

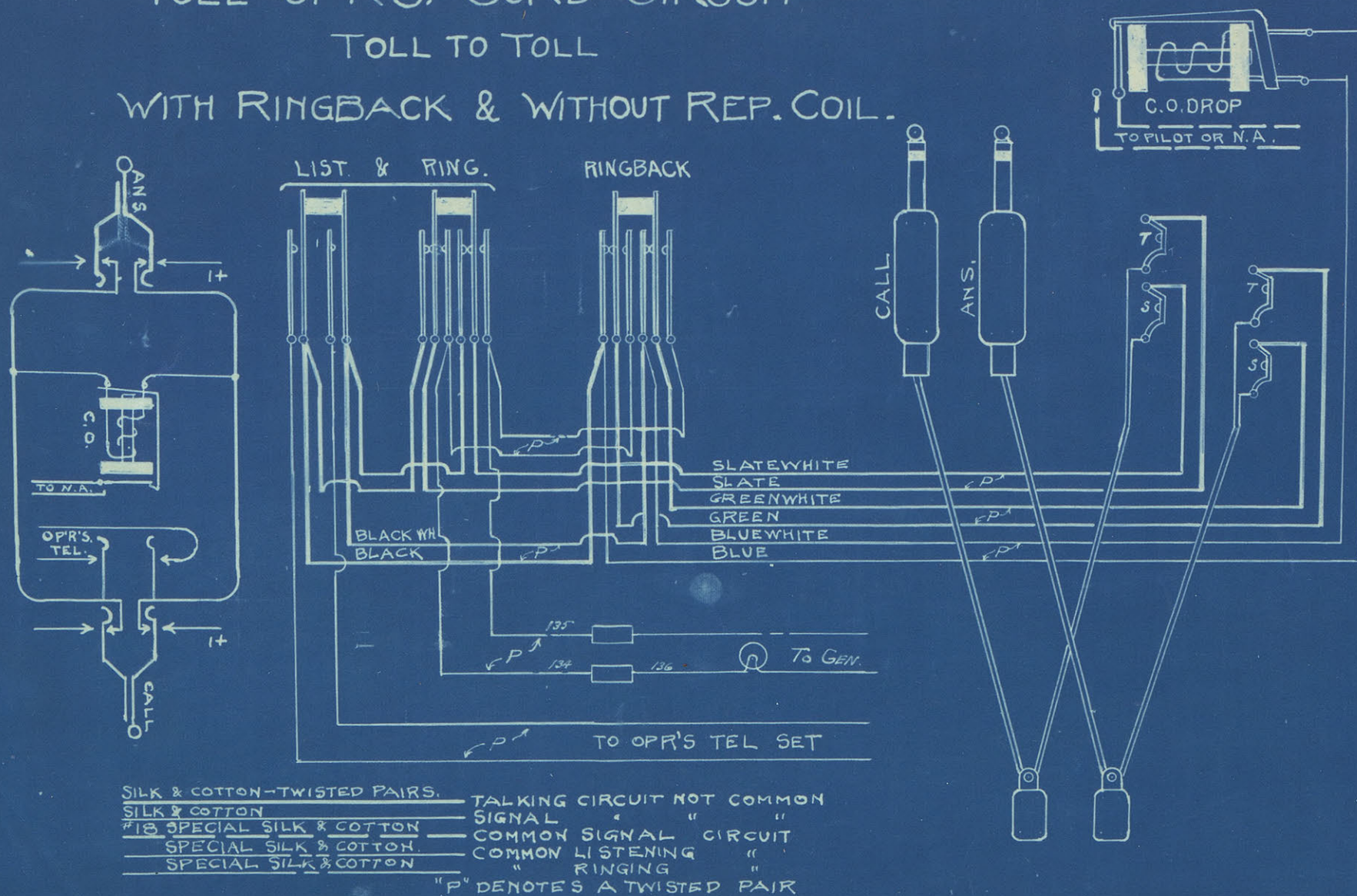
THESIS.

PLANS AND SPECIFICATIONS FOR A 500 DROP
TELEPHONE EXCHANGE.

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1906.

TOLL OP'R'S. CORD CIRCUIT TOLL TO TOLL WITH RINGBACK & WITHOUT REP.COIL.



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In telephone systems as in all other different branches of business, the materials to be used should be of the best. This is advantageous to all the persons connected with the management of the system. The better the materials the better will be the service, and the less will be the future expenses to the owner. If a larger amount of money is invested at first, in buying the best materials, the amount will soon be made up in the better service, and the lowered expense of replacement. It is, then considered to be an advantage, to buy the best grade of materials for use.

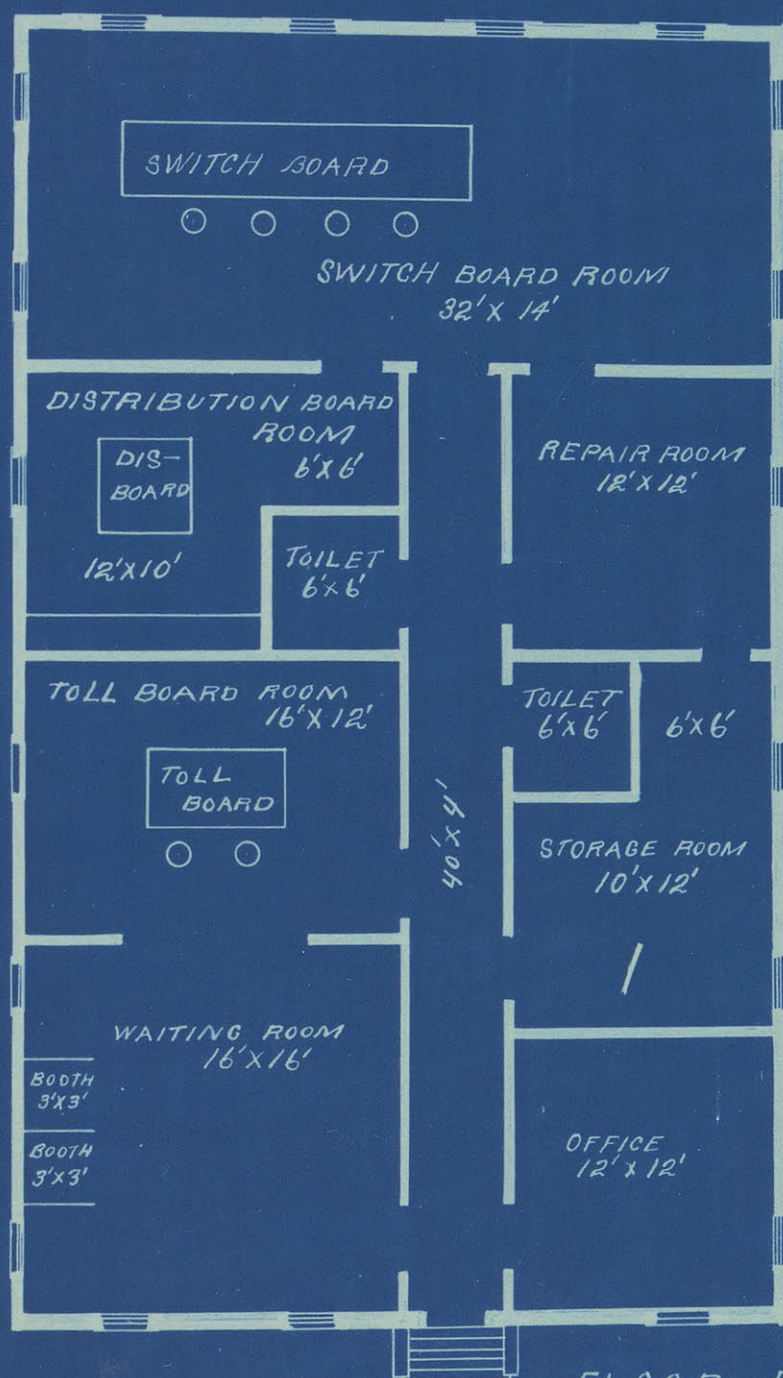
It has been the purpose of the writers to determine what types of instruments, etc., will give the most satisfaction to the owner and subscriber of the average small telephone exchange. Only such specifications have been given as are somewhat different from any of the present commercial forms. It is believed that if a system be planned embodying the special features here given, a most efficient system will be the result.

Central Station.

(a) Switch board cable and switch board wire.

(1) ,All lines running from the distributing board to the switch board shall be contained in cables of 20 regular pairs and 2 extra pairs of conductors. The wire used shall be #22 B. S. G., tinned wire, insulated by one layer of silk thread wound over each wire, and a superimposed layer of cotton thread.

The pairs shall be bound together by two layers of dry paper, over which shall be a layer of tin foil. The outside cover shall consist of two layers of heavy cotton braid



FLOOR PLAN
OF

EXCHANGE BUILDING

FIG 1

which shall be saturated with powdered soap stone and then painted. One conductor of each pair shall be covered with colored cotton thread while the other one shall be white.

A system of coloring to assist in distinguishing the pairs shall be arranged in some such manner as the following: blue, orange, green, brown, drab, blue with white threads mixed, blue and orange mixed, blue and brown, blue and slate, orange and white, orange and green, orange and brown, orange and slate, green and white, green and brown, green and slate, slate and white. The colors for the two extra pairs shall be solid red.

These cables shall not be placed in damp places or any place where water is liable to reach them.

A galvanized, water tight, iron duct of sufficient size to accommodate all of the cables which run from the distributing board to the switch board, shall be constructed and placed beneath the floor.

(b) The switch board.

The switch board shall consist of 3 sections of 200 drops each. The frame shall be constructed of structural steel and all wood work shall be of quarter sawed oak finished according to the specifications for the substation cabinets.

The plug shelf shall be covered with sole leather.

(1) Drops and jacks.

The drops and jacks shall be self restoring, self contained and mounted on an iron frame.

The drop coil shall be wound with the very best silk insulated soft drawn copper wire, and heavy fiber end pieces. A soft iron enclosing shell shall be provided around the drop

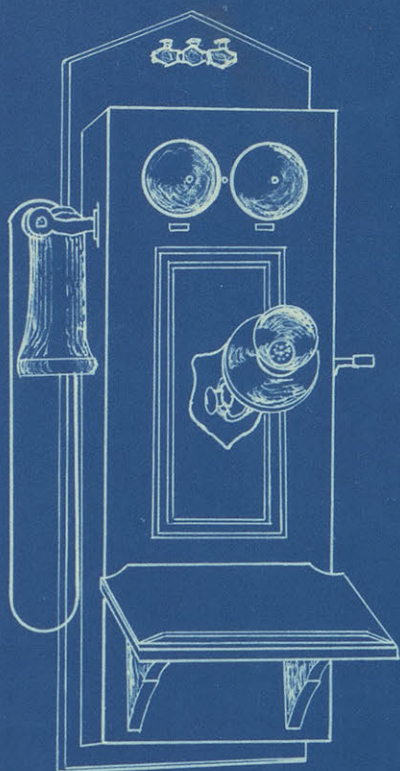


FIG 1

TELEPHONE.
WALL SET.

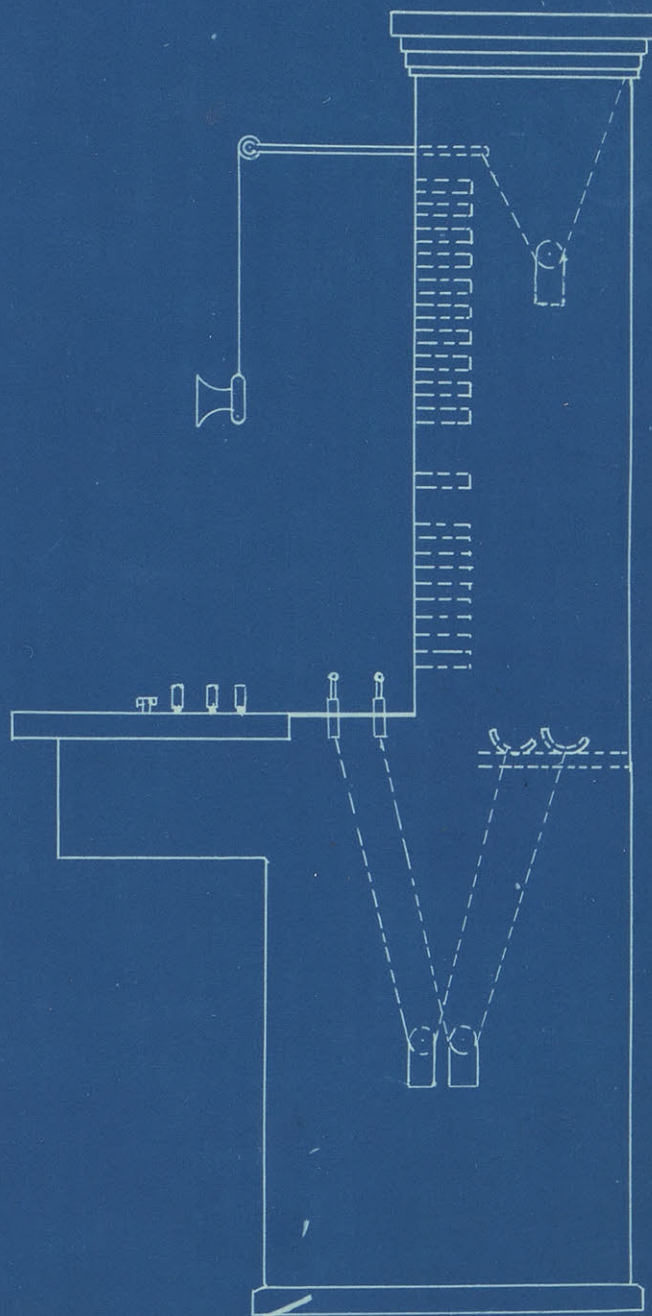


FIG 2

STANDARD SWITCH BOARD.
END VIEW.

E.W.T.
PLATE 2

coil.

The armature and shutter arm shall be copper plated.

The jack springs shall be of the best german silver, bolted to the shell of the drop with mica insulation between the springs. The two lines of springs of the jacks shall be soldered to the terminals of the drop coil.

(2) Keys.

All springs shall be of the highest grade german silver, and shall be provided with platinum points. The springs shall be mounted on a hard rubber sleeve. In all other respects they shall be essentially of either the Western Electric or Kellogg types, and shall consist of a listening, ringing and ring back key for each cord circuit.

(3) Plugs.

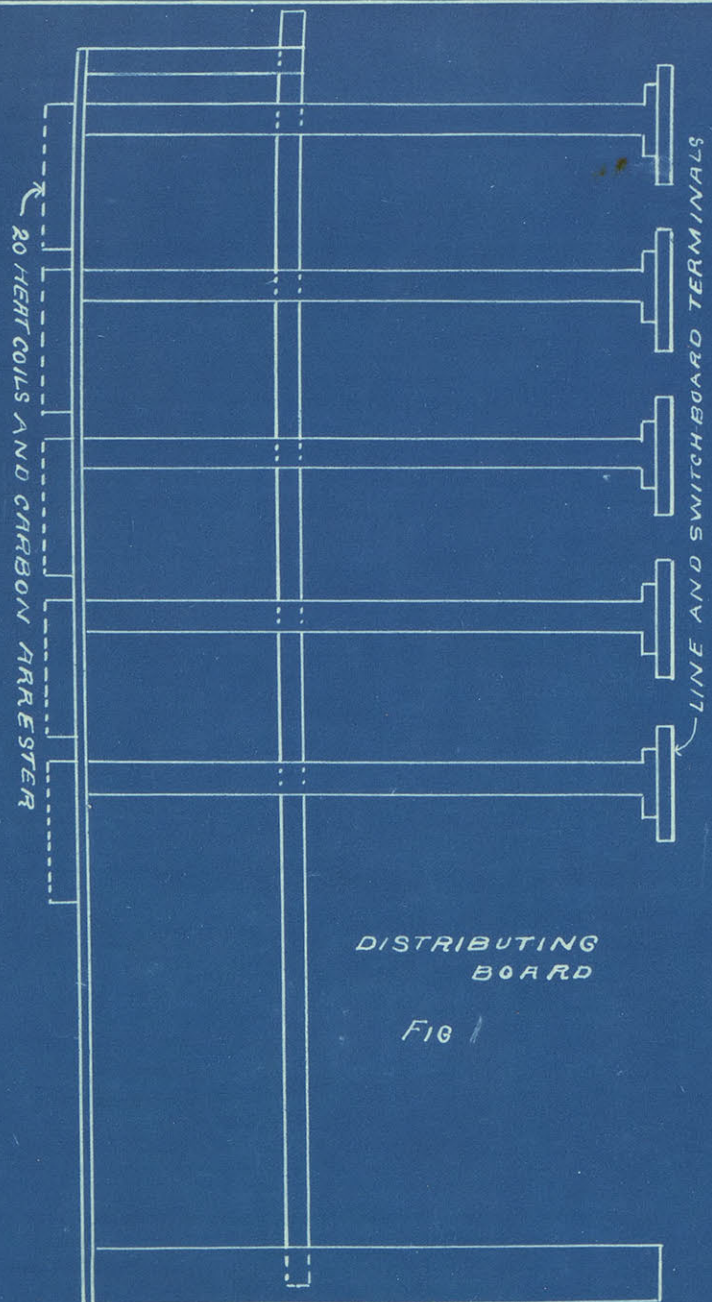
The plugs and cords shall be of the two conductor type. The cord weights shall weigh approximately 8 ounces.

(4) Operators Telephone Set.

There shall be three operators telephone sets.

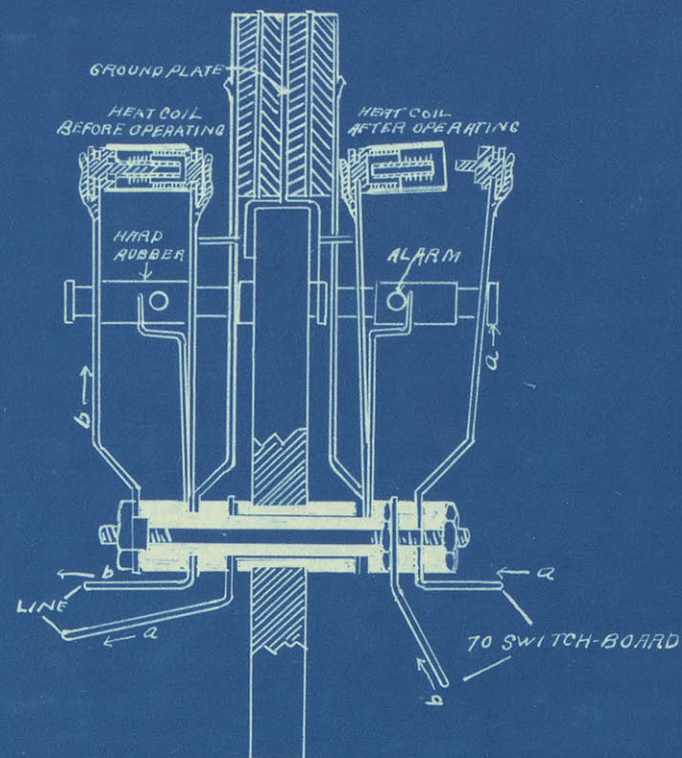
The receivers shall be of the watch case type, the permanent magnets to be of the ring type and cross magnetised. The magnets and coils shall all be mounted in a hard rubber cup or shell and the diaphragm shall be clamped between the cup and earpiece. The binding posts shall be placed within the shell.

The head band shall be made of flexible steel, covered with leather, and shall be attached to the receiver by a hinge joint. All exposed metal parts shall be carefully insulated from coils and other parts having electrical functions.



DISTRIBUTING
BOARD

Fig 1



COMBINED HEAT COIL AND
CARBON ARRESTER.

Fig 2

The conductors in the receiver cords shall be composed of tinsel, twisted with a few fine copper wires somewhat like twisted rope.

The transmitters shall be of the type as specified for wall set phones, and shall be so attached to the top of the board that they may be adjusted to any desired position by the operator.

Distributing Frame.

The distributing frame shall be made of cast iron. A single section of this frame with its line strip divided into five short strips of twenty terminals each is shown in Fig. 1. Plate 4. The line terminals and the switch board terminals are mounted on alternate vertical strips arranged on the same side of the frame. Thus when the arresters are mounted in conjunction with the switch board terminals, there are alternate vertical rows of arresters and of line terminals. The jumper wires lead from their respective terminals through iron rings to opposite side of frame. The lightning arester shall be as shown in Fig. 2, Plate 4. It shall be a combination of heat coil and carbon arrester.

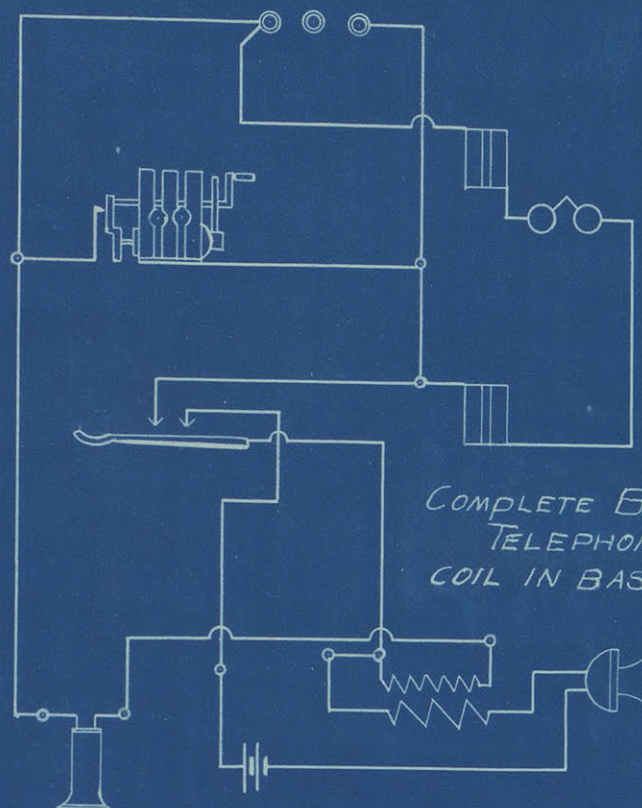
The Sub-station.

There shall be 500 phones installed which shall consist of two kinds:

- (a) Desk sets;
- (b) Wall sets;

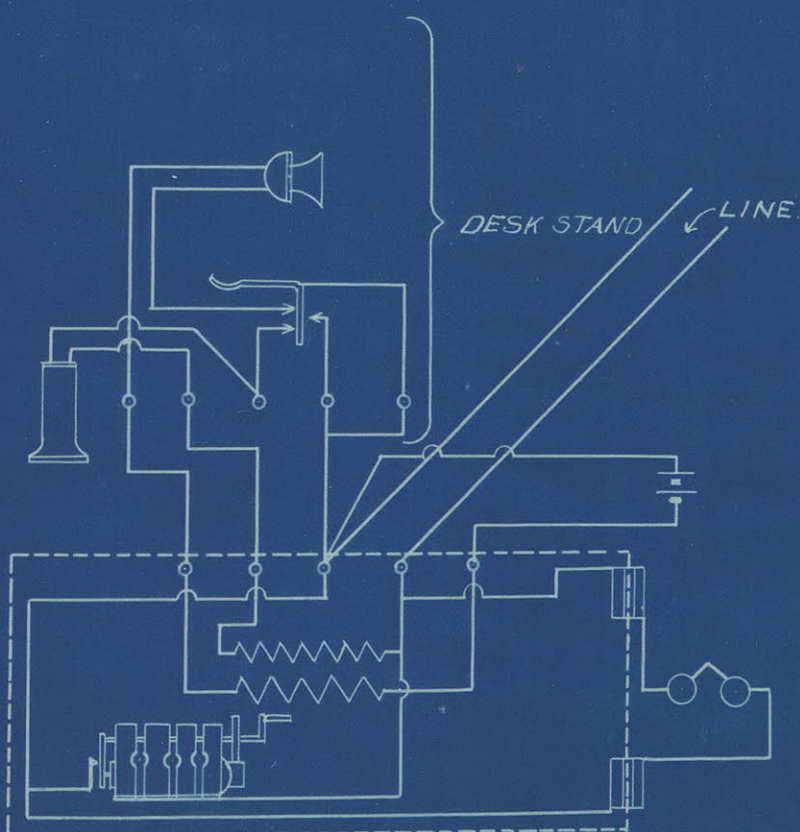
Section I.

There shall be 75 desk sets in each of which the coil shall



COMPLETE BRIDGING BELL
TELEPHONE CIRCUIT.
COIL IN BASE OF ARM.

FIG 1



BRIDGING DESK SET CIRCUIT.
COIL IN BELL BOX.

FIG 2

E.W.T.

be located in the bell box.

The telephone proper shall consist of a base, a transmitter stand, and a shell, all of which shall be so fastened together that they cannot fall apart, no matter in what position the base is laid.

(a) Desk sets.

(1) The transmitter stand shall be made of steel, surmounted by a brass knuckle in such a manner that the transmitter shall be adjustable and securely held.

The switch hook lever must be pivoted on the steel stand and be well insulated by hard rubber of the best quality.

A leather rim must be counter sunk all around the bottom of the base, so that the desk or other wood work will not be marred or scratched.

(2) All receivers shall be of the double pole all metallic type, with a hard rubber shell of the best quality. The electro-magnets shall be wound with silk covered wire and all parts insulated very thoroughly.

The ear piece shall be of hard rubber and threaded in such a manner as to hold the diaphragm in the proper position.

The diaphragm shall be of soft iron not more than 1/100 inch in thickness.

The leading in wires of the receiver shall be soldered to the binding posts and also soldered to the respective terminals of the coils on the electro-magnet.

(3) The transmitter shall be of the solid back type and shall have a bridge which shall hold the operating parts securely.

The diaphragm shall be made of aluminum, with a hard rubber enclosing pocket, suitably dampened by felt covered retaining springs.

The carbon cup shall be attached to the diaphragm and shall be sealed. The mouth piece shall be of hard rubber of the best quality.

(4) Induction Coils.

The primary winding shall consist of at least 450 turns in three layers of # 22 B. S. G. single covered silk wire of a resistance of approximately .90 ohms.

The secondary winding shall consist of at least 2,285 turns in 11 layers of # 30 B. S. G. single silk covered wire with a resistance of approximately 70 ohms.

The core shall be between 4 and 5 inches long by from $5/16$ to $7/16$ inches in diameter. The diameter of winding to be from $7/32$ to $9/32$ inches with a distance between the heads of $2\frac{1}{2}$ to $3\frac{1}{2}$ inches.

(5) The ringer shall consist of 5 permanent magnets and the armature shall be wound with # 35 B. S. G. wire to a resistance of 350 ohms.

The ringer magnets shall be wound with # 33 B. S. G. single silk covered wire to a resistance of 1000 ohms.

The generator must be able to ring twenty thousand ohm bells in multiple over a resistance of 1000 ohms between the generator and the first bell.

(6) A three conductor cord shall be used to connect the desk stand to the generator box.

(b) Wall sets.

There shall be 425 wall sets in each of which

the coil shall be located in the base of the arm.

(1) The transmitters and receivers shall be the same as those specified for the desk sets. The ringers and induction coils also shall be identically the same as those of the desk sets.

(2) The cabinet shall be made of quarter sawed oak, well seasoned and kiln-dried, tongued, grooved, and glued at the corners. It shall be well sanded before finishing and shall be finished as follows:

1st, a coat of stain;

2nd, a coat of filler;

3rd, a coat of white shellac, and

4th, two coats of rubbing varnish.

The two shelves shall be held in place by means of screws.

The wiring shall be done on the back of the cabinet in grooves, and then covered with beeswax.

There shall be two "1900 Dry Cells" with each wall and desk set.

(3) All lightning arresters shall be of the carbon block type, consisting of 2 sets of carbon blocks held between brass springs.

(4) All inside connections shall be made with # 19 B. S. G. rubber covered braided copper wire.

Aerial Lines.

(a) General Characteristics;

Aerial lines shall be embraced in three types as follows:

(a) Bracket lines;

(c) Cross arm lines;

(d) Aerial cable lines;

(b) Bracket lines are those of small capacity and the circuits are carried on brackets placed on sides of poles. This type of lines shall be limited to six wires - three being placed on each side of the pole.

(c) Cross arm lines are those using cross arms for the support of the circuit. The maximum capacity of cross arm lines shall be limited to 10 arms of 10 pins each. The total capacity will be 100 wires.

(d) Aerial cable lines shall be those which use dry core paper cables suspended by messenger strands to the poles - The no. of aerial cables shall be limited to four and the maximum size of each cable 150 wires.

(e) Material specifications.

Poles;

Guy stubs and anchor logs;

Brackets;

Cross arms;

Pins;

Insulators;

Cross arm braces;

Cross arm bolts;

Pole steps;

Guy rods;

Guy wires;

Strand clamps;

Fuses;

Copper line wire;

Tie wires;

Cables;

Conductor materials;

Insulation;

Color of insulation;

Twisting of cabling;

Sheath;

Splices;

Cable heads and the pot heads;

Hanging of cables;

(f) All poles shall be of the best quality of live green timber free from rot, sound and substantial in every respect, close and hard grained. The heart sound and firm. Every pole shall be straight. Poles shall vary in length, from 20 to 60 feet and shall have a uniform decreasing cross section from butt to top. Shall be well seasoned. All bark and soft wood shall be removed from poles. All knots trimmed and butts squared. Each pole shall have a roofed top and such number of gains for cross arms cut in each pole as may be specifically directed for pole in question. The first gain shall be 10 inches from top of pole and center of each subsequent gain shall be 24 inches below that of the preceeding one. Each gain for standard cross arms shall be 4 1/2 inches wide, and 1/2" deep. For light cross arms the gain shall be 3 3/4" wide and 1/2" deep. All gains shall be cut true and square with the axis of pole so that the cross arms will stand at right angles to the axis of the pole. Each gain shall be bored with a 11/16" hole for one 5/8" bolt. The general apperance of the poles and pole tops shall be as shown in Figures 1 and 2, Plate 5.



FIG 1 POLE ELEVATION

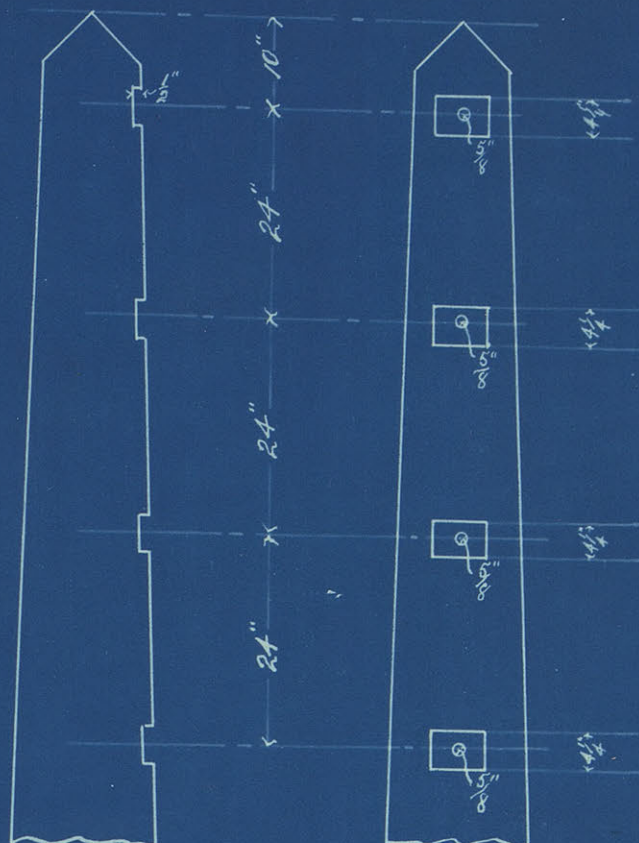


FIG 2 POLE TOP

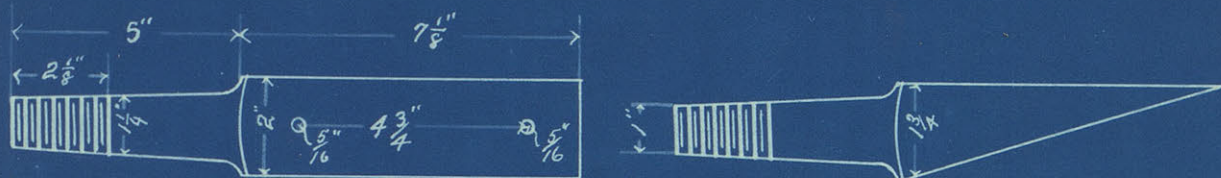


FIG 3 WOOD BRACKETS

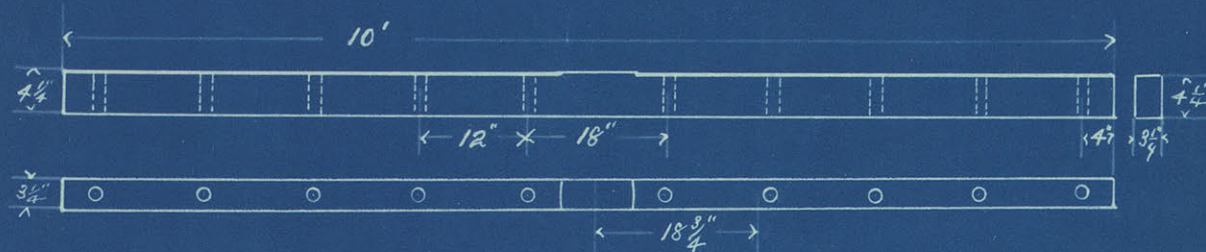


FIG 4 STANDARD CROSS ARM

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(g) Guy stubs and anchor logs.

The timber used for guy stubs and anchor logs shall correspond in all respects with the specifications for poles. Anchor logs shall not be less than 18" in circumference at the smallest point and shall be at least 3' long.

Guy stubs shall not be less than 16" in circumference at smallest end and of such length as to enable stub to extend 5' out of the earth.

(h) Wood brackets shall be used. They shall be of the general form and dimensions as shown in Fig. 3 Plate 5. They shall be made of the best quality of oak, sound and perfect. The bolt holes shall be accurately spaced and carefully bored with insulator thread perfectly and truly cut, and a good fit for standard telephone insulators.

(i) Cross arms.

There shall be three kinds of cross arms.

Standard cross arms;

Light cross arms;

Cable cross arms;

(1) Standard cross arms.

All cross arms except cable arms shall be made of thoroughly seasoned straight grained wood. The timber used shall be free from sap wood or knots which may weaken it. Every arm shall be solid, sound, and substantial. A drawing of the standard cross arm of ten pins is shown in Fig. 4, Plate 5.

(2) Light cross arms.

For light lines or those which can be erected in a protected and in exposed place it is permissible to use

1472-3
a slightly lighter arm.

(3) Cable cross arms.

The cross arms for supporting cables shall be made of angle iron. Each iron shall be fitted to carry four cables and it shall be fastened to pole 1' below lowest open wire. Iron cable arms shall consist of a piece of angle iron 3' long. The cables shall be 11" and 15" from center of pole. Each cross arm shall be furnished with four steel U-bolts.

(j) Pins;

Wooden pins shall be used. There shall be three kinds of pins.

(1) Line pins;

(2) Transposition pins;

(3) Terminal pins.

(1) Line pins.

All pins shall be made of the very best quality of thoroughly seasoned locust wood, sound, clear, free from knots, and sap wood. All pins shall be cut to the dimensions specified in Fig. 1, A, Plate 6. They shall be solid, substantial and free from cracks or other defects, and shall be fully up to all dimensions as specified.

(2) Transposition pins.

The transposition pins shall be of the form shown in Fig. 1 B, Plate 6. It shall differ from the line pin only in having the insulator thread $3 \frac{1}{4}$ " instead of $2 \frac{1}{8}$ ".

(3) Terminal Pins.

The terminal pins shall be of same form and have dimensions shown in Fig 1 C, Plate 6. It shall differ from the line pin only in the diameter of shank.

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(k) Insulators.

Insulators shall be of glass and of two kinds.

(1) Line insulators;

(2) Transposition insulators.

(1) Line insulators.

Line insulators shall be used for ordinary work.

The general form and dimensions are shown in Fig. 2B, Plate 6.

(2) Transposition insulators.

Transposition insulators shall be used where transposition is to be made. The general forms of the insulator is given with dimensions in Fig. 2 A, Plate 6. All insulators shall be made of standard white or green glass free from cracks or flaws. Screw threads shall be carefully molded and shall accurately fit the threads of the standard pins.

(1) Cross arm braces.

Front cross arm braces shall be used. They shall be placed on the same side of the pole as the cross arm and shall be made of flat iron 28" long, 1 1/4" wide, 1/4" thick and shall have 1 13/32" hole drilled 1" from one end and 1, 13/22" hole drilled 1" from the other end, as per dimensions.

(m) Cross arm bolts.

Cross arm bolts shall be of steel and supplied in two sizes, 1/2" and 5/8" in diameter. There shall be five lengths as follows: 12", 13", 15", 18" & 20" long. Each bolt shall have a thread cut on its end 4" long. All threads and nuts shall be U. S. Standard.

(n) Pole steps.

Pole steps shall be of steel, 5/8" diameter.

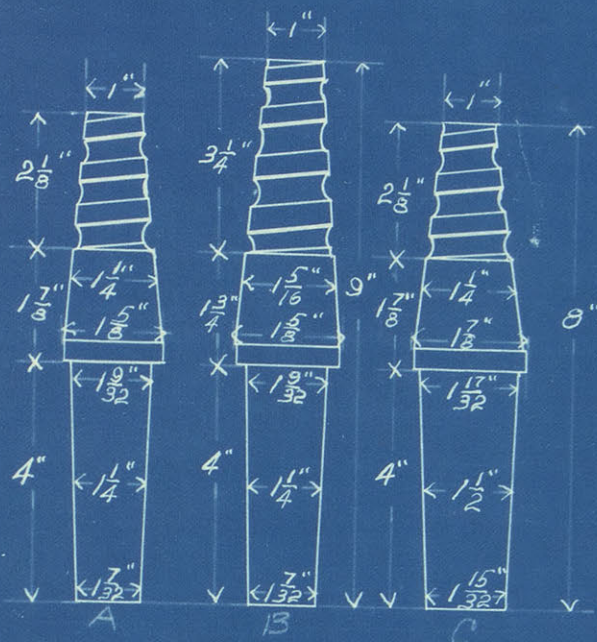


FIG. 1 WOODEN PINS.

11 THREADS
TO THE IN.

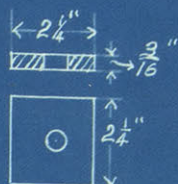


FIG. 4



FIG. 2 GUY ROD.

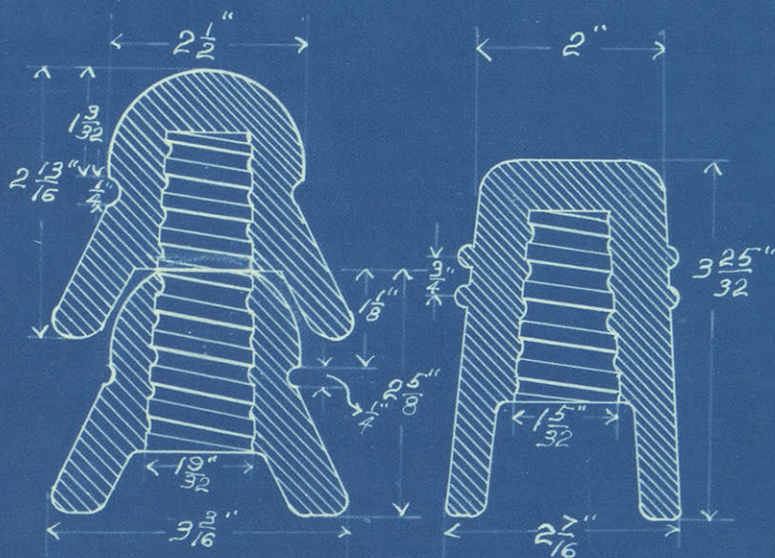


FIG. 2 INSULATORS.

144 3
10" long over all, turned up for 1 1/2" at outer end and provided with a lag bolt thread for 3" on the other end.

(o) Guy rods.

Guy rods shall be made of wrought iron or mild steel. They shall be 5/8" in diameter, 18" to 60" long over all. The rod is furnished with an eye welded at one end, U. S. Standard thread and nut at other end, and shall be of dimensions as per Fig. 3, Plate 6. Each guy rod shall be supplied with an iron washer as shown in Fig. 4, Plate 6.

(p) Guy wires.

All guys from end of the guy rod to the pole shall be made of first class quality wire rope. Every strand shall contain at least seven wires.

(q) Strand clamps.

Strand clamps shall be of two sizes. The two-bolt and the three-bolt clamp. The two-bolt clamps shall be used for 1/4" strands only; three-bolt clamps for all strands over 1/4". All clamps shall be of the best quality of malleable iron or soft steel castings. The clamp groove shall match the strand specified in section 13.

(r) Fuses.

Line fuses shall be of the general type. Clamps shall be capable of being attached to any wire between 5 and 12 B & S. Fuses shall blow at 3, 5 & 7 amperes. Each fuse shall be plainly marked with its capacity. The fuse gap shall be not less than 3'. The fuse case shall be of water proof material and each terminal provided with locked nuts.

(s) Copper line wire.

All copper line wire shall be hard drawn. It shall be cylindrical in section, uniform in quality, smooth surfaced, free from all die marks, scales, splits, flaws, etc. All wire shall be full in section, and shall not vary more than .001" on either side of the diameter specified and the weights shall not vary more than 3 1/2 per cent on either side of the weight specified. The conduction of all wire shall be at least 97 per cent of Matherson's standard.

(t) Tie wires.

Tie wires shall be of same size and material as the line wires they are to secure and shall be made of wire that is carefully annealed. The lengths of the wires shall be as follows:

.08	.16
.104	.19
.165	.22

(u) Cables.

The cables shall be the "Patterson, Dry core" or "Paper cable". Each piece shall consist of a certain number of copper wires, each one insulated from all others by a loose wrapping of paper. The wires shall be twisted together in pairs. A sufficient number of pairs shall be provided to aggregate the total number required in each size of cable and shall be twisted together or 'cabled' into a rope or "core". This core shall be inclosed in a lead pipe. The cables shall be to connect subscribers to central office. They shall be strung on cable cross arms on the poles.

(v) Conductor material.

All conductors for all cables shall be of first class soft

1415 3
drawn copper wire. The wire shall be true and round. Each size of wire shall be capable of standing not less than sixty twists in a length of two inches.

(w) Insulation.

Each conductor shall be insulated from all other conductors by a continuous wrap of paper. The paper shall be of first class quality and shall be four mils in thickness.

(a^m) Color of insulation.

One pair of wires in each cable shall have one conductor covered with paper colored blue and the other insulated with paper colored white or gray. All of the remaining pairs shall have the insulation of one wire colored red and the other colored white or gray. The blue paper is to designate the test pair of wires.

(x) Twisting of cables.

Each pair of conductors shall be twisted together in such a manner that the length of the twist shall not exceed 3" for wire # 19 guage, or over 6" for wire # 17 to # 19 guage, and 14" for wires of # 10 to # 14 guage. All pairs shall then be formed into a cylindrical core, arranged in inalternately reversed layers and spiraled about the central pair with a twist, not to exceed one turn in 24".

(y) Sheath.

The core of each cable shall be inclosed in a pipe made of pure lead and after the core is inclosed the cable shall be passed through a bath of melted tin, so applied as to give the exterior a continuous and uniform coating of tin. On completion the sheath shall be absolutely tight and free from

147 3
all cracks, blow holes, pin holes, or other defects.

(z) Splices.

To join two pieces of cable the sheath is stripped away from each end for 18 or 24". Then a piece of lead pipe an inch or an inch and one half larger than the cable and about 2' long is slipped partly over one of the cables. The paper from individual wires is then stripped off and each wire in one cable twisted to its proper mate in the other. The wire joint being protected by a paper sleeve. When all the pairs are then connected the lead sleeve is slipped over the splice and one end "wiped" on the sheath of the cable, the splice is then "boiled" out by being immersed in boiling paraffine for some little time, after which the remaining end of the sleeve is wiped on the sheath of the other cable and the splice is complete.

(a') Cable heads and the pot head.

The cable head consists of an air tight box or receptacle, to which the sheath of the cable may be soldered and inside of which the circuit is fanned out and attached to pins or studs extending through the sides of the box. Thus affording exterior connections to each cable wire. After the cable sheath is attached to the head and the wires connected to the terminals the head is sealed up. Where cables run into open wire lines the head must be placed on the line poles as close as possible to the cross arms and the pins of the head connected to the open wires of the aerial lines by short lengths of rubber covered wire called "Bridle wires" or pumpers. There shall be placed between the cable head and open wire a fuse and lightning arrester to guard from atmospheric electricity

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3
and accidental crosses with other electric wires.

(a'') Hanging cables.

Wire rope $3/8$ " to $5/8$ " in diameter called a "messenger wire" or "strand" shall be attached to poles as an ordinary open wire line, and the cable shall be attached at frequent intervals as often as 18" to 2'. They shall hang from an angle cross arm.