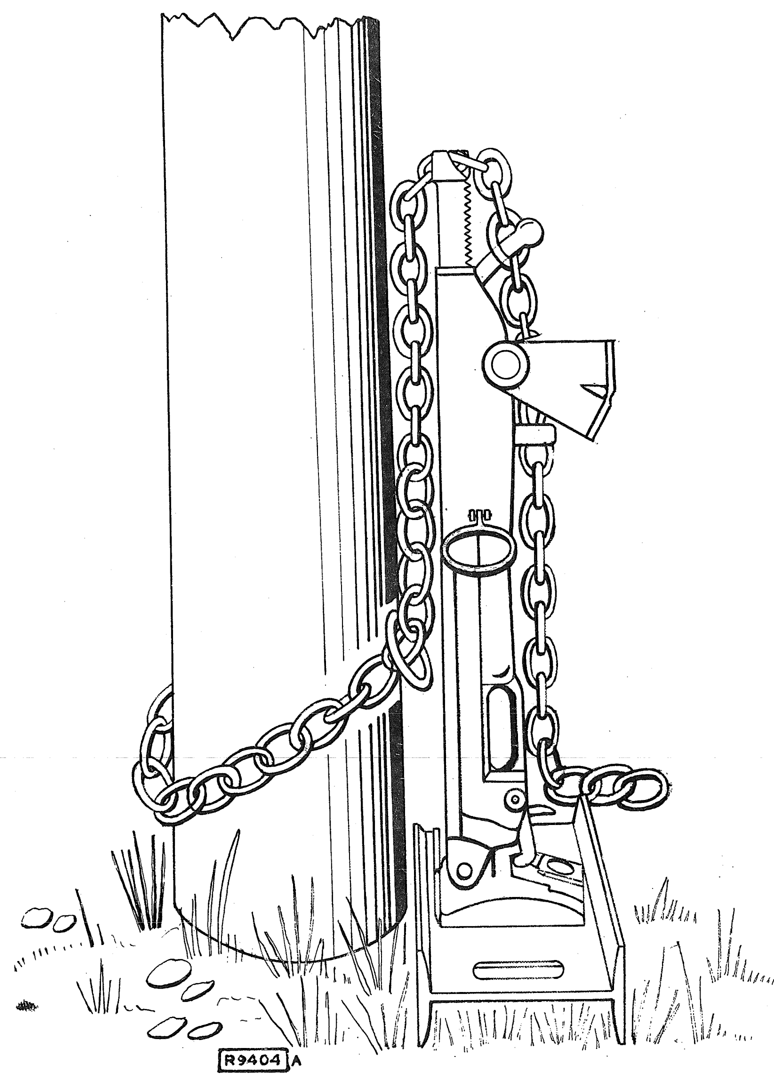


Fig. 13

MECHANIZED ERECTION AND RECOVERY OF POLES

Pole Erection Unit

In the endeavour to mechanize pole erection, several machines have been tried by the B.P.O. One called the Horndraulic pole borer had a hydraulic powered auger mounted on the rear of a tractor, and a hydraulic boom on the front for lifting poles. Another pole hole borer was the Cheshire Highways; this had an earth auger powered by its own diesel engine mounted on a turntable at the rear of a Ford truck. Neither of these aids were equipped to transport poles. Then a line construction vehicle was used experimentally which was designed to perform several external construction works.

The pole erection unit is a development of this latter vehicle, but is designed purely for pole erection. There are two makes of unit in use by B.P.O. namely:

(a) Simon Polecat

(b) King tel-e-lect.

Both units are similar, and the equipment is mounted on the chassis of a 4-wheel drive diesel truck. The equipment is completely hydraulic powered, and the hydraulic pump is driven by the vehicle engine via the power take off and main gear box. The unit comprises a hydraulically rotating derrick mounted on the rear near-side corner of the vehicle, see Fig. 14. The derrick will rotate through .360° and will raise to 75° above the horizontal for (a) and 80° on the (b) machine; both will lower to 15° below the horizontal. The boom of the derrick is 14 ft. long for (a) or 13 ft. 6 in. for (b) from the centre of rotation to the auger, but both have an extendible section approximately 8 ft. long called a "stinger" which increases the length to approximately 22 ft. The pole-hole borer is driven by a hydraulic motor, and when not in use it is folded back and stowed along side the main derrick. This is done by attaching a steel wire to the auger shaft, and rotating the auger. The wire winds round the shaft causing it to rise to the stowage position where it is held in place. The auger is mounted near the end of the extension so that its digging radius is variable. The auger, which is normally equipped with steel digging teeth, but for rocky areas tungsten teeth are available, can be 10, 12, 14, or 16 inches in diameter; normally the 12 inch size is used. A hydraulic motor driven winch is mounted at the very end of the boom, and is capable of lifting a load of 8 cwt at maximum radius and one ton at a minimum radius of approximately 6 ft. Before the derrick is moved the vehicle is stabilized by means of a hydraulic outrigger which is located at the rear adjacent to the derrick, and a simple hydraulic jack is fitted on the opposite side. These are lowered sufficiently to just take the weight off the rear wheels and springs. Associated with the unit are a punner and pole jack, and external hydraulic outlets with quick couplings are provided to supply these tools. The hydraulic controls for operating the equipment are situated at the rear of the vehicle. The hydraulic componenets are designed for working at 2000 lb/in pressure and steel tubing is used except where flexibility is required. Bypass valves are provided to ensure that this pressure is not exceeded, for example when the 'stinger' comes to the limit of its travel.

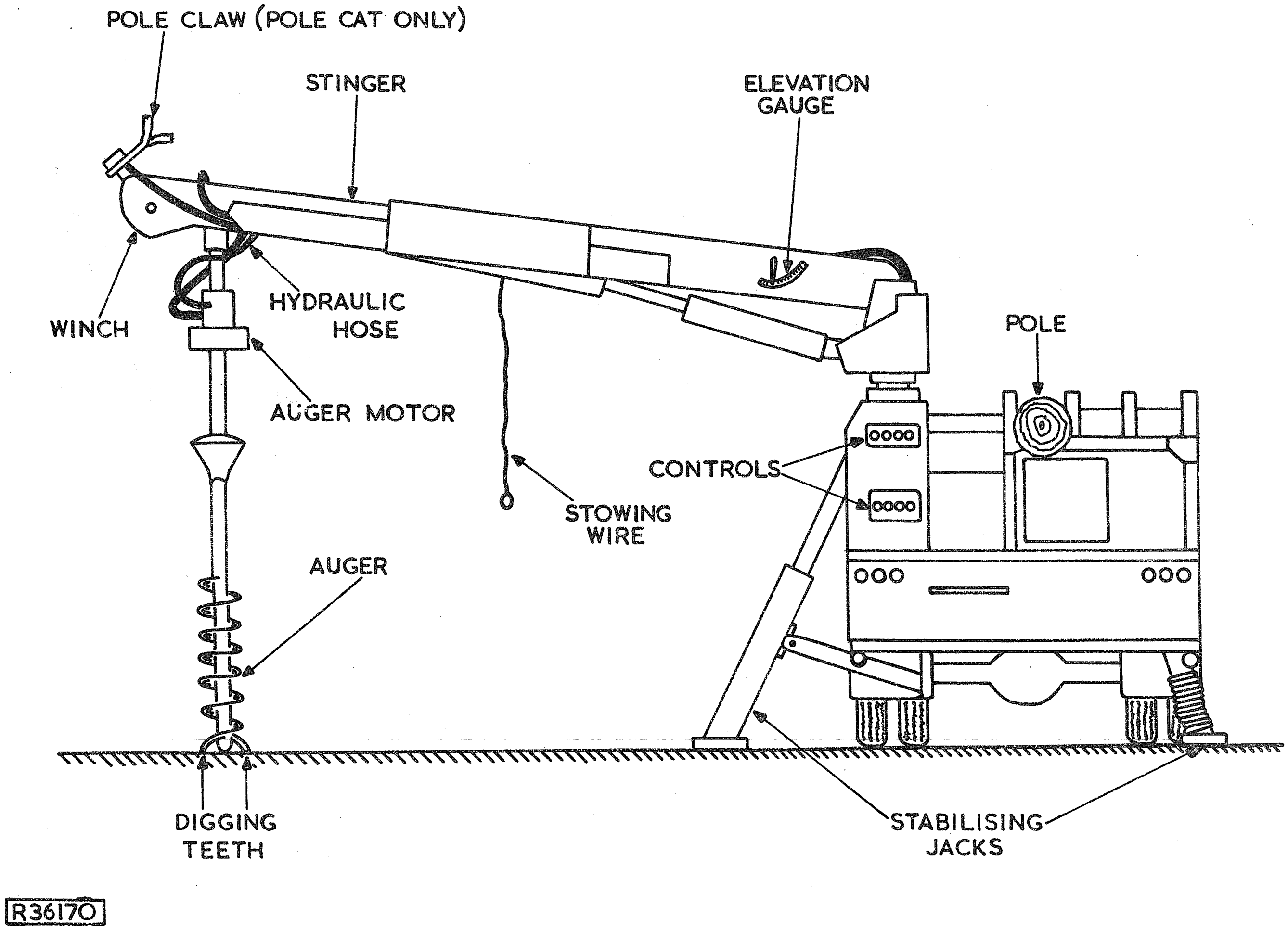


Fig. 14

The unit has been designed to carry up to nine poles, subject to a weight limit of 30 cwt., and operated by two men, bore holes within a distance of 22 ft., erect poles up to a limit of approximately 50 ft., and insert screwed stay anchors. Thus, the unit enables pole erection gangs to be reduced in size, resulting in increased efficiency.

Checking for the presence of buried services

Before an actual pole-hole is bored, a check that no buried service exists below the proposed pole site must be made. The check is made using a located No. 1A This consists of a radio type transmitter, which has an 80 kHz carrier output modulated by a 1000 **Herz** audio tone, and a receiver (or detector) which are used separately, but clipped together when stored. Each section has a frame aerial which is directional giving maximum response along the side of the unit. The transmitter has an ON/OFF switch, pull out for one, push in for off (i.e. cannot be left on when stored), and a battery test button with meter to test the internal batteries. The output switch on the transmitter is marked "Induce" and "Connect". Switched to "induce", the signal connected to the aerial and is radiated, but switched to "connect" the signal is fed to terminals for direct connection to a known cable or pipe and earth (this is used on the other functions of the locator).

The receiver is switched on by inserting the headphone plug into the jack, it has a range switch HIGH and LOW with a sensitivity control for fine adjustment and a meter which is used both in a battery check circuit, and as a visual indicator of the received signal strength. The receiver also has a built in spirit level to indicate when the receiver is tilted at 45° (used for depth measurement).

To use the locator for this 'radial search' test requires two men. One man with the headphone connected holds the receiver on its edge over the proposed pole hole. In this position the receiver is most sensitive to signals received from directly below. The range on the detector is set to 'low'. With the transmitter switched on and the output control switched to induce, the other man takes the transmitter a distance 30 ft. away, and holds it by the handle in line with the receiver. The sensitivity control of the receiver is adjusted so that only a low level of tone is heard, and the transmitter is then moved round in a circle keeping the radius as constant as possible, ensuring that both the transmitter and receiver are always in line, see Fig. 15.

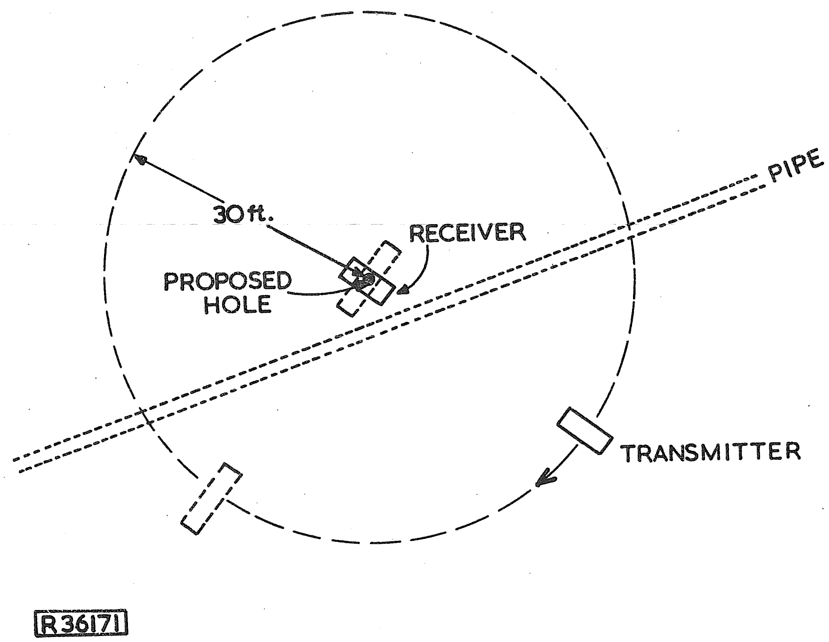


Fig. 15

If a pipe or cable runs near the proposed pole hole, when the transmitter passes over the cable a strong signal is induced into it, which in turn radiates the signal, giving a sharp increase in the level of tone heard in the receiver headphone. During the radial search it is important to keep the distance between transmitter and receiver constant, but if narrow roads or obstructions make it necessary to vary the separating distance, the received signal will alter, and thus the sensitivity must be readjusted. It is essential not to confuse these variations in tone level with those resulting from the detection of a service. When, however, a service is detected by a sharp rise and fall in tone, the transmitter is placed on the ground where maximum signal is received. Keeping the receiver vertical it is moved sideways left and right until the point of maximum signal is found; this is then the position of the service. Fig. 16 shows a radial test being carried out.

R36172

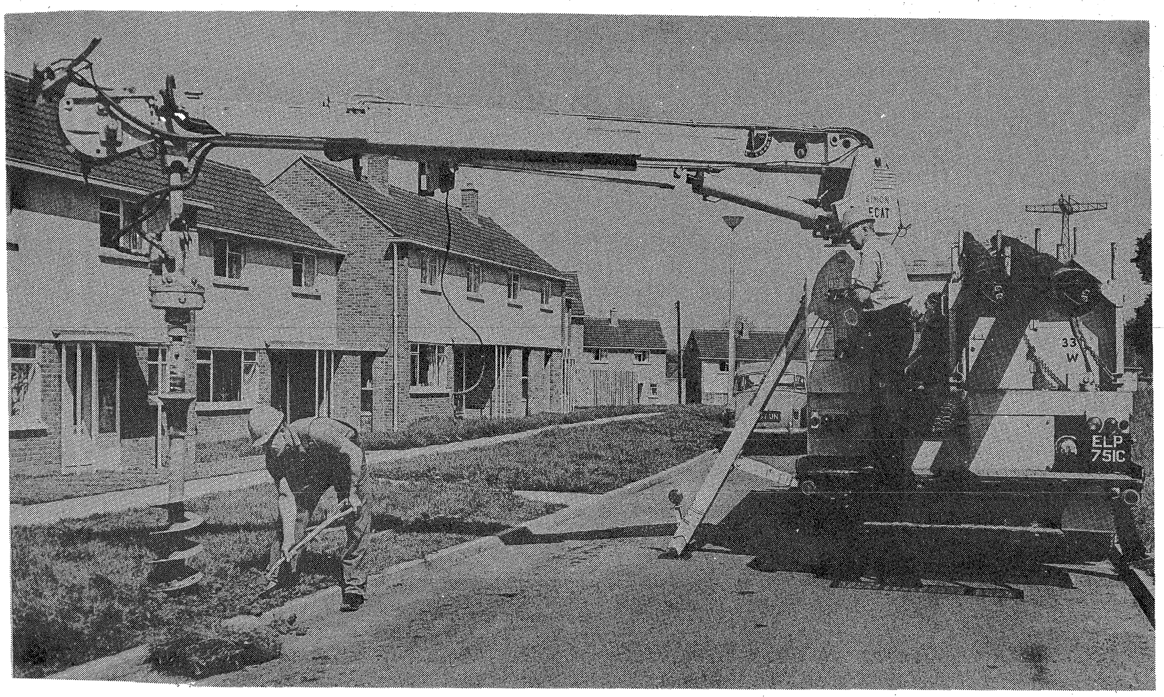
Fig. 16

When a Service has been detected and plotted, it is necessary to check for the presence of an additional adjacent service. When services run close together it is frequently difficult to detect or trace them separately, as a strong signal from one service may obscure a weak signal from a smaller (or less conductive) adjacent service. With the receiver sensitivity set high, the transmitter is placed horizontally over the known service and adjusted so that minimum signal is detected by the receiver, i.e. minimum tone is being induced into the known service, but any other service not directly below this receives a strong induced signal. The receiver is then moved left and right, and if the signal increases an adjacent service is indicated.

Erecting Poles

The unit is set up by putting the transfer gear box into neutral, and engaging the power take-off; the motor then drives the hydraulic pump. Before any work is carried out the stabilizing jacks are lowered sufficiently to just take the weight off the rear wheels. The poles may be loaded on to, and unloaded from the pole erection vehicle by means of the winch at the end of the derrick. When this is carried out the winch is positioned immediately above the point of attachment to the pole. The winch hawser is attached to the pole such that it is slightly top heavy; then with a sash line attached round the butt one man can guide the pole, while the other operates the vehicle controls.

In preparation for boring the auger is lowered from its stowed position, then under direction of one man the auger is lined up over the site of the proposed hole. It is important to have the extension 'stinger' partly extended to allow for adjustment in the vertical alignment of the auger during digging operations. The auger is lowered until it touches the ground, and is then rotated at full speed in the forward digging direction. A steady downward pressure is applied to it by lowering the derrick in small steps. During the descent, the auger is kept in vertical alignment by moving the 'stinger' in or out. Fig. 17 shows digging in progress. When the auger has reached the desired depth, or requires cleaning,



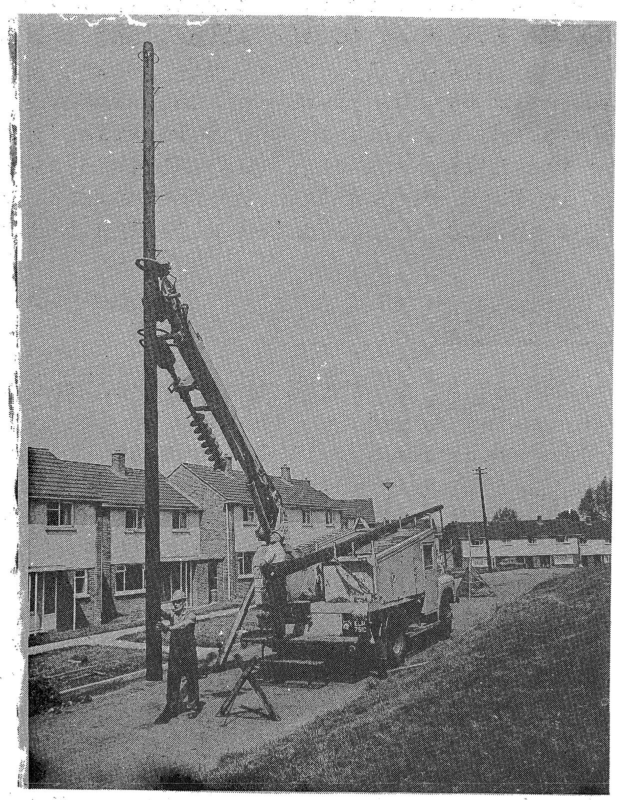
R36173

Fig. 17

it is kept rotating while the derrick is raised slightly. As the auger starts to rise, the rotation is stopped, and it is lifted clear of the ground. The auger is cleaned, and if necessary digging is continued. After the hole has been dug, the auger is cleaned and re-stowed on the boom of the derrick, see Fig. 18. (During this operation the 'stinger' must be fully retracted.)

R36174

Fig. 18

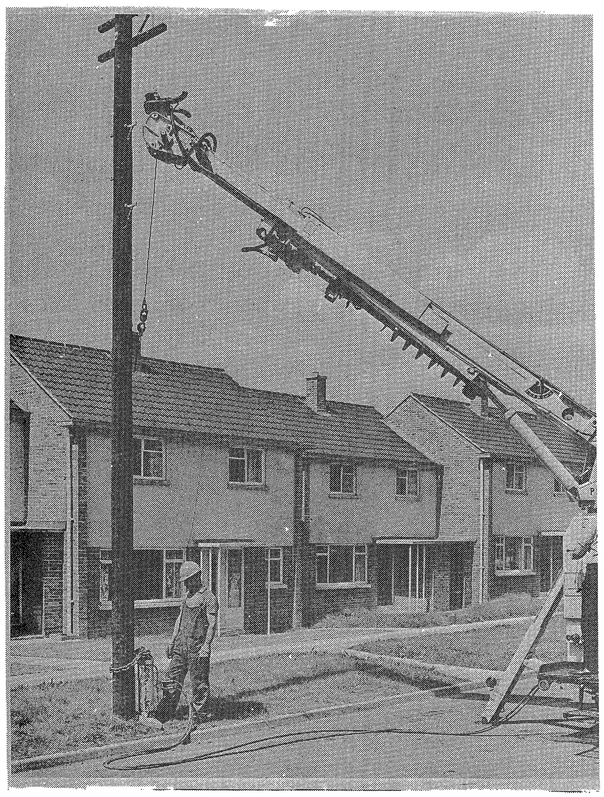


R36175

Fig. 19

R36176

Fig. 20



R36177

Fig. 21

To erect a new pole, a sling is attached to it approximately two thirds of the way up its length, ensuring that the pole is butt heavy. The hawser of the winch is attached to the sling, and the winch is operated until the pole is lifted as shown in Fig. 19. The pole, which is secured on the Simon machine by the pole claws, and by the checks of the winch on the King machine, is lifted just clear of the ground, rotated to the pole hole, and with the aid of the second man lowered into the hole, see Fig. 20. At this stage the pole is twisted if necessary. The pole is held in position by the derrick until the soil around the pole has been filled in and consolidated with the aid of the incorporated hydraulic punner.

Pole Recovery

The depth to which the pole is set in the ground is estimated, and a sling is attached two thirds of the way up the pole (from the butt). The derrick is raised, and the winch hawser is let out at the same time until the winch is approximately the same distance above the point of attachment as the pole is in the ground, see Fig. 21. The hydraulic jack is set up at the foot of the pole, and a chain passed round the pole with both ends attached to the jack. The chain is not 'choked' as for the manual jack. The jack is operated in the up position and as the pole is lifted out of the ground the hawser is winched in to hold the pole. When the jack reaches its full extension, it is lowered, and the chain is re-attached as before. When the butt reaches ground level, the pole is winched clear of the ground, rotated to its required position, and lowered to the ground.

It must be emphasized that poles are not pulled out of the ground by the winch, or action of the boom, but jacked out.

METHODS OF STRENGTHENING POLE LINES

Stays

Poles are subjected to two kinds of stresses which tend to deflect the head of the pole (so upsetting the regulation of the wires), or even to break the pole by bending. These are:-

(a) stresses due to stationary forces such as the steady inward pull of the line wires at an angle-pole; they are known as static stresses.

(b) stresses due to forces of motion produced by wind pressure on the poles and line wires; they are known as kinetic stresses.

When necessary and practicable, staying is used to relieve the poles of these bending stresses and to prevent the deflection of the pole-head, by providing additional support for the pole. The stays are generally made of stranded galvanized-steel wire.

The primary consideration is that the factor of safety on the stays shall be greater than the factor of safety on the line-wires. Then, in the event of the sudden application of an abnormal load, the wires and not the stays will break first, so ensuring the stability of the poles.

The types of stay employed on pole routes are:-

(i) Terminal Stays

Terminal stays are fitted to counteract the stress imposed on terminal poles by the line wires. A terminal stay is fitted on the side of the pole opposite to the line wires and in a direct line with them.

(ii) Longitudinal Stays

Longitudinal stays are fitted at intermediate poles to limit the effects of breakdowns on the remainder of the pole route and to counteract unbalance stresses in the direction of the line. Longitudinal stays act in a similar manner to terminal stays. They are provided in single or double form, the latter consisting of two single stays, one on each side of the pole.

Single longitudinal stays are provided at rail and road crossings, one on each side of the crossing; and at poles where there is a considerable change in longitudinal stress. Such changes occur where there is a change of wire gauge or where several line wires terminate or branch off.

Double longitudinal stays are provided at approximately quarter mile intervals along the pole route. In this case the two single stays at crossings are considered to form a double longitudinal stay. Double longitudinal stays are also provided at poles where open wires and aerial cables terminate from opposite directions and at intervals of less than a quarter mile where the line is exposed to special risk of damage from falling trees or branches.

(iii) Angle Stays

Angle stays are provided to act against the stress imposed by the inward pull of the wires at angles in the pole line. An angle stay is fitted in line with the bisector of the angle of the line wires to oppose equally the pull of the line wires on each side of the pole.

(iv) Transverse Stay

Transverse stays are provided to strengthen the pole line against transverse stresses caused by wind pressure on the line. Transverse stays are fitted at approximately quarter mile interval. Two stays are fitted to opposite sides of the pole in a plane at right angles to the direction of the line.

(v) Overhead or Gallows Stay

Where a pole requires additional strength and the required stay cannot be fitted in the normal manner an overhead or gallows stay may be provided. An overhead stay consist of two stays, in line in a horizontal plane, connected by an additional pole. This enables the stay to be carried over a road, footway, building or other obstruction before reaching the ground, Fig. 22.

(vi) V-Stays and Parallel Stay

V-stays and parallel stays may be fitted where a single stay will not be sufficiently strong. V-stays consist of two stays fitted at two points on the pole, equidistant from the resultant point of the forces acting on the pole due to the line wires, and terminated at the ground on a single anchorage. They are fitted where two stays will provide sufficient strength and the single anchorage is sufficiently secure to take the total stress. Parallel stays consist of two or more stays secured to the pole so that the upper and lower stays are equidistant from the resultant point, each stay having an individual anchorage at ground level. Parallel stays are fitted where conditions are unsuitable for V-stays or where more than two stays are required to give the necessary additional strength.

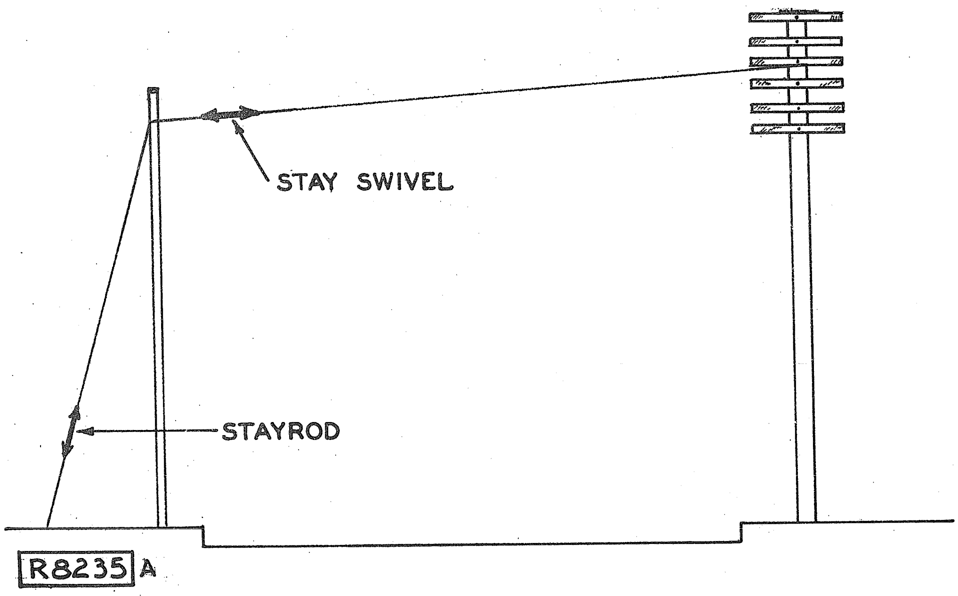


Fig. 22

Struts

Cases arise where stays are unsuitable - usually where, on account of the proximity of a road margin or building, there is sufficient space to admit of the attachment of a stay with a reasonable stay-spread. In such cases, it is frequently possible to find room for a ground fixture on the opposite side of the pole line, and in these circumstances the use of a strut is given consideration.

A strut gives lateral support in both directions, but is more expensive than a stay, both in stores and labour. It cannot generally be attached to the pole at the resultant point of the line tension and, therefore, it is inherently weaker than a stay. Again, for complete stability, it is necessary to block the bottom of the pole, in order to resist the tendency under severe loading for the line reaction to lift the pole out of the ground. For these reasons, stays are to be preferred to struts wherever circumstances permit.

Blocked Poles

It may happen, in a situation where stays and struts are inadmissible, that, the use of A-poles is likewise ruled out - for instance from consideration of size, as in a residential area, or because they are not justified by the load to be carried. In such cases the only solution is the use of a pole sufficiently strong to carry the line-load unaided. It is then necessary to ensure not only that the pole shall be of adequate strength, but also that its foundations shall be sufficiently strong. The use of blocks, fitted near the butt of the pole and about 18 ins. below ground level, is a ready means of strengthening the foundation. The blocks are so placed as to present their full surface to the soil in the direction in which the pole would tend to overturn under severe loading.

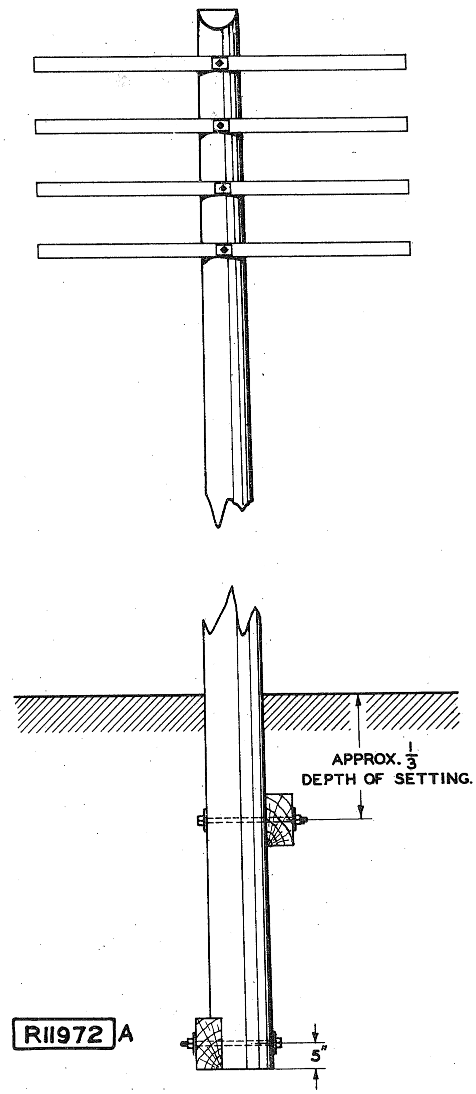


Fig. 23 Method of blocking poles

Thus, at terminal points, the blocks are fitted at right-angles to the direction of the line; at intermediate points, where blocks are required to counteract transverse stresses, they are placed longitudinally, as shown in Fig. 23.

Normally two blocks are fitted, one at about one third of the depth of setting below the ground line and the other on the opposite side of the pole at the extreme butt. A medium or heavy stayblock, depending on the capacity of the line and/or the character of the soil, is used for the upper block. A light stayblock will generally suffice at the butt, owing to the greater earth resistance at the lower position.

In fitting the upper block, it is more convenient to fit the bolt to the pole before the pole is erected, and leave the block to be fixed in position after the hole has been filled-in to a point level with the underside of the block, i.e. 5 in. below the bolt. When the filling-in has been completed to this point, the bolt is partly withdrawn and the pole-hole carefully trimmed, so that the block may be wedged tightly between the pole and solid, undisturbed earth, and afterwards, bolted to the pole. If attached before the pole is erected, there is a distinct likelihood of the upper block obstructing setting and filling-in operations

Except in unsuitable soil, a single stayblock at about one third of the depth of setting will generally provide all the additional support required for a light pole.

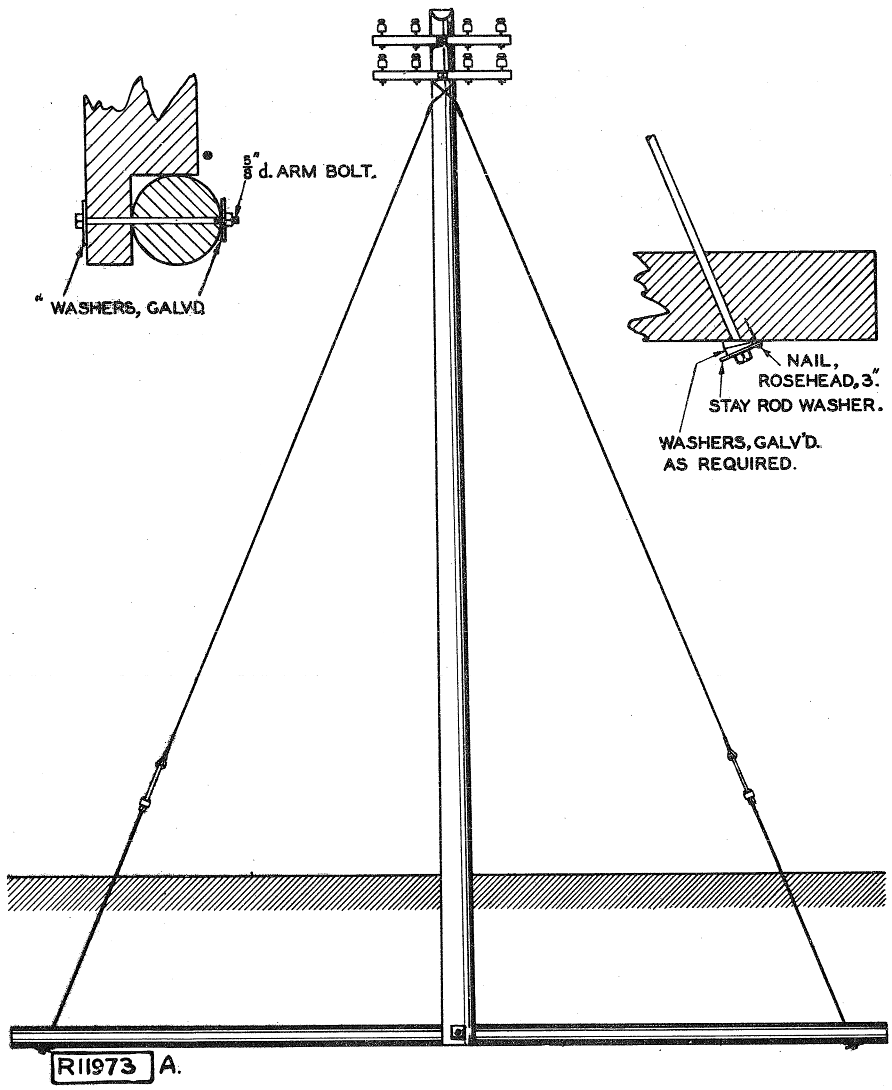


Fig. 24 Blocked pole in unstable ground

Poles in unstable ground

When a pole has to be set in swampy ground or other unsuitable soils, or on a pebble beach, it is advisable to bolt a stayblock to the butt as illustrated in Fig. 23. Alternatively, the pole may rest on the stayblock, the latter being fastened to the end of the pole by means of a 9 in. galvanized-iron spike. In very soft bog, a short pole may be bolted to the foot of the line pole and stays attached to the ends of the buried pole, as shown in Fig. 24.

Where the additional vertical load imposed by staying would be likely to cause a pole to sink deeper in the ground, the pole should be blocked.

ERECTION AND ATTACHMENT OF STAYS AND STRUTS

A stay takes up little space, is easily and cheaply fitted, and does not necessitate boring or other treatment on the pole. It may be attached at, or very near, the resultant point of tension of the bed of wires. Generally the resultant point is midway between top and bottom arms, though, where heavier conductors are erected on the upper arms, the resultant point will be shifted to slightly above the midway position. The possibility of addition to the loading should also be borne in mind when determining the point of attachment. Where tensions are severe (as at terminal pole), the stay may readily be duplicated or triplicated. Whenever a pole or a pole-line requires support, therefore, the possibility of staying is given first consideration.

The most efficient angle at which a stay can be fixed is at right angles to the pole in the direction to counteract the pull on the pole; as the angle between the pole and the stay diminishes so the efficiency of the stay decreases. If a stay is anchored at too great a distance from a pole, not only is it unsightly, but a greater weight of material may be used than that necessary to provide two separate stays forming a smaller angle and acting jointly as an efficient support. Stays should be fitted with the base, or spread, at least half the height of the pole and whenever circumstances permit the spread should be equal to the height of the pole. It should be borne in mind that a number of light stays, of the total strength required for a section of line and spaced at short intervals throughout the section, provide a more efficient support against wind-pressure than heavier stays, of the same total strength, spaced at longer intervals. One method of fixing a stay in the ground is illustrated in Fig. 25.

The point of anchorage and of attachment to the pole is arranged so as to provide the best possible clearance between the stay and adjacent line wires; the minimum clearance permissible is 2 inches.

Except for overhead and other stays which approach the horizontal the stay is attached immediately below, and not above, the arm. See Fig. 26.

When choice of the position of anchorage is so limited that the stay would be within 2 inches of a line wire, additional clearance should be obtained by shifting the line wire inwards or outwards as required and specially boring the arm for the insulator spindle. Where, however, such practice would involve a line-wire separation of less than 7 ins., or the fixing of a spindle at a point less than 2 ins., from the end of an arm, the necessary clearance should be obtained by fitting a stay crutch. See Fig. 26.

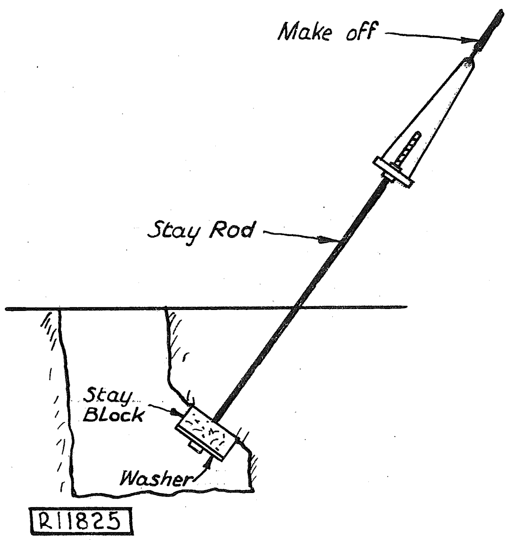


Fig. 25

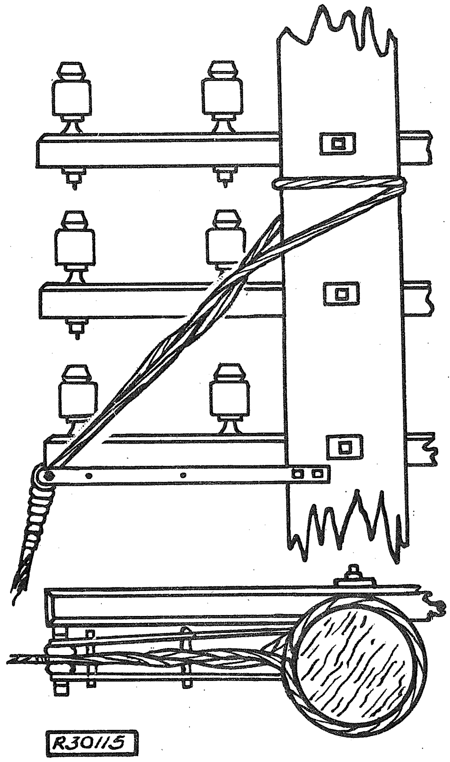


Fig. 26

Fitting of stay-wire

Stay-wires are attached by looping the end of the wire round the pole or thimble and then "making-off" upon the standing part of the wire. A large or a small stay-splicing tool, illustrated in Fig. 27 is used when making-off all stay-wire, except 7/14 strand, which can easily be made-off by hand. Two hooks are provided, one at each side of the tool, so that the wire may be made-off in either a right- or left-hand direction, according to the lay of the strand. A left-hand lay is now standard. Use of the large tool facilitates the operation, and is therefore preferable where sufficient space is available.

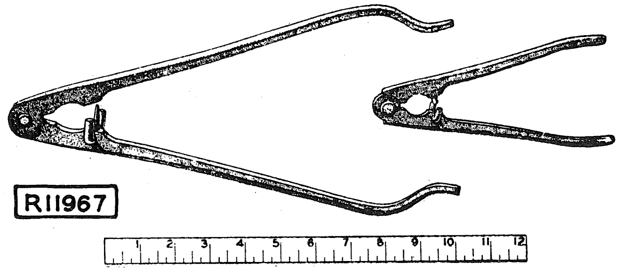


Fig. 27 Stay-splicing tools

Suitable cutters are used to cut stranded stay-wire to the required length.

Stay-wires are, generally, attached to poles before erection. When fitting stays to existing poles, care should be taken to avoid contact between the stay and the line-wires. The small splicing tool is generally used. That portion of the stay-wire which is likely to foul the line-wires may be insulated from them by enclosing it temporarily in a length of split rubber hose of $\frac{1}{2}$" dia.

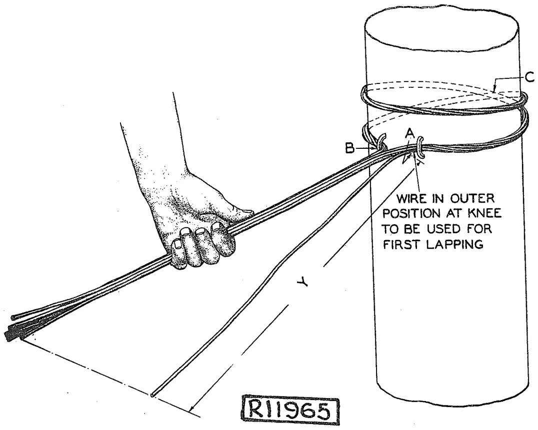


Fig. 28

It is advisable to make-off the wire of an angle or transverse stay at the back of the pole - i.e. opposite to the side on which the arms are fitted - and parallel with the line-wires. In this position the small splicing tool can generally be rotated without difficulty. When the make-off is completed, the stay-wire is turned to its correct position, and secured by means of staples.

Where only one stay is being fitted at one point on a pole, the wire is lapped twice round the pole, the second turn crossing the first on the side opposite to the make-off (Fig. 28). Where two stays are being attached at the same point, but on opposite sides of the pole, only one turn of each stay-wire round the pole is required, but one stay-wire should be crossed over the other.

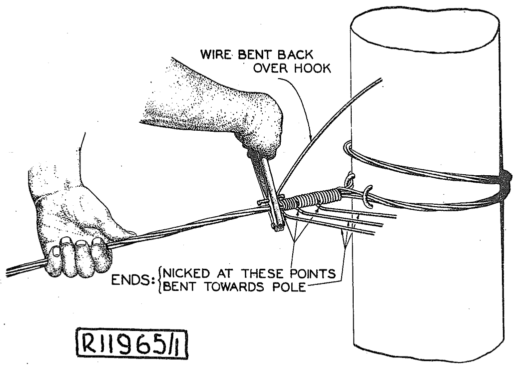


Fig. 29 Making-off: Splicing tool in position

When the wire has been passed round the pole, it is secured by means of two galvanized iron staples, and then bent to form two knees, as illustrated by (A) and (B) in Fig. 28. The free end will then lie closely along the standing part, and the wire can be made-off close to the pole, thus minimizing any tendency to slip under load. The length of wire wound the pole should be sufficient to ensure that, when the stay is tight, the lower loop (A-C-B in Fig. 28) is approximately in alignment with the rest of the stay, clearance from arms, etc., being taken into consideration.

Stay-wire is made-off in the following manner:- Unstrand the free end, and straighten out the individual wires. The portion of the stay-wire which is lapped round the pole is not unstranded. Select, for the first lapping, the wire which crosses the others at the knee on the side remote from the main wire, bend it outwards at the knee and arrange the remaining wires symmetrically alongside the main wire, as illustrated in Fig. 28 so that the completed make-off may be as neat and compact as possible.

Next, place the splicing tool in position with the hooks pointing in the direction of the lay of the strand, see Fig. 29, and engage the free wire with the hook on the pole side of the tool. Bend the wire back over the hook, and, keeping it in this position, revolve the tool in the same direction as the lay of the strand, thus binding the wire closely and tightly round the main wire and the remaining strands. Make eight laps with this wire, bend the end towards the pole and out of the way of the tool, and leave it to be shortened and pressed into the make-off later. Then select and bend up a wire for the second lapping and, engaging it with the same hook of the tool, turn as for the first wire. Deal with each succeeding wire in a similar way.

The position of each wire remaining, after the requisite number of laps have been made, should be shortened sufficiently to permit the end being worked into the make-off; the length should be such that one lapping finishes at the beginning of the next. This is done by nicking each wire, by means of pliers, at the point where the lapping will finish (Fig. 29) and, after it has been pulled into the make-off by means of the splicing tool used in the manner already described, breaking the wire off by bending it from side to side. The splicing tool is then placed over the make-off so as to embrace the end of the first of the shortened wires and, by revolving the tool in the same direction as the lapping, the end is pressed into position. This procedure is repeated for each of the ends in turn. A finished make-off is illustrated in Fig. 30.

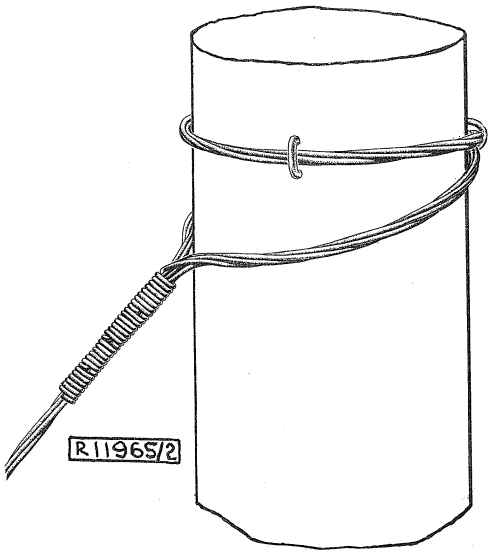


Fig. 30 - Make-off on pole finished and stapled in position

When the make-off has been completed, the two staples at the knees - Fig. 15 and 16 - are removed and, before the stay is tightened, the stay-wire is finally stapled to the pole as follows:-

(a) When the stay-wire is lapped twice round the pole, only the upper turn is stapled. Three staples are used at 120° spacing, one being fixed at the point where the two turns cross.

(b) When the stay wire is only taken once around the pole, the stay is stapled only on that side which is remote from the make-off.

The length of the stay-wire should be such that:-

(a) Full engagement of the nut of the stay-rod, stay-swivel or tightener is obtained without deflecting the pole from the vertical more than is necessary to allow for settlement, and

(b) The maximum length of screw-thread is available for subsequent adjustment. This is determined before beginning the second make-off by carefully tightening the wire, or, in the case of an overhead stay-wire to be made-off on the ground, by measurement.

A draw-vice is used to tighten the wire. Fig. 31 shows such a vice in use for tightening an iron line-wire, but serves to show the nature of the mechanism. A key is provided, one end of which is used to tighten the wing-nut, and the other end to tighten the tension-ratchet. The draw-vice is connected to the stay-rod or corresponding holdfast by means of a length of 400 lbs. galvanized-iron wire. The vice jaws should grip the whole stay-wire.

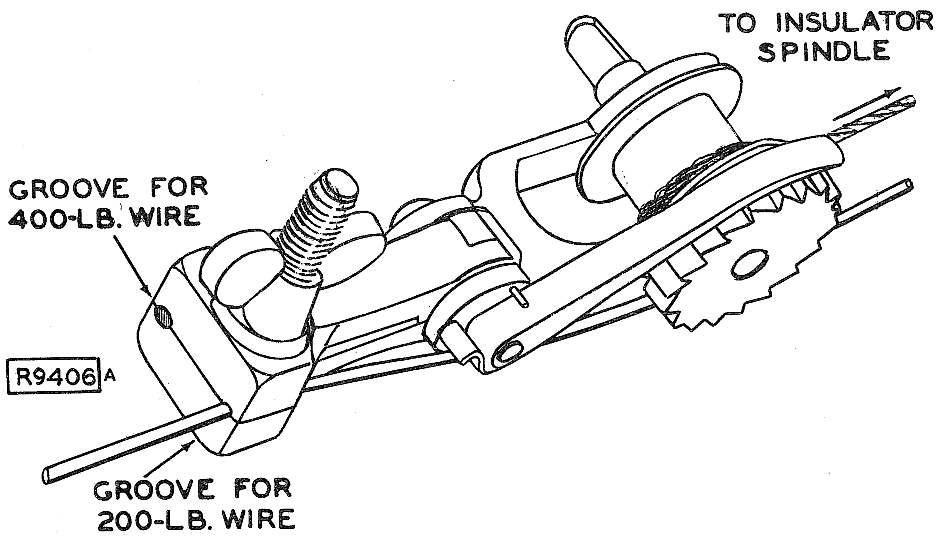


Fig. 31

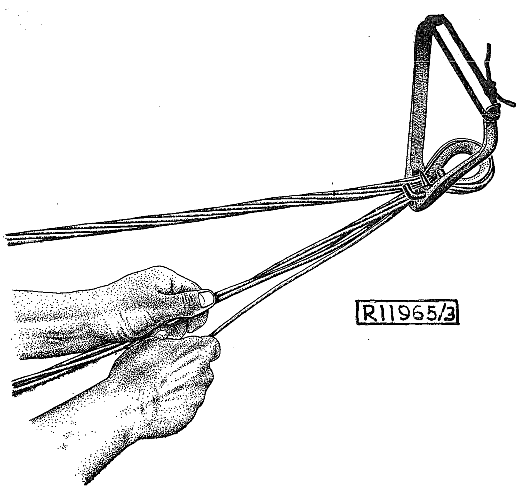


Fig. 32. Making-off to thimble: knees held together by splicing tool while unstranding free end.

The stay-wire is bent to form two knees at the point where it is to be made-off to the thimble. The wire is then made-off as detailed above. Making-off will be made easier by the removal of the draw-vice. This may generally be done when the first turn or so of the make-off has been made, but, where the tension to be maintained is such that the removal of the vice at this stage would result in slipping, one of the individual wires of the free end (the central wire in the case of 7-strand wire) should be connected to a second vice, which should be attached to the main wire before the first is removed.

Stay rods, swivels and tighteners

The final tensioning of the stay is effected by one of these fittings, the construction of which is illustrated in Figs. 33, 34 and 35. The stay rod, which is either 6 or 8 feet long, is used in conjunction with a stayblock of creosoted pine. Stayblocks are in three sizes, designated light, medium and heavy, and the choice depends on the length of stay, the tension in the stay-wire, and the nature of the soil. To prevent interference with the adjustment of the stay by unauthorized persons, a locking rack-nut is used to secure the bow to the rod. The lower end of the stay-rod terminates in a stout, square bolt-head; a large square washer, having a square central hole fitting the neck of the rod, abuts against the head. A circular hole is provided in one corner of the washer, through which a rosehead nail is driven into the stayblock, to prevent the stay-rod turning when the stay is being adjusted.

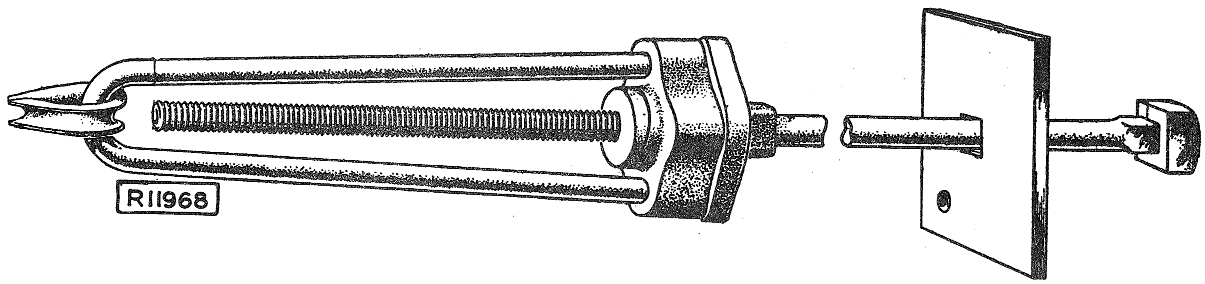


Fig. 33 A stay rod

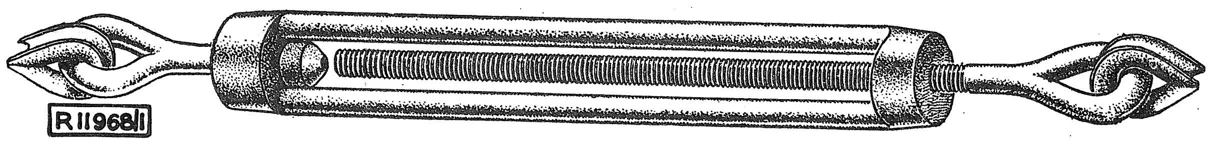


Fig. 34 A stay swivel

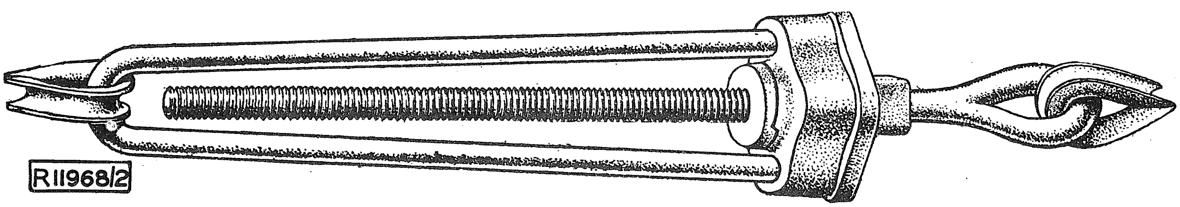


Fig. 35 A stay tightener

Stay swivels, Fig. 34, consist of a turnbuckle with a screwed eye-bolt at one end and a swivel-eye at the other. They are provided for the adjustment of all stays not incorporating a stay-rod, in positions where the tightening device, fitted near the point of anchorage, is not liable to interference.

Tighteners, Fig. 35, have a short, screwed eye-bolt in place of a rod, but are in other respects identical with a stay-rod. They have a self-locking rack-nut, and are used in place of stay swivels where the stay adjustment is accessible to unauthorized persons.

Excavation for stayblock

The stayblock is buried to a depth varying from 4 ft. to $6\frac{1}{2}$ ft. according to the character of the soil, but as most of the unscrewed portion of the rod is buried, in normal situations, the depth is generally determined by the angle of the stay. The hole is under-cut as shown in Fig. 36, so that the stayblock may

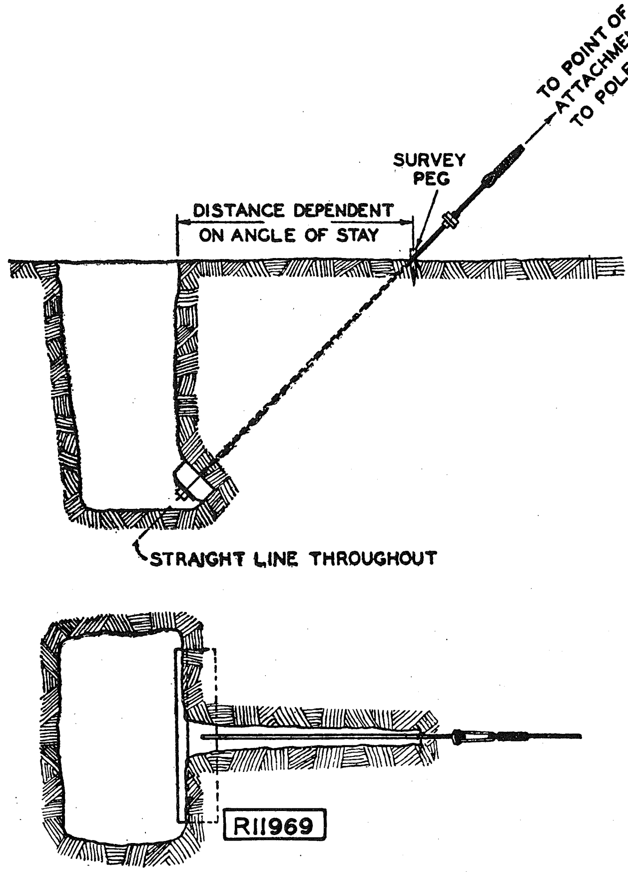


Fig. 36

be at right-angles to the direction of the stay and bear against solid, undisturbed earth, and thus provide the maximum resistance to the upward pull. A groove, as narrow as possible, is cut from the ground surface to the under-cut portion of the hole, to take the stay-rod and permit of its alignment. Generally, for cutting the groove, a pick is most suitable near the surface and crow-bar or a digging bar for the deeper portion. When using the pick, cut from the hole towards the shallower end of the groove, and so avoid displacing soil unnecessarily from the side of the hole.

Staying with the aid of a P.E.U.

Staying may also be carried out using a pole erection unit P.E.U. and screw anchors, instead of stay rods and stay blocks. A screw anchor is shown in Fig. 37 (a).

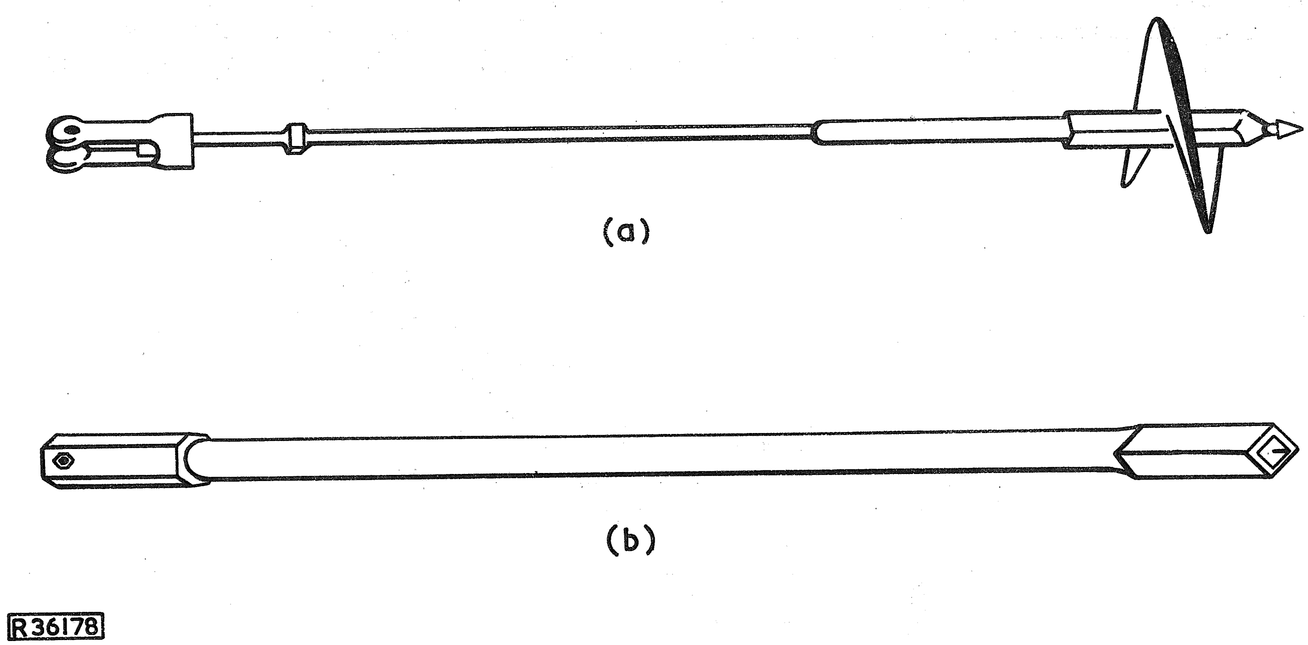
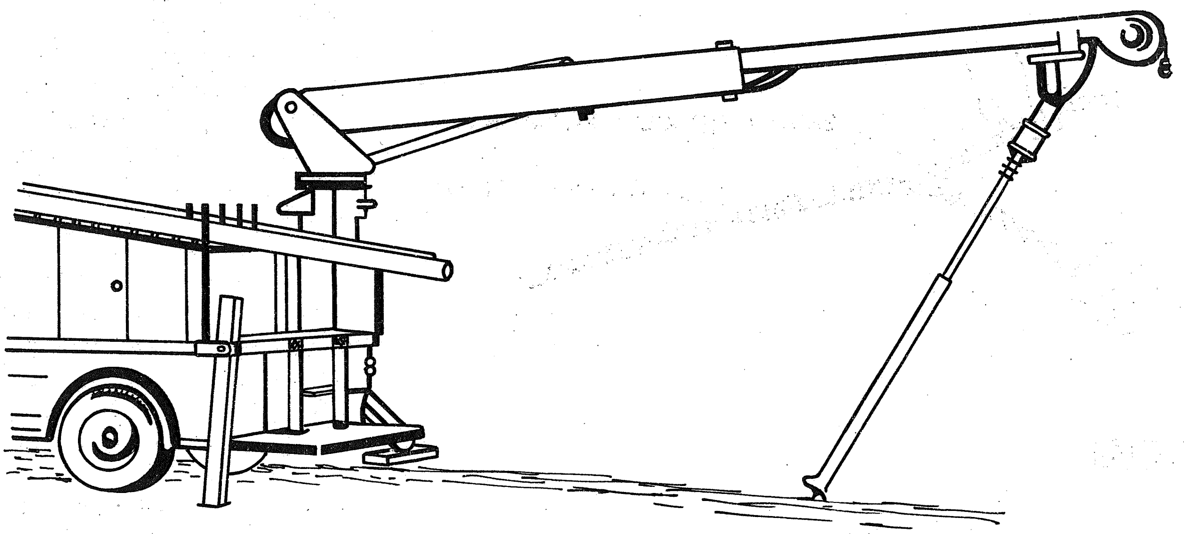


Fig. 37

This type of anchor is used in conjunction with a 7/14 high tensile steel stay wire, which is equivalent to a 4/8 galvanised stay wire. Where greater strength is required, two stays are fitted. The screw anchor is designed to be installed by a P.E.U. and this necessitates the use of an adaptor which is fitted on the hexagonal drive shaft in place of the auger, so that the drive may be transmitted to the stay anchor.

The P.E.U. is set up as previously described, and locator tests for other services are carried out at the position selected for the stay anchor. As the stay is screwed into the ground at an angle, two tests are made, one above the point of entry of the stay, and one above the estimated final position of the screw anchor blade. The auger is removed from the hexagonal drive shaft, and the hexagonal end of the tubular adaptor, shown in Fig. 37(b), is slid on to the shaft, and secured by an auger retaining bolt. The screw anchor is then inserted into the tubular adaptor and pushed up until the squared end of the anchor engages with the adaptor. The screw anchor is positioned vertically at the point where it is anticipated that the rod will finally protrude from the ground. Using a slow rotary motion of the auger drive with slight downward pressure of the boom, the screw anchor is driven into the ground approximately six inches. The rotary movement is then stopped, and the boom repositioned to tilt the stay over to the required angle, as shown in Fig. 38. The anchor is then screwed into the ground while depressing the derrick, and retracting the 'stinger' in small steps to maintain the correct stay angle.



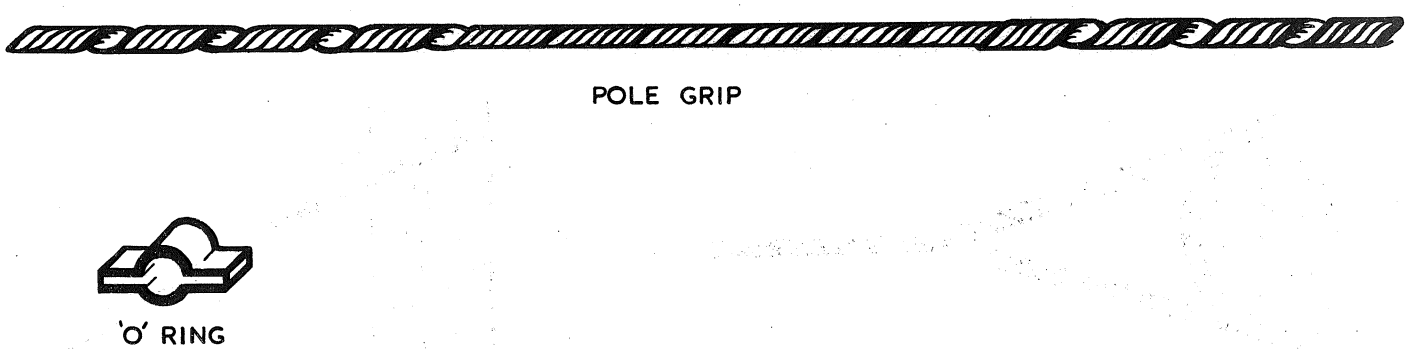
R36179

Fig. 38

It is important that the speed of rotation of the screw is low, otherwise it may enter the ground faster than the adaptor is moved, and thus pull itself out of the square end.

When the anchor has been screwed into the ground so that only 12-18 inches remain protruding above ground, rotation is ceased, and the tubular adaptor is withdrawn from the stay rod. The adaptor is then removed from the derrick, and the auger is replaced.

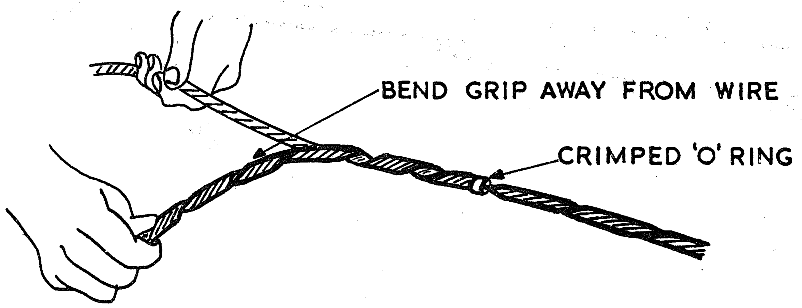
The stay wire is fixed to the pole with the aid of a grip and 'O' ring (see Fig. 39). The grip is made up in three parts, namely a frictional gripping helix, a close wound centre section, and a further gripping helix.



R36180

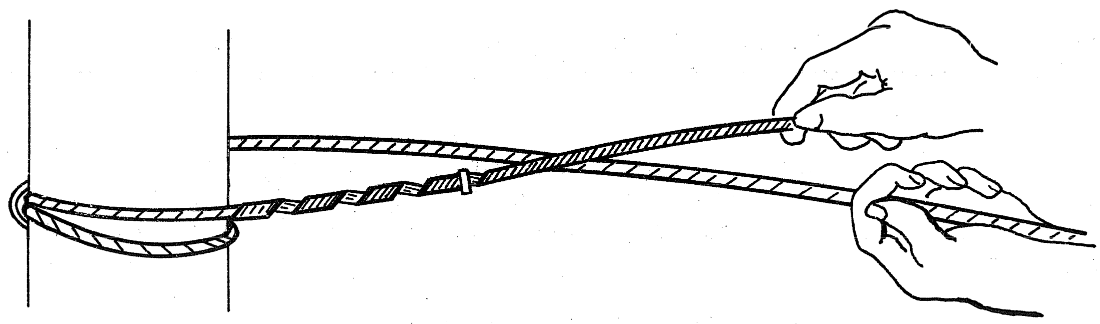
Fig. 39

An '0' ring is slid onto the centre section of the grip, and the free end of the stay wire laid in the helix of the grip. The '0' ring is slid back over the junction and crimped tightly with pliers so as to secure the grip to the stay wire. The gripping section is then wrapped round the stay wire, see Fig. 40. The stay wire is wound round the pole one and a half times such that the end of the grip is 1½ inches from the pole, and a 2 in. galvanised staple hammered into the pole on the opposite side from the stay. The free end of the grip and the stay wire are brought together to form a crutch, and the stay wire laid in the other helix, see Fig. 41. The gripping helix is wrapped round the



R36181

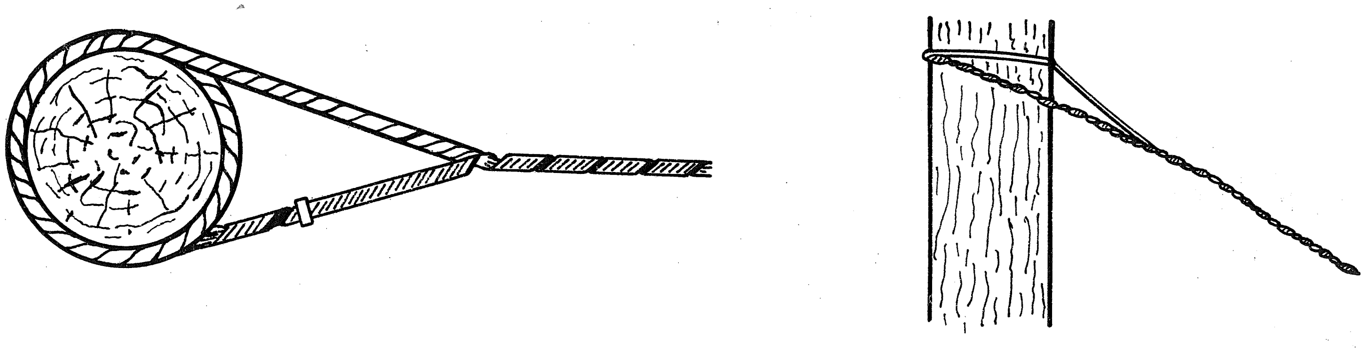
Fig. 40



R36182

Fig. 41

stay wire to complete the pole top termination, as shown in Fig. 42.



R36183

Fig. 42

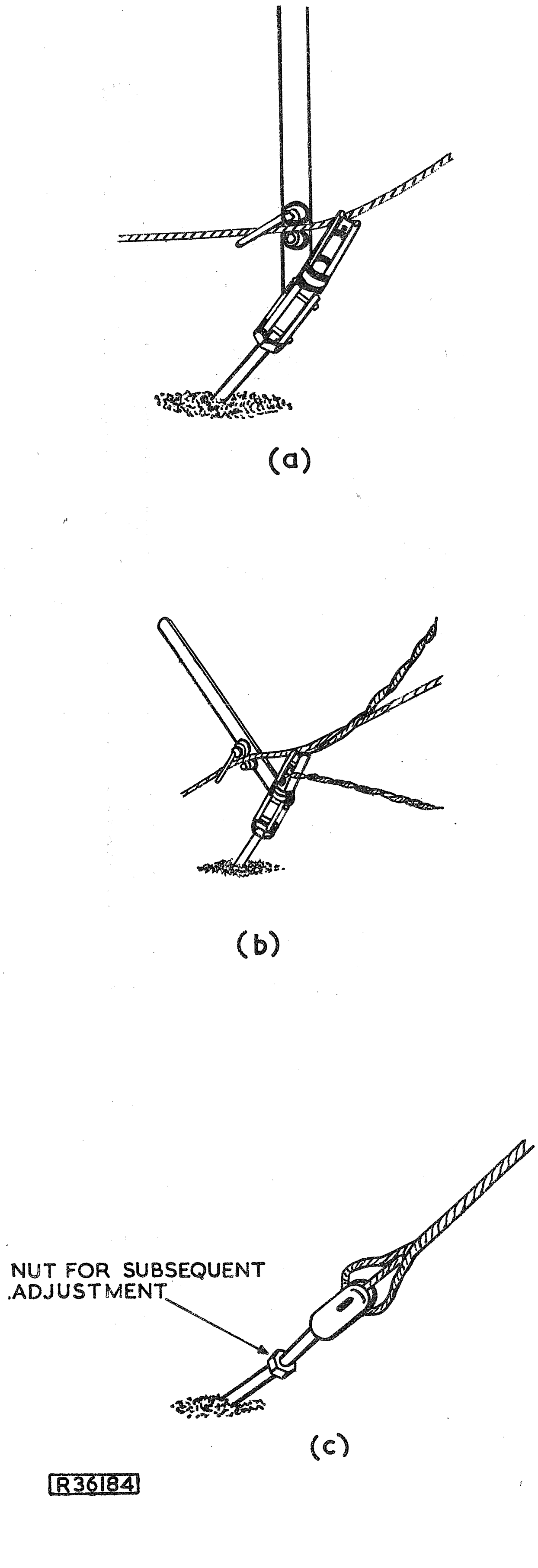


Fig. 43

To make off the stay wire at the anchor, the stay wire is cut slightly over length allowing sufficient to pass through the hole in the swivel eye of the anchor plus a further allowance of 12 in. A stay wire tensioner is assembled on the stay anchor just below the swivel eye. The stay wire is threaded through the hole provided and out of the side of the swivel eye, pulled hand tight, and locked in the eccentric clamp of the tensioning tool, see Fig. 43(a). The handle of the tensioner is then pulled backwards to tension the stay wire. Maintaining the stay wire in tension, a stay wire grip, which is similar to the pole top grip but without the centre section, is then threaded through the swivel eye. The two ends of the grip are laid adjacent to the stay wire which is then placed in the helix of one end of the grip as shown in Fig. 43(b). This end is wrapped around the stay wire for a distance of approximately four inches. The other end is also wrapped around the stay wire for the same distance. At this point both ends are then twisted on together to complete the termination. The tension in the stay wire is then increased, which causes the closed loop of the grip to open out, and using bolt cutters the stay wire is cut flush to the cheek of the swivel eye. This releases the additional tension just applied, and the sharp end of the cut stay wire is pulled back inside the hole of the swivel eye. Additional tension can be given if necessary by the nut provided for this purpose. Fig. 43(c) shows the completed anchor termination.

Stays Near Power Lines

When it is necessary to fit a stay near to a power line, or a pole jointly used by the P.O. and Electricity Board, precautions have to be taken to prevent accidental contact with the power supply line. An insulator is inserted into the stay to insulate the upper part of the stay. This arrangement is shown in Fig. 44, where it can be seen that four grips in all are used.

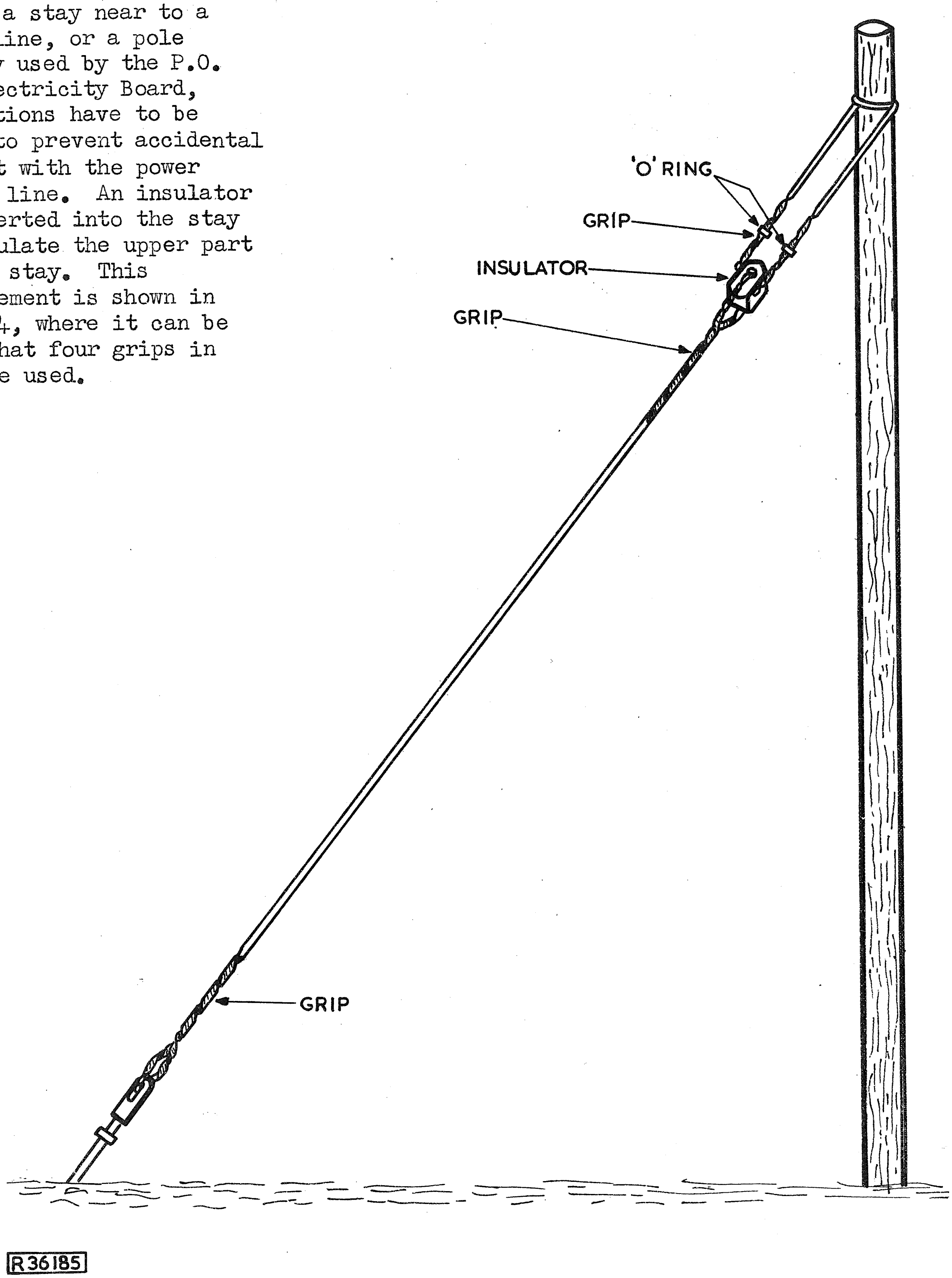


Fig. 44

Stayguards

Stayguards are used to protect stays and render them readily visible, and thus avoid risk of damage and of injury to persons or animals. All stays anchored beside footways, or road margins or grazing land, or in other places where collision with the stay could occur, should be fitted with stay guards. These are normally 8 ft. long of creosoted pine, and buried to a length of 2 ft as shown in Fig. 45.

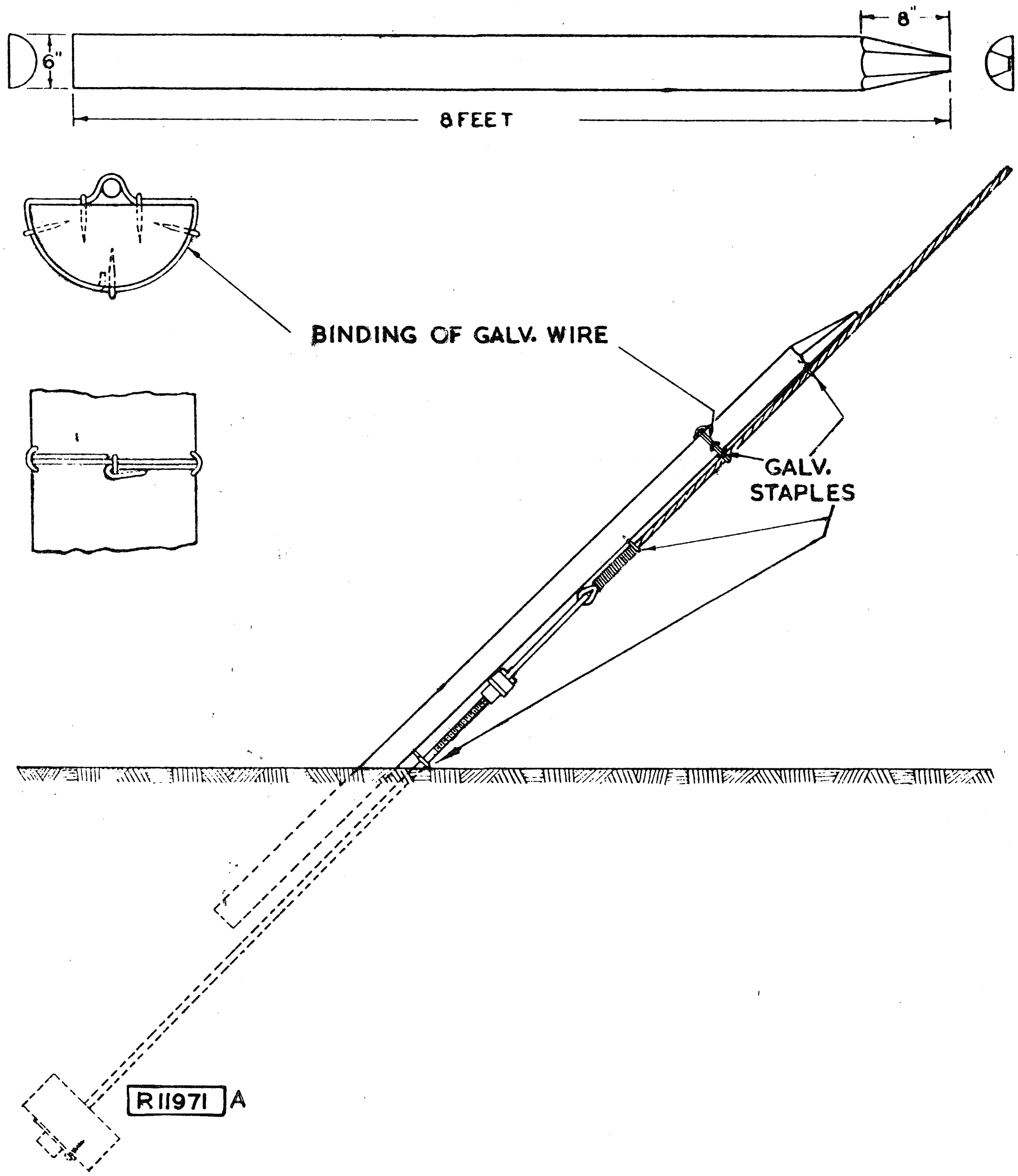


Fig. 45

Strutted Poles

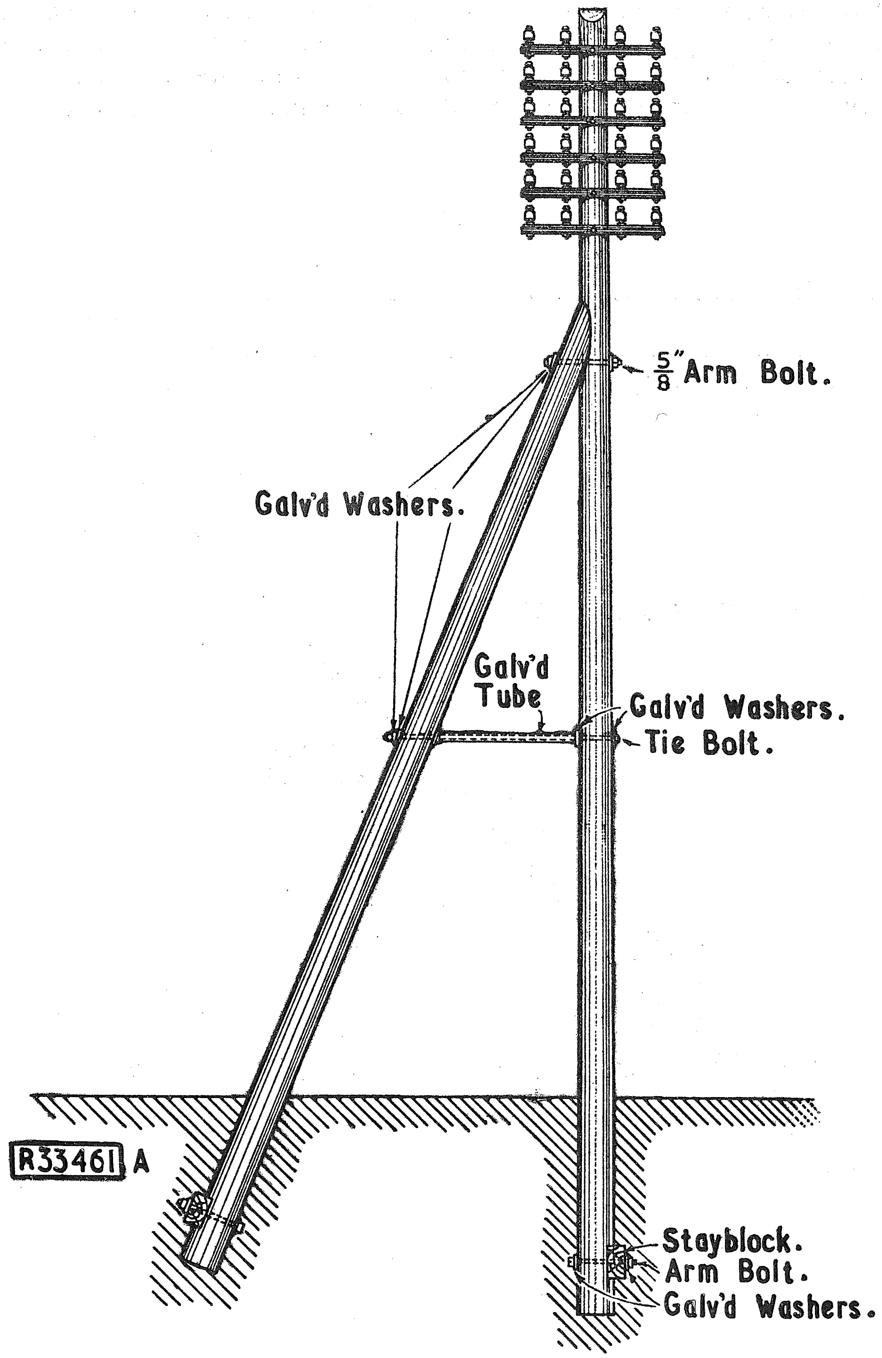


Fig. 46

A strut consists of a pole, somewhat lighter than the pole to be strengthened, bolted to the existing pole as shown in Fig. 46. The spread of the strut should be, as near as possible, equal to the height of the pole. As the strut is fitted below the arms and therefore below the resultant point of the forces acting on the pole due to the line wires, there is a tendency for the pole to break at the junction with the strut. For this reason strutted poles are normally one class heavier than the pole which would otherwise be used and no cuts or mortices are made in the pole to facilitate fitting the strut. The head of the strut is brought to a feathered edge and scarfed to fit the pole. The surfaces of the strut and pole which came into contact are treated with creosote and tar. The strut is secured by a $\frac{5}{8}$ in. arm bolt, which passes through the bottom of the scarfed position, and a tie bolt. The tie bolt is fitted between the strut and the pole at a minimum height of 12 ft. above the ground and approximately midway between the head of the strut and the ground. A galvanized steel tube acts as a spacer for the tie bolt and hollowed and taper washers provide a seating for the securing nuts at right angles to the bolt. The tie bolt and spacer give the structure the rigidity to withstand stresses in both directions in line with the strut and pole. These stresses, however, tend to lever the pole out of the ground when acting in one direction, and also tend to push the strut into the ground. To prevent this, stay blocks are fitted near to the bottom of both strut and pole.

END