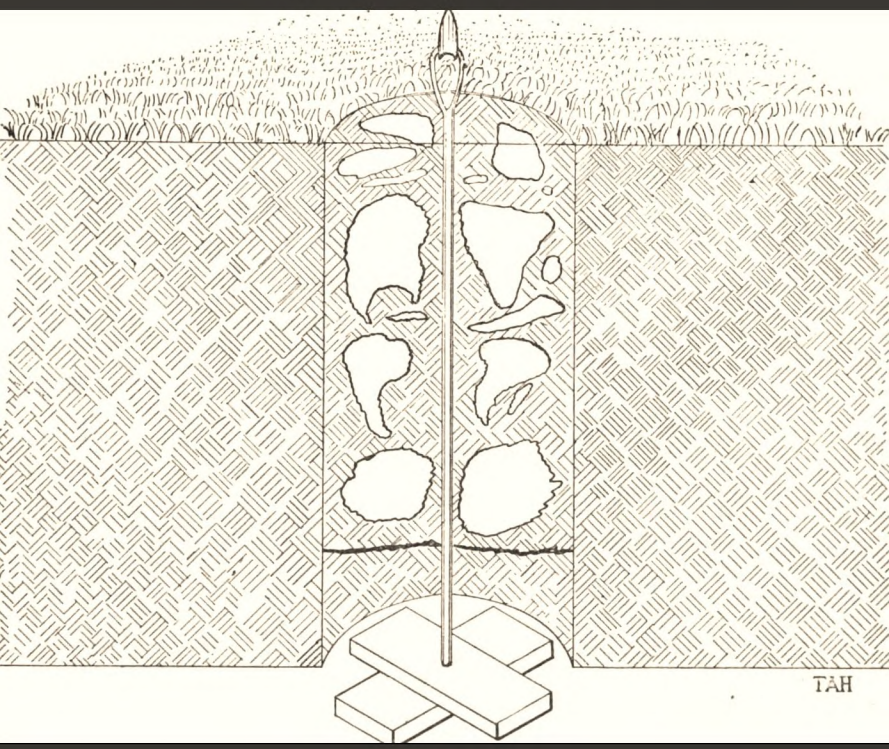
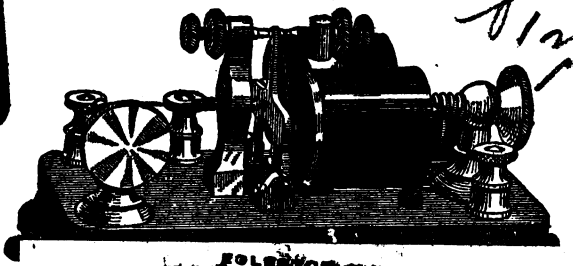


Official diagrams of the Postal-Telegraph Cable ...

Postal Telegraph-Cable Company,
John F. Skirrow



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Manufact ph Apparatus

20 PAR EW YORK

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TELEGRAPH AGE
253 Broadway, New York

OFFICIAL DIAGRAMS

OF THE

Postal Telegraph-Cable Company's

Apparatus

AND

RULES GOVERNING THE CONSTRUCTION AND REPAIR OF LINES.

The official numbering of the sketches and diagrams by the Postal Telegraph-Cable Company have been retained in this publication.

PUBLISHED BY TELEGRAPH AGE,

253 Broadway, New York

PREFACE.

Under authority of Mr. William H. Baker, vice-president and general manager of the Postal Telegraph-Cable Company, New York, this unique work is publicly presented. It has been prepared under the immediate supervision of Mr. John F. Skirrow, associate electrical engineer of the company. It contains the official diagrams of telegraph apparatus and descriptions of the same, used by the Postal Telegraph-Cable Company. The diagrams were made from the official blue prints, and are therefore absolutely accurate.

The book also contains the rules governing the construction and repair of telegraph lines; rules governing the splicing of submarine, underground and aerial cables; rules governing the wiring of offices, and the care of dynamos and batteries Valuable tables of wires and resistances are also given.

The book offers an extremely valuable source of information, such as to be of practical advantage in promoting the study of every part of the Postal equipment.

J. B. TALTAVALL, Publisher.

New York, February 1, 1906.

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INDEX TO DIAGRAMS.

RULES GOVERNING CONSTRUCTION AND REPAIR OF TELEGRAPH LINES

1st—After a route has been selected by the proper officials and material shipped to distributing points, the first duty of the foreman will be to carefully check up all material from invoices furnished him by the office of his superintendent, after which he will sign and return said invoices to his superintendent without delay, reporting if any shortage is found.

2d—The foreman will consult his superintendent regarding the number of men that he shall employ on each piece of work and also rates of salary to be paid the men. Each foreman will be allowed to select his assistant, who must be competent in all branches of construction and repair work, and a person acceptable to his superintendent.

3d—Where camp cars are used the foreman will be held strictly accountable for the governing of the camp, the expenses thereof, and the behavior of the men occupying such camp. He will purchase all supplies for the commissariat, forwarding receipted bills for same with his regular monthly report. New equipment or repairs where the expense will exceed $10 must be referred to his superintendent for his approval before such expenditure is made, if possible. Where men are kept in one place for one week or more, a weekly rate should be secured and wherever possible it is advisable to secure a contract covering the boarding of the men, as follows: "I hereby agree to board foreman ——— ——— and his men at the rate of ——— per meal and ——— per lodging while they remain at my house." Forms for this purpose will be furnished on application.

4th---The foreman will be held strictly responsible for the care and protection of all the company's property in his charge, including teams, tools, material and camp equipment.

5th—The foreman will make requisition on his superintendent for the necessary funds to settle all bills before moving to a new location.

6th—At the close of each day's work the foreman will fill out and mail daily report card to his superintendent. On or before the 4th day of each month he will make up and forward by registered mail or express, his report for the previous month.

7th—The minimum depth that poles shall be set beneath the surface of ordinary firm earth is as follows:

25-foot poles.....	5 feet	50-foot poles.....	7 feet
30-foot poles.....	5 feet	55-foot poles.....	7 feet
35-foot poles.....	5½ feet	60-foot poles.....	8 feet
40-foot poles.....	6 feet	65-foot poles.....	8 feet
45-foot poles.....	6 feet		

When rock is encountered at the surface and is of a good, firm nature, 25-foot and 30-foot poles should be set 4 feet deep; 35-foot poles 4½ feet; 40-foot and 45-foot poles 5 feet; 50-foot and 55-foot poles 6 feet; 60-foot and 65-foot poles 7 feet deep. Where rock is encountered from 1 to 2 feet below the surface, 6 inches should be added to the depth for poles ranging between 25 feet and 45 feet, and 1 foot for poles ranging from 50 feet to 65 feet; 25-foot poles may be set 4½ feet deep where frost does not exceed a depth of 1 foot. All holes must be dug large enough to permit the use of 3 tampers to one shovel in packing in the filling, after which, soil shall be banked around the pole at least 1 foot above the surface. Stone should be used in keying the butt of poles when possible. Where the ground is soft or water is encountered in sufficient quantities to prevent proper tamping, pole braces or anchors and guys should be used. When extraordinary conditions exist, the superintendent of construction should be consulted before proceeding with the work.

8th—Gains for cross-arms shall be cut just deep enough to make a flat surface on the face of the pole and should not exceed ¾ of an inch in depth on poles that are 8 inches or less in diameter at the top. One pair of cross-arm brackets should be used on each arm, the braces to be fastened to the back of the arm. Four inches of the tops of poles shall be used for the roof, and care must be taken to get the apex of the roof in the center of the pole and at right angles with the cross-arms. The top of the first gain will be placed 8 inches from the apex of the pole, and each additional cross-arm will be placed 2 feet between centers. In all new work there should be 1 or more extra gains cut in each pole. The holes for center-bolts in these extra gains cut, will be bored unless otherwise ordered. Where sawed poles are used no gains will be cut; arms will be attached to poles by a center-bolt with nut on face of arm.

9th—In places where the ground is uneven the line should be graded as far as practicable by using the longer poles in the low places and the shorter poles at high points, but in no case should a pole be set on a high point too short to clear the wires of the bottom gain 12 feet above the ground. Poles must be so located as to leave a free passageway to all bars and gateways, barn doors, and so forth.

10th—A lightning rod of No. 8 iron wire shall be securely attached to every 5th pole with 1½-inch staples. The rod shall extend from 3 inches above the top of the pole to within 1 foot of the butt, where 4 spiral turns will be made around the pole and a hand coil of about 6 feet fastened to the bottom.

All office and cable poles will be equipped in the same manner, except two No. 8 iron wires shall be used. In all exposed places such as office poles or adjacent to private or schoolhouses, stores, etc., the lightning rod wire must be driven well into the pole and covered by a strip of board about 3 inches wide and 8 feet long to prevent danger of coming in contact with it during lightning storms.

11th—Cable, office and all painted poles shall be equipped with standard pole steps, unless otherwise ordered. The bot-

tom step shall be on the sidewalk side of the pole, and the lowest step on the street side of the pole shall be not less than 8½ feet from the curb, the steps to be three feet apart alternately, making an 18-inch tread, except where city laws require them to be placed on the front and back of the pole, straight with the curb line.

12th—Holes for 6-feet anchor rods should be dug not less than 5½ feet deep and 2 feet in diameter from the top to the extreme bottom. The slugs or planks through which the anchor rod passes should be two pieces of timber 24 inches long, 12 inches wide and 3 inches thick. These should be split or hewn from the butt of an old pole or other good, sound timber, and a ⅝ hole bored through the center of each, passing the anchor rod through and placing the washer on the bottom and turning the nut up the extreme length of the thread on the rod. When placed in the hole the pieces of plank or slug should be placed at right angles with each other, and the anchor rod set in direct line with the lead of the guy, after which the earth shall be thoroughly tamped with 3 tampers to 1 shovel until the hole is filled to the surface. (See Sketch No. 1.)

13th—Rock anchors should be used only where the rock is of a good firm nature. Where the rock is level with the surface, a hole should be drilled not less than 10 inches deep, and in it placed a rock anchor 12 inches long. Where rock is encountered under the surface, the holes should be drilled the same depth in the rock and 2 or 3-feet anchor rods should be used, according to the depth of the rock below the surface. The eye of the anchor in all cases should project at least 2 inches above the surface.

14th—On heavy corners the corner pole and the 1st pole each way from the corner should be double-armed, and if 4 or more cross-arms are carried, two 6-foot anchor rods should be placed not less than 5 feet 6 inches deep and not less than 20 feet ahead of the double-armed pole and in a straight line with the poles, one guy to be attached close under the top cross-arm and 1 close under the 3d cross-arm. The number of strands of guy wire should be determined according to the weight of the straight line that they are intended to hold. One or more anchor rods should be placed not less than 8 feet from the corner pole and not less than 5½ feet deep, from which a guy should be extended to a point close under the top cross-arm. (See Sketch No. 2.) Square road crossing should be treated in practically the same manner. (See Sketch No. 3.) On long straight lines every 15th pole should be double-armed and head and back guyed according to Sketch No. 4. Lines carrying 1, 2 and 3 cross-arms should be treated the same as heavier lines except that 1 anchor rod instead of 2 should be used. (See Sketch No. 5.) Where necessary to extend guys across to the opposite side of the road, a guy pole should be set not less than 5 feet deep and not smaller than the 7-inch specifications of poles, and should extend to a sufficient height to clear the guy at least 18 feet above the road bed. Each guy stub should be anchored to 1 or more anchor rods, according to the strain that it is required

to hold. (See Sketch No. 6.) Guy wires should be wrapped twice around the pole and fastened with a 3-bolt clamp—a clamp will also be used in attaching the guy to the anchor. All guys running to anchors in exposed places should be protected by a guard of wood or iron pipe.

15th—Foremen will be advised when starting each piece of new line or reconstruction as to the number of poles to be set to the mile. The 1st and 2d poles from the corner must not be set to exceed 75 and 100 feet, respectively, from the corner pole, and as much closer as necessity may require, which in all cases should be determined by the weight of the line and the side strain of the corner pole.

16th—All special fixtures required shall be submitted to the superintendent of construction for his consideration and approval of the article desired. Whenever practicable a drawing should accompany the requisition for such fixtures.

17th—The necessity for double-arming and head-guying poles adjacent to the corner pole should be determined by the amount of side strain on the corner pole, which may be determined by measuring the distance that the corner pole is out of line with the poles on either side of it. If the corner pole is found to be 10 feet or more out of line the poles on either side should be double-armed and head-guyed. Corner poles should be so located that the wires will not turn at an angle of less than 157½ degrees, or a side strain of about 18 feet on 1 pole. See Sketch No. 7, showing the angles by degrees and location of poles. Facing a heavy corner 1 pole back of the double-arm pole each way should be set with the arms facing the corner, and in all other places the arms should be faced alternately. On slight curves side guys should be placed, using anchors wherever practicable. Where it becomes necessary to use tree guys, a lag bolt should be placed in the tree well around to the back, and good substantial blocks placed between the guy wire and the tree to prevent the wire from injuring the bark. Wooden braces should not be used to support corner poles.

18th—To protect working wires from foreign circuits crossing over the top at right angles, two guard wires should be placed according to Sketch No. 8. Poles No. 1 and No. 2 should be 1 foot longer and poles No. 3 and No. 4 should be 2 feet longer than the poles on either side marked O. The two guard wires, as shown in Sketch No. 8, should be of No. 8 iron wire, both of which should extend to and be thoroughly wrapped around poles marked O. The cross-arms used to support the guard wires on poles No. 3 and No. 4 should correspond with the arms which carry the working wires, but should be equipped only with the end pins and braces.

19th—At all river crossings with spans of 200 to 400 feet, poles on either side should be equipped with double arms. River spans from 400 to 1,000 feet or more, two poles should be set in a parallel on either side a reasonably safe distance back from the ordinary water line and double cross-arms of a special make should be placed on these poles. The arms should be of 4 by 5 good, seasoned pine lumber and 12 feet in length. The gains

on these poles should be cut 3 feet between centers and the pins placed at equal distances, according to the number of pins required in each arm, not exceeding 8 pins to the arm, the object of these special arms being to spread the wires a safe distance apart. All river crossing poles should be thoroughly guyed back on the line and also on the upper side of the line, in order to hold the poles to their proper position when the flow of current, ice, etc., strikes them. (See Sketch No. 9.)

20th—At all railroad crossings the poles at either side should be double-armed, and of such height as to allow the arm in the bottom gain to carry the wires at least 27 feet above the rail, unless otherwise required by law or by the railroad company's regulations.

21st—Where choice fruit trees are encountered, poles of sufficient length should be set to carry the wires over them without seriously damaging the trees by trimming. Shade trees located near a residence should be trimmed very carefully, using a saw for taking off the large limbs and pruning shears for the light trimming. It is always desirable to trim shade trees from the bottom, thereby enabling the wires to be carried on short poles under the limbs and allowing the tree to grow and spread above the wires. Whenever possible, limbs should be taken off on all sides of the tree, thereby leaving it symmetrical. Employees desiring to trim shade or fruit trees should always endeavor to see the property owner and explain to him that we do not wish to injure such trees by trimming more than is necessary. This rule should be followed in all cases, even where the right of way and trimming privileges have been paid for, as it aids greatly in securing and holding the good-will of property owners. In all cases where trimming is done in front of improved property the limbs and brush should be carefully gathered up and carried away and piled up in some place suitable for depositing rubbish, or burned. In no case should a hand axe be used in taking off limbs of any kind of a tree, as it usually leaves the remainder of the tree ragged and unsightly.

22d—When brush or other rubbish is burned, the foreman must see that the embers are completely extinguished before leaving the place. All broken and discarded glass, fragments of guy wire, etc., which are worthless, must be carefully gathered up and buried. All old poles and cross-arms which are discarded must be taken from the highway, either by the abutting property owners who want them or by the foreman before leaving that locality. Open holes must be carefully covered up or properly protected before leaving them.

23d—Hard drawn copper wire must be handled very carefully to prevent short bends or kinks and nicks or abrasions of the wire, and teams or vehicles must not be allowed to pass over it when stretched along the ground preparatory to placing it on the poles, and it must never be thrown from a moving train. All joints must be made with McIntyre sleeves. In making this joint pass each end of the wire through the sleeve until it extends ¼ of an inch beyond the end of the sleeve, then place a steel tie wrench or connectors on each end of the sleeve, the outside of

the tool to be at least ¼ of an inch from the end of the sleeve, after which three complete turns should be made, using great care to keep the sleeve absolutely straight. This joint requires the use of no solder. Sleeves of the proper size to fit the different gauges of wire will be furnished on requisition and must be used in every case. In tying copper wire to insulator, place the tie wire in groove in back of the insulator, and bring the two ends forward in front, crossing them; now put the line wire over the cross in the tie wire, and complete the tie by giving four or more complete spiral turns, using up each end of the tie wire. (See Sketch No. 10.)

24th—In tying iron wire place the tie wire, which should be No. 8 gauge 14 inches long, in the groove of the insulator, place the line wire on top of the tie wire, and give each end of the tie wire 1½ turns around the line wire. All joints in iron wire must be soldered thoroughly.

25th—Wires on straight lines must be tied on the inside of the insulator, or the side nearest to the pole, except on curves or corners, where it must be tied so that the strain will be against the insulator.

26th—The following table shows in inches the sag of wires between poles at the different temperatures:

Temp.	Span 75 ft.	Span 100 ft.	Span 115 ft.	Span 130 ft.	Span 150 ft.
0	1	2	2	3	4
20	2½	4	4	5	6
40	4	6	6	7	8
60	5½	8	8	9	10
80	7	10	10	11	12
100	8½	12	12	13	14

27th—All aerial cables must be suspended on a messenger wire by the use of standard cable hooks or a spinning-jenny. When cable hooks are used they should be securely fastened to the cable with marline at equal distances of 18 inches apart, after which the hooks are placed on the messenger wire and closed up by the use of pliers or connectors to prevent them from becoming unhooked. The foreman will consult his superintendent regarding the standard method of tying hooks to the cable. For hanging cable with spinning-jenny the best quality of 3-ply marline or hambroline should be used and should be greased before being wound on the jenny. A piece of raw tallow thoroughly rubbed over the marline is very satisfactory and enables it to pay out freely and smoothly when the jenny is being drawn over the messenger wire and cable. The messenger wire must be securely attached to the side of the poles by the Hallet cable hangers or others equally as good, or by a jay-bolt attached to the cross-arms. (See Sketch No. 11.) On the outside of buildings porcelain knobs must be used for securing cables to the walls, ceilings, etc. Porcelain or some other material approved by the electrical department must be used where cables enter buildings or pass through walls or partitions. Wire

staples or wooden cleats of any description must not be used for fastening cables or wires to the walls. Standard cable boxes approved by the electrical department will be used. (See Sketch No. 12.) No. 14 B. & S. braided wire, as specified by the electrical department, must be used for connections between the main line and cable boxes, and such connections must be soldered to the main line. Acids must not be used on copper wire. A suitable soldering flux will be furnished on application. All cables should be connected up by tracer, and the numbering must be consecutive whether one or more cables are used. A 3-inch sample of each piece of new cable must be sent to the superintendent of construction promptly, giving exact length of cable used in each place and the number of conductors.

28th—The foreman will ask his superintendent for disposition of cable reels as soon as they are empty.

29th—Foremen are expected to report defective material and tools to their superintendent by letter, stating anything that they may know which will be of interest or advantage, and whenever practicable will send a sample with their communication.

30th—Foremen must bear in mind that it takes time to fill requisitions. Material or tools should not be ordered by telegraph except in cases of emergency.

31st—When fences have been disturbed or destroyed, the foreman will see that they are properly replaced without delay.

32d—When shipping material by freight, foremen are expected to take a regular bill of lading, showing number of cases or packages, and will forward same to the person to whom shipment is made, unless otherwise instructed.

33d—In case a foreman has reason to believe a serious storm has passed over the territory adjacent to his work, he will, if possible, put himself in communication with the nearest district superintendent or wire chief and follow his instructions, advising the superintendent of construction at the first opportunity as to movements of gang. Should the foreman be entirely cut off by wire trouble, he will exercise his best judgment as to disposition of his men for the purpose of restoring communication.

34th—Reports should be made at once by wire to the superintendent whenever a person is injured, and prompt attention should be given to the injured one, so far as the actual necessities are concerned. If instructed to continue the salary during disability, you should send the salary and expense vouchers to your superintendent for reimbursement by the legal department. Time allowed on account of injuries should be separated from the allowance for time during which work was performed. Foremen should send as early as practicable full details of any accident, including in addition to expense incurred:

1—Full name and residence of person injured.
2—Age and occupation.
3—Date, hour and place of accident.
4—The cause. (Give full particulars.)
5—How long in the service of the company.
6—Married or single.
7—His capabilities in the service.

8—If married, names and residence of wife and children. Names of parents or nearest relatives.

9—Nature and extent of injuries to be given as fully as possible.

10—What was done with him and for him.

11—Full name and address of physician who rendered first attention, accompanied by his written statement of the case, whenever possible.

12—Present address of injured person.

13—Prospect of recovery.

14—Full names and addresses of all eye-witnesses, with full-statement in writing from each witness, whenever possible.

15—Statement from other parties in gang who did not see the accident, to the effect that they did not witness it.

16—Condition of tools and material at the time of the accident. If material and tools are defective, ask for disposition of same.

17—Statement of the injured person as to cause of the accident, and the extent of his injuries. If his statement can not be secured, give reason why or his reason for refusing to make a statement.

Promises should not be made to continue the salary or hospital expenses until the injured person is able to return to work, or for any other indefinite period.

No definite promises of any character should be made.

STANDARD TOOLS.

Axes, Chopping, No. 6 (pole axe).
" Hand, No. 4 (both edges beveled).
" Handles.

Augers, Post, 15-inch.
Blocks, Pulley.
" 4-inch.
" 5-inch.
" 8-inch.
" 10-inch.
" Snatch, 8-inch.
" " 10-inch
} Anvil brand or their equal wood.

Belts, Tool (Klein's 383A), or their equal.
Bars, Digging, 1⅛ inches by 9 feet, octagonal steel.
Braces, Ratchet.
" Drill.
Boxes, Tool (Purchasing order).
Bags, " Canvas (Klein's 393A), or their equal.
" " Leather (W. E. Co.), or their equal.
Blow Torches (Klein's 457 Hot Blast), or their equal.
Bits, Irwin.
" Extension.
Cant Hooks (Klein's 399) or their equal.
Carry " 5 and 7 feet (Klein's 406 and 408), or their equal.
Clamps (Haven's Nos. 368 and 369), or their equal.
" (Buffalo Nos. 1 and 2), or their equal.
" American (Klein's 359), or their equal.

Climbers (Klein's 382), 16 and 18-inch, or their equal.
Chisels, 2-inch framing.
" 3-inch slick.
Connectors (Klein's 309, 303 and 307B), or their equal.
Cutters (Pipe).
Drawing Knives, 18-inch.
Drills, Rock. 3, 5 and 7 feet long.
" 1⅛-inch Black Diamond steel.
Files, Bastard, 12-inch.
Files, Saw (triangular), 6-inch.
Grindstones (No. 15 stone), with frame.
Hammers, Drill No. 6, double-faced.
" " " 8, "
" Claw.
Hooks, bush.
Ladders, extension.
" step.
Ladle, Ulich, for tight wire.
Pike poles, 12 ft.
" " 14 "
" " 16 "
" " 18 "
" " 20 "
" " 22 "
" butting or dead man.
Pliers, 5, 7, 8-inch.
Pole trucks.
Padlocks.
Planes (jack and smoothing).
Pumps.
Raising crutch (Klein's 3940), or their equal.
Rope, ⅜, ½, ¾ and 1-inch manila.
Reels, stringing (Klein's 385), or their equal.
" coiling (" 387), " " "
Stencil plate, sample attached.
Straps, climbers.
" reel (new style).
" jack.
Saws, No. 7, 22-inch.
" hack, 12-inch.
Saw sets (Sterling, 12-inch).
Screwdrivers, 6, 12 and 18-inch over all.
Shovels, 9-ft. handles (H. S. & B., Chicago), or their equal.
Spoons, 9-ft. handles.
Soldering Furnaces, }
" Bowls, }
" Ladles, } (Kelly & Co.), or their equal, Chgo.
" Irons, }
Squares, 2 ft.
Stencils, P. T.-C. Co., Post No Bills.
Shears, trimming (Klein's 394), pole or their equal.
" " Hand.

Tape Lines, 50 feet (Chesterman), or their equal.
" " 100 " " " " "
Tampers, Wood handles, 8 feet (Klein's 397), or their equal.
" Iron " 8 " (" 398), " " "
Wrenches, Monkey, 12-inch.
" Bolt (Klein's 326), or their equal.
" Tie (" 320), " " "
" Splicing (Klein's 321), or their equal.
" Pipe.
Water Kegs (20-gal.).

SUBMARINE CABLE SPLICES.

Turn back the armor strands in the usual way and lash the cable ends in proper position for splicing, making sure of proper alignment. When this is done the conductors are ready to be spliced. Lay a conductor of one cable end against a corresponding conductor of the other, draw out all slack so that they lay side by side and parallel, now cut in about the center of the splice to be, both conductors with one cut of the pliers. This will leave the conductors at just the desired length; that is, so the ends just meet, no more and no less. Now trim back the insulation on these ends and bevel the rubber in very much the same way as a pencil is sharpened, leaving one inch of the copper conductor exposed. Untwist the strands and clean each separately, exercising care to remove as little of the tin from the copper as possible. Lay the strands back in their former position and tin well with soldering iron.

The conductors are to be joined by means of a copper sleeve made from thin sheet copper which has previously been tinned on the side which is to form the inner surface of the sleeve. This is cut so as to make a sleeve two inches long and wide enough to not quite wholly wrap the conductor, so that a slight gap or slit about one-sixteenth of an inch wide is left along the sleeve for the admission of solder. Pass the conductors through the opposite ends of this sleeve until both ends meet in the center.

Turn the sleeve so that the gap is on the upper side and then sweat the whole together by applying a soldering iron to the under side of the sleeve and if necessary add more solder through the gap or slot. Treat each conductor in this way until all are joined and an equal tension on all the conductors will be the result, which cannot easily be obtained by any other method. A joint made in this way has the further advantage of enclosing all strands so that none can turn back and perforate the insulation, as occasionally happens in the ordinary twisted splices. When soldering, rosin is the only flux to be used. Acids or salts cause corrosion, while soldering pastes or sticks contain an oily or greasy compound which decomposes the rubber insulation.

To make the rubber patch, pure gum, which can be furnished in sheet form by the supply department, should be

used. First scrape with a clean knife the rubber surfaces to be patched, then cover with a thin coating of rubber cement, using preferably the little finger for this purpose, which should be clean and dry. Allow the cement to dry one or two minutes until most of the naphtha has evaporated from same, after which apply the pure gum in the following way: Cut the sheet gum into strips about three-quarters of an inch wide and eight inches long. The grain of the pure gum must positively run crosswise with the strip, otherwise good results cannot be obtained. Wrap the joint with this tape, keeping it stretched almost to a breaking point, reverse each wrap until the joint has been insulated to a thickness slightly above the diameter of the regular insulation and allow it to lap over the original insulation about two and one-half inches from the splice, making the total length of the patch about seven inches. When this is done the whole should be firmly pressed together with the fingers or the palms of the hands, so as to make all the layers unite with each other and with the original insulation. Wrap the whole with one layer of Manson tape to protect the rubber from mechanical injury.

While the patching rubber is being applied, the temperature of the air should not be below 75 degrees Fahrenheit, and if the air is at all cold the work can be easily performed over a charcoal furnace. Applying heat directly to the splice by means of a hot iron or flame must never be resorted to. The conductors are now ready to receive their bed of jute. When this is done the armor wires are lapped, served and the ends turned up and cut off in the usual manner.

The rubber cement should be made by dissolving in naphtha or gasoline some pure gum for patching. This should be done before starting work and a supply kept on hand in a bottle as it takes some little time to dissolve.

UNDERGROUND CABLE SPLICES.

PAPER TO RUBBER, PAPER TO COTTON, PAPER TO FIBRE.

Remove lead from the cable ends for a distance that will allow of the connecting of the different wires conveniently. This will depend largely upon the size of the cable to be spliced. Slide over each conductor of one or the other cable ends a cotton sleeve about three inches long and then connect each wire of one cable to the corresponding wire in the other, being guided by the marked wire placed for that purpose in each layer. Draw the cotton sleeve over the joints as fast as they are made. After all conductors are connected, boil out by pouring hot paraffin over the whole. When this is done, wrap all the conductors snugly together with white cotton tape about one inch wide, then boil out with paraffin again; after which slide the lead sleeve in place and wipe same to cable in the usual way; place the sleeve in a horizontal position, make two perforations on opposite ends and upper side of the sleeve. Fill the joint with boiling paraffin through one of these holes until the air bubbles cease coming out at the

other hole, which indicates that all moisture has been expelled from the joint; seal the holes with solder and the joint is complete.

In underground cable repairs when a cable has been opened at a joint or otherwise and it is found desirable to leave the joint temporarily unfinished, it should be protected from moisture by passing the lead sleeve over the unfinished joint and wrapping the ends of same to the cable with a waterproof tarred tape one and one-half inches wide and known as P. B. tape, which will be furnished on requisition. This will keep the moisture out for a number of hours. If it is not feasible to draw the lead sleeve over the joint, wrap the whole tightly with several layers of P. B. tape. Cotton sleeving for insulating the joints is furnished on spools. This should be cut into lengths of four inches, boiled in paraffin, allowed to cool, then forced over a lead pencil. This forms it into a firm cylinder which the conductors will readily pass through.

When making the copper splices care should be exercised to see that the twisted joint lays snugly against its conductor, so that it cannot puncture the cotton sleeve and become crossed with a neighbor.

If cotton sleeves are not available then white cotton tape three-quarters of an inch wide can be used. Cut the tape about ten inches long, wrap the joint and fasten the end of the tape by passing it under the last lap. This makes a securer job than do the cotton sleeves, as there is absolutely no danger of crosses, for the copper joint cannot puncture the several thicknesses of the closely meshed tape; but the additional length of time it takes to make a splice in this way over that made with cotton sleeve makes it undesirable, especially in large cables.

When it is desired to loop through wires out of a main cable into an office or test box, the splice where the spur or subsidiary cable leaves the main cable must be made as follows:

Fasten the conductors in the subsidiary cable in pairs; that is, tie two adjacent conductors together; or better still, pass them through a cotton sleeve. Pair off in this way all that are to be used as loops, then cut a through wire in the main cable, connect both ends of this severed wire to the two conductors of a paired off loop in the subsidiary cable, doing the same to all conductors that are to be looped at this point. When all conductors are spliced, finish the joint in the usual way.

Should the subsidiary cable be wrecked or a fire occur at its terminal, open the joint just described, cut off the (previously paired off) subsidiary conductors and connect straight through, the resulting two ends of the main cable conductors.

It is obvious that in this way every wire can be cut through straight without the customary testing and consequent delay at perhaps a very critical period.

With this method the transposition of through wires is hardly possible.

Single-Wire Joints.

Joints on all outside and inside wires, including all call circuit wires, must be wrapped with tinfoil before taping.

All wires directly connected to earth, dynamos, accumulators, or to an electric light system, must be soldered.

Aerial Cable Splices.

Cut back the rubber insulation two or three inches, clean the conductors well, make an ordinary twisted joint, using care to splice all conductors, so that each will carry the same amount of strain. Then wrap the copper joint with tinfoil. The best thickness for this is a medium light tobacco foil which will roll about 3,000 to 3,150 square inches to the pound and which will be furnished on requisition.

Then scrape the rubber insulation clean and apply cement and wrap with pure gum as described in the submarine splice. If the cable has many conductors the joints should be staggered over a space of twelve or fourteen inches, so as to not make it too bulky in one place. To seal the cable, lay strips of Manson tape lengthwise over the splice and allow to lap the original outside covering of the cable six or eight inches. These strips should lay all around the cable and are intended to add tensile strength to the splice. Wrap the whole with two layers of Kerite tape and finish with one or two layers of Manson tape, then varnish or paint with any good weather resisting compound.

RULES FOR WIRING OFFICES AND CABLE BOXES

Terminal Office.

1st—For all terminal offices, standard Postal springjack slate switchboards are to be used.

2d—The main terminal room should be within the building as near the point of entrance of the underground cables as practicable, and accessible from the outside in the event of the destruction of the wires leading therefrom to the operating room.

3d—The line wires after entering the main terminal room should be first brought to standard porcelain terminal room pin jack blocks, the other terminals of which are to be connected by cable having conductors not less than No. 14 B. & S. gauge, to the terminals of standard fuse blocks containing ½-ampere fuses, the other terminals of which are to be connected to standard lightning arrester plates having between them and the ground, mica plates 10 mils thick.* These fuse blocks and arresters are to be mounted upon an iron cross-connecting frame located as near the main switchboards in the operating room as practicable. The terminal bars upon the cross-connecting frame are to be connected by office cables of No. 19 B. & S. conductors to the switchboards and tables. (See diagram No. 311.)

4th—Aerial cables entering the building should (where practicable) be brought to the operating room cross-connecting frame via the main terminal room.

5th—Where it is impracticable to bring the cables from the underground conduits directly to the main terminal room, they must be protected as well as possible by fireproof coverings between the terminal room and the points where they enter the underground conduits.

* 1,000 mils equal one inch.

Intermediate Offices.

6th—Switchboards are to be set off at least 6 inches from the wall upon iron brackets or legs that will be provided by the supply department.

7th—All aerial and underground conductors entering intermediate offices must be first connected to the terminals of standard fuse blocks containing 20-ampere fuses, the other terminals of which are to be connected to standard lightning arrester plates having between them and the ground, mica plates 100 mils thick. These arrester plates are then connected directly to the switchboard binding posts as per diagrams for intermediate office wiring, Nos. 301, 302, 303A, 303B and 304.

8th—These arresters and fuse blocks must be located as near as possible to the point of entrance of the conductors in the building, and not less than 6 inches from curtains or other

inflammable material as per rules of the National Board of Fire Underwriters.

9th—In each instrument circuit of an intermediate office there must be inserted a lightning arrester with a perforated mica plate 10 mils thick, and a standard porcelain fuse block containing ½-ampere fuses, as per diagram No. 303, A and B, and so arranged that they will be placed underneath or on one side of the switch, but that the instrument wedge or plug, when not in use, shall be so located as to make it impossible for it to get in contact with any of the line connections.

10th—Operators in charge of the switchboard shall make sure that the switch plugs or pins are pushed in as far as they will go, and that the nuts or screws of binding posts holding wires are tightly screwed up to maintain perfect electrical connection at all times.

11th—Intermediate offices having not over 6 line wires in and 6 line wires out shall be equipped with a Postal standard 6-line intermediate switchboard frame as per diagram No. 301.

12th—Intermediate offices having over 6 and under 12 through line wires, should be equipped with a Postal standard 12-line intermediate switchboard frame; and over 12 and under 25 through line wires, a 25-line intermediate switchboard frame; and over 26 and under 50 through line wires, a 50-line intermediate switchboard frame (diagram No. 302).

13th—Intermediate offices at present equipped with vertical strap peg switchboards or cross-barred switchboards are to have the wires leading from the switchboard to the instrument arranged with arresters and fuses as per diagrams Nos. 303A, 303B and 304.

14th—When the connections between the office pole and the fuses and arresters of intermediate offices are made by aerial or underground cable, it should have its conductors laid up in pairs and the conductors of each pair must be used to take the same wire in and out of the office. Requisitions should designate this kind of cable as "leading-in cable," stating the number of pairs.

15th—At intermediate offices, a pole lightning rod shall be put as an extra safeguard on the first pole next to the office where the overhead bare line wires terminate, or enter the office. This should be a No. 6 iron wire or a No. 9 B. & S. gauge hard-drawn bare copper wire connected to a good earth and run up the pole through staples. It may be found necessary in some cases to protect the rod from injury by inclosing it in an iron pipe for a few feet above the earth. (See 10th rule in Book on Rules governing Construction and Repair.)

Submarine and Underground Cables.

16th—For submarine and underground cables which do not terminate in an office the line wires at both ends of each cable are to be connected to the cable conductors in a standard moisture-proof cable box as follows: The conductors from the cable are first brought via lock-nut blocks to standard lightning arresters having between the line plates and the earth perforated mica plates 10 mils thick. The other side of the arrester to be

connected to standard fuse blocks containing 20-ampere fuses, the other terminals of which are to be connected to regulation insulated bridle wires connecting with the wires of the overhead line as per diagrams Nos. 312 and 313.

17th—In case one end of a submarine or an underground cable is connected directly into an office, the above arrangement is only to be made in the cable box at the distant end of the cable, and in the office the arresters and fuses are to be according to the rule given for such office, either intermediate or terminal as it may be.

Aerial Cables.

18th—For all aerial cables which do not terminate in an office, and which are connected to the open line wires, a cable box should be used at both ends for protection of the conductors from the weather and for convenience of testing, and all such aerial cables over 5,000 feet in length are to have their conductors first brought to porcelain blocks (No. 65) in the cable box, the standard lightning arresters having between their line plates and the earth perforated mica plates of not more than 100 nor less than 50 mils thickness, the thickness in each case to be determined by the electrician in charge. The other terminals of which are to be connected to regulation insulated bridle wires connecting with the wires of the overhead line as per diagrams Nos. 312 and 313. Brass latches are to be used, instead of fuses, in the blocks, to allow "cutting in" for tests.

19th—In case one end of the aerial cable over 5,000 feet in length terminates in an office, the regular arrangement of fuses and arresters in such office will be sufficient protection. If the cable is less than 5,000 feet in length, arresters will not be necessary in the cable box where it connects with overhead wires at the outside end of such cable; but the cable conductors are to be terminated in the cable box upon standard lock-nut blocks, the posts on the opposite side of the blocks are to hold insulated bridle wires, the other ends of which are spliced and soldered to the terminal ends of the overhead wires upon the pole. The posts upon the blocks are to be connected by brass latches which may be had on requisition. These latches on being removed, afford an opportunity for testing, and when replaced must be securely fastened in position by the lock-nuts to insure a permanent electrical connection. (See diagrams Nos. 314, 315, 316.)

20th—Only the standard bridle wires supplied on requisition must be used in making connections between outside wires and cables in cable boxes.

Call Circuits and Call Boxes.

21st—Each call circuit where entering or leaving a building, must be provided with a standard fuse block containing 10-ampere fuses which, together with the call box, must be located in a thoroughly dry place as near to the place where the wire enters as is practicable, and only wire approved for this purpose is to be used.

Leased Wire Offices.

22d—Wires entering leased wire offices must be connected to standard fuse blocks containing 10-ampere fuses, thence to standard porcelain base springjacks, thence to the instruments, as per diagram No. 305 (A & B).

Branch Offices.

23d—At all branch offices each wire on entering must be connected to standard porcelain fuse blocks containing ½-ampere fuses, thence to standard arresters with a mica plate 10 mils thick between the line plate and the ground, thence to porcelain base springjacks, thence to the instruments, as per diagram No. 306.

24th—Call circuit wires entering branch offices must be connected to standard porcelain fuse blocks containing ½-ampere fuses, thence to standard arresters with mica plates 10 mils thick, thence via pin jacks, to the instruments as shown in diagrams Nos. 307, 308, 309.

Miscellaneous.

25th—Where wires or cables are brought through walls or windows they must be incased in standard porcelain tubes and carried by standard porcelain cleats to the point where they connect with the fuses and arresters.

26th—The wires and cables connecting between the fuses and arresters and the switchboards and tables in the office must be run in a neat and workmanlike manner in such a way as to afford them all possible protection from mechanical injury and also from any damage that might arise from hot pipes, the hot sun, moisture, etc., and the greatest care taken to preserve their insulation. Double pointed tacks or staples should not be used except where unavoidable in running brokers or call wires into such offices, and then the staples must be used with the greatest care to prevent injury to the insulation of the wires.

27th—The gauge and kind of wire to be used in cable boxes or in connecting overhead, underground or submarine cables with switchboards in offices or in cable houses and also in connecting up the various instruments in an office, must be according to the list on page 29.

28th—In case it is found necessary or advisable to deviate from the requirements of the foregoing rules in the use of fuses or arresters, either as to the standard pattern furnished, or their entire omission, or a change in the capacity of the fuses or thickness of the mica plates, the particular case must be first referred to the electrical engineer for instructions.

29th—The importance of a good ground wire is very great. It should connect to earth as direct as possible and be without kinks or sharp bends, which prevent the free discharge of lightning. A good permanent ground must be secured by connecting the wire to a water or gas pipe (preferably water pipe). If a gas pipe is used the connection in all cases must be made between the meter and the street service pipe, but if this is not practicable when an inside connection is made, care must

be taken to make a metallic connection around the meter between the building pipe and the street pipe, so that the meter will interpose no harmful resistance, and the removal of the meter will not disconnect the ground wire.

30th—Where the water and gas pipes of cities, towns or villages cannot be used, proper ground connection can only be had in moist earth or in a river that does not flow a long distance in a channel of rock. A sheet of zinc, or tinned copper, of about one-sixteenth of an inch thick and 4 feet square should be buried horizontally in a hole deep enough to get below dry sand, rock or earth. The bottom of the hole, which must be where the earth is always moist, should have a layer of crushed coke 2 feet deep on which the plate is to rest, and over the plate a layer of crushed coke 2 feet thick, and the hole filled up with moist earth. Connection with the plate should be made by a hard-drawn copper line wire, the end being well soldered across the surface of the ground plate for the full distance of 4 feet if possible.

31st—In places where lightning is severe and causes trouble in quad and duplex relays, a table lightning arrester should be inserted between their main and artificial circuits, as per diagram No. 317, the mica plate in such arrester to be about 2 mils in thickness, or sufficient to prevent the main line currents from jumping and grounding via the arrester.

32d—Fuses are not intended primarily for protection from lightning, but are to protect our offices and apparatus from electric light and other foreign currents.

33d—In certain localities where terrific thunder storms are liable to occur and from which buildings may receive strokes of lightning that no known arrester can render harmless, experience has shown that telegraph offices have suffered much less, in proportion to their number, by damage from lightning bolts than any other classes of buildings.

34th—It is very important that the proper thickness of mica plates be maintained in arresters and that no fuses except those of the required capacity are inserted in fuse blocks.

35th—Arresters are to be carefully examined after severe lightning storms and kept clean and dry.

36th—No cotton-covered paraffined wire, nor any other wire not in accordance with specifications, is to be used in our offices for any purpose, and the arrangement of the wiring of machinery and apparatus in our offices must be made in accordance with the diagrams and specifications approved by the electrical engineer of the company.

37th—Copies of the Rules and Requirements of the National Board of Fire Underwriters for governing the wiring of telegraph, telephone, messenger and similar circuits, can be had on application to the electrical engineer's department. The employees of this company are to observe such rules so far as they do not conflict with the foregoing.

In case of any demand by the inspectors of the Fire Underwriters or any local authorities, that is inconsistent with the foregoing rules, the subject should be referred through the regular channels to the electrical engineer's department for action.

RULES FOR CARE OF MOTORS AND GENERATORS.

1st—Keep every part of the machines, and room in which machines are installed, clean.

2d—Keep all of the insulation free from metallic or carbon dust or gritty substance.

3d—Keep all bearings of machines well oiled.

4th—The bearings when running should be examined at least once a week. When it is necessary to renew the oil, draw the oil from the reservoir through the opening in the side of the pedestal.

5th—From time to time, or whenever the bearings show signs of heating, the plug at the bottom of the bearings should be removed, the oil drawn off and replaced by new.

6th—Keep brushes properly set and see to it that they are trimmed frequently so that full contact is obtained between commutator and brushes, and that there are no stray parts getting across on to the other bars.

7th—Keep the brushes clean and if there is any cutting of the commutator wipe same occasionally with a canvas cloth slightly coated with vaseline. If the brushes are graphite no vaseline will be needed.

8th—If a commutator begins to give trouble by roughness with attendant sparking and excessive heating, it is necessary to immediately take measures to smooth the surface. Any delay will aggravate the trouble and eventually cause high temperatures, throwing of solder and possibly displacement of the segments. No. 0 sandpaper fitted to a segment of wood with a radius equal to that of the commutator, if applied in time to the surface when running at full speed (and if possible, with brushes raised), and kept moving laterally back and forth on the commutator, will usually remedy the fault. If this does not suffice, it will then be necessary to tighten the segments and turn them off true. A machine tool will not leave the surface smooth enough to give perfectly satisfactory results. It is always necessary before putting on the load after the commutator has been turned, to carefully smooth the surface with the finest sandpaper, thus removing all traces of the tool point, and treat with a small amount of pure vaseline until commutator is brought to a hard smooth surface.

9th—See that all connections of wires between machines and starting boxes, and on the machines themselves, make good contact.

10th—The best grade of dynamo oil should be used in the bearings, and this should be changed occasionally so that bearings will continue to run at normal temperature.

RULES FOR THE CARE OF CALLAUD BATTERY.

1st—The standard battery racks are built as follows: The uprights are two inches by three inches; the shelves are each of four 2-inch by 3-inch strips, with a space of one inch between them. The end supports for the shelves are one inch by two inches, and the cross braces one inch by two inches. The perpendicular space between the shelves is twelve inches clear. The space between lower shelf and the floor is not less than six inches clear, as per diagram No. 310.

2d—All wood is to be North Carolina pine, or its equal, dressed smooth.

3d—The racks should be oiled or well painted to prevent spilled solution from adhering to the wood.

4th—The battery sink should have an overflow side outlet and a plug at the waste outlet. Sinks of this type may be had upon requisition when unobtainable locally. (See diagram No. 310.)

5th—The elements of the gravity cell are a glass jar containing zinc, copper, blue vitriol (sulphate of copper) and soft clean water. The zinc is the positive element of the battery and the copper is the negative element. When the cell is connected up, the current is assumed to flow from the zinc to the copper within the cell and from the copper to the zinc outside the cell, thus the positive (+) pole of a cell is at the copper stem and the negative (—) pole is at the zinc terminal or binding post. Each cell will have an electromotive force of 1.07 volts, and an average resistance of 2½ ohms.

6th—A hydrometer should be used to determine the condition of a cell. The hydrometer will sink 20 degrees, when the cell is at its best. Hydrometers furnished upon requisition.

7th—Before using the jars clean and dry them thoroughly.

8th—Spread the plates of the copper apart and curve the ends slightly to fit the jar. The insulated wires must be firmly connected to the coppers by rivets and the insulation not cracked or swelled. The insulation must begin close to the copper.

9th—Place a copper on the bottom of a jar and put therein three pounds of sulphate of copper (bluestone).

10th—Suspend the zinc in the jar, and add water until it rises above the top of the zinc to within one-half an inch of the top of the jar. Hard or alkaline water must not be used.

11th—No copper crystals smaller than a nutmeg should be used. The cells should not be replenished by frequently dropping in a few crystals, nor should fine or powdered bluestone be used, as it will cake in bottom of the jars, impairing the battery and will be very difficult to remove.

12th—New cells may be started by short circuiting or connecting the copper at one end of the battery to the zinc at the other end, by a piece of copper wire, and leaving it thus connected until the zinc solution becomes dense enough to enable the battery to perform the service required.

13th—After the battery has been put into use make frequent tests with the hydrometer and do not allow the density of the solution in the cells to fall below 5 degrees, nor to rise above 25 degrees—the latter is prevented by the addition of water.

14th—If the zinc solution is allowed to rise above 25 degrees, the chemical action of the cell will diminish and crystallized sulphate of zinc will form upon the zinc and upon the edge of the jar above the solution.

15th—If the density of the zinc solution in a new battery is less than 5 degrees, and the battery does not furnish sufficient current, add old zinc solution, or short circuit the battery as per Section 12, until a density of 20 degrees is obtained.

16th—A cell in good condition will show a bright blue sulphate of copper solution extending from the copper about half way towards the zinc with a clear line of demarkation between the blue and the water-colored solution of zinc sulphate above it.

17th—When the density of the zinc solution reaches 25 degrees remove some of it and add water. Where a battery syringe is not available a convenient method of "drawing off" is to use a syphon, or a piece of half-inch soft rubber tubing, about three feet long. Immerse this in water and let it fill. Grasp both ends firmly with the fingers, to prevent the water from escaping, and carry the filled tube to the place where you wish to use it. Place one of the closed ends an inch or two below the surface of the solution to be drawn off and hold the other end over a receptacle two or three feet lower than the cell. Release the pressure on the ends of the tube and the water will run out and the solution from the cell will follow it. The flow may be stopped at any time by closing the ends of the tube, leaving the syphon full of liquid, ready for use in drawing solution from another cell. Keep the syphon clean as the solutions cause the rubber to decay.

18th—If a jar breaks it should promptly be removed, and the shelf carefully cleaned. Clean, dry shelves must be maintained at all times.

19th—If the insulating material swells or cracks on the wire that passes through the solution to the copper, renew the cell immediately, putting in a copper with a perfect stem. The defective stem can be renewed with new standard battery jar wire.

20th—To prevent the creeping of the salts formed by the zinc solution over the edge of the jars to the outside, keep the density at 20 degrees as per Section 15. When oil is not used in the jars, occasionally wipe their inner edges with a sponge containing cotton-seed or heavy paraffine oil.

21st—To prevent evaporation apply approved battery oil to a depth of between 1-16 and ⅛ of an inch over the top of the solution in each jar. The inside of the jar above the solution must be perfectly clean and dry, and there should be no time lost, after the battery has been newly set up, in applying the oil.

22d—Only approved battery oil and standard battery jars and wire must be used.

23d—If it becomes necessary to replace a zinc in a working cell without renewal of the solutions, the new zinc must be

dipped in water before lowering it through the oil into the solution of the cell.

24th—Cells should be renewed when the original charge of sulphate of copper is nearly exhausted. They will usually become too much clogged with sediment and deposits to repay the addition of more bluestone.

25th—In drawing off, refilling, or taking down cells, and, in fact at all times, be careful to disturb the contents as little as possible. Avoid filling the cells with a strong jet of water. The mixing of the zinc and copper solutions is hastened by motion. Keep this in mind when taking down the battery. Remove the zincs gently and put them in a tub to drain. Turn the zinc solution from upper part of the cells into a tub.

26th—Where oil is used it may be saved by inserting a faucet into the side of the tub close to the bottom, and drawing off the solution into another vessel. As the oil floats at the top it will be the last to reach the faucet and can thus be run into a separate vessel.

27th—Remove the coppers and lay them aside to be cleaned. Put the remainder of the contents of the jars into a box at the side of the sink and let it drain. The sediment and the stubs of zincs can be sold. Preserve them, separately, in boxes or barrels, and obtain instructions regarding sale from the superintendent.

28th—Zincs should be cleaned as often as they become thickly coated, and immediately upon their removal from the jars. If allowed to dry, their coating will harden and become difficult to remove. If this occurs, soak them awhile in water. Clean them by scraping and washing, using a knife with a heavy blade, such as the standard battery knife.

29th—Coppers may be cleaned by laying the plates on a flat surface and hammering off the deposited copper, great care being taken not to injure the insulated wires. At some stations the heavy coated coppers can be sold at a price so high that there is no economy in cleaning them.

30th—The temperature of a battery room should never be lower than sixty degrees Fahrenheit; nor will good results be obtained if the temperature rises much above 100 degrees.

31st—What is termed the "life of a cell" depends upon the work performed and the attention given to the cell. The average life of a "local" cell is from five to eight weeks; a main line battery supplying one or more wires two months; and a quadruplex battery about six months; this, however, does not refer to the water supply, which should be frequent enough to keep the fluid within one-half an inch of the top of the jar.

32d—Always keep the jars clean and dry on the outside.

33d—The jars should not be placed close together on the shelves or racks. Allow a clear space of not less than three-quarters of an inch between jars.

34th—It is not necessary to remove all the accretions from a copper when cleaning it. Only such quantity should be taken off as is necessary to reduce the copper to nearly its original size and weight or to such size as will permit its easy placing in or removal from the jar without danger of breaking the jar.

35th—Extreme watchfulness should always be exercised concerning battery connections. The part of the copper stem where connection is made with the zinc of the next cell, or with a wire leading from the battery, should always be kept clean and bright, and such connections should be thoroughly tight and strong. The connecting post and screw on the zinc, including the hole in which the connecting wire is placed, should be clean and bright at the point of contact and the screw well tightened. Frequently the poor results obtained from batteries are entirely due to dirty and carelessly made connections. The connection between the insulated "stem" and the copper itself (where the stem is riveted to the leaves) should be tight and strong.

36th—When zincs are ordered with battery supplies, state whether any new hangers are needed, otherwise none will be sent. Hangers, with care, should last for years.

37th—In case the jars break frequently from changes in temperature or from an unknown cause, the breakage may be due to bad quality of glass. All cases of an improper quality of battery supplies or any unusual occurrences in the operation of a battery, should be promptly reported by the manager to the electrical department, through the superintendent.

RULES FOR THE CARE OF LECLANCHE CELLS.

1st—The elements of the Leclanche cell are a glass jar containing zinc, carbon, salammoniac and soft clean water. The carbon is the negative element and positive pole of the battery; and the zinc is the positive element and negative pole.

2d—Each cell will have an electromotive force of about one and one-fourth volts and an average resistance of from one to two ohms.

3d—Place six ounces of salammoniac in the jar and add water enough to reach the shoulder of the jar when the carbon cylinder is inserted. Stir the solution until little or no salammoniac remains undissolved; insert the carbon cylinder, taking care to keep the upper part dry and clean; place the zinc rod in the central hole and see that it goes down all the way to its shoulder.

4th—Observe the rules as to cleanliness, etc., given for gravity cells.

5th—These cells must only be employed for intermittent service, and should last from three to six months (according to use). They should then be taken down, thoroughly cleaned, all accretions scraped from the carbon cylinder and the cell set up with a new zinc element and a fresh solution. Salammoniac should never be added to the old solution in these cells. Examine the zincs occasionally and if found to be considerably eaten away they should be renewed without disturbing the other elements and solution.

RESISTANCE COILS.

Standard resistance coils are to be used as follows:

130-ohm coils for leg locals upon quads, duplexes, duplex repeaters and direct polar relay repeaters at 40 volts.

180-ohm coils for single Morse repeater locals at 40 volts.

200-ohm coils for all Morse locals and bug trap repeating relay locals at 40 volts.

200-ohm coils for all city, pony and main line wires worked from main or from district switchboards at 40 volts.

300-ohm coils for all city, pony or main line wires working from main line switchboards at about 90 volts.

400-ohm coils for all wires working from main line switchboards at 110 to 130 volts.

600-ohm coils for each of the long end and short end plus and minus potentials of all quads. Also for all duplexes. This resistance is to be made up by placing two 300-ohm coils in series.

600-ohm coils for all wires working from main line switchboards from 130 to 200 volts.

Standard coil boards, 5 feet long, 5 inches wide and 1 inch thick, of slate to hold fifty coils.

SIZE AND INSULATION OF WIRE CABLE FOR INTERIOR USE.

IN MAKING REQUISITION GIVE NAME AND COLOR ONLY.

No.	Name of Wire	Gauge of Condr.	Diameter Outside Inch	Color of Braid	REMARKS
1	Office	16	9/64	Black	For use in connecting up Tables, Switchboards, and general instrument work.
2	Switchboard	18	8/64	Black	For wiring Switchboards and Terminal Frames.
3	Bridle	14	12/64	Black	For use in wiring Cable Boxes and making connections from them to Aerial Wires.
4	Pothead	14	10/64	Unbraided	For making Potheads upon Lead-covered Cables.
5	Battery Copper Stems	14	10/64	Unbraided	For Gravity Battery Coppers.
*6	Terminal Splicing Cable	14	8/64	Unbraided, Lead Covered	For connecting Paper Cables to Terminal Frames, Cable Boxes, etc.
7	Leading-in Cable	14	12/64	Each Condr. Black. Braided, in Twisted Pairs, and Braided over all, or Lead Covered	For connecting Aerial Wires at intermediate offices with Fuses and Arresters inside.
8	Office Cable 5 Condr. 10 " 25 " 50 "	19	8/64	Each Condr Black Braided, Whole Cable Taped and Painted	For general inside permanent work between Switchboards and Tables, etc.
9	Call Circuit Duplex Call Circuit laid parallel	16	9/64	White, Brown, Black, Mahogany	For interior Call Circuit work in Halls, Elevator Shafts, etc.
10		16	9/64		
10A		16	24/64	Black	Circular loom.
11	Annunciator	18	8/64	Black, Mahogany,	For use in Call Circuit work in customers' offices, etc.
12	Twin Annunciator	18	8/64	Brown.	

* Stock sizes of No. 6 cable are 10, 20, 26, 31, 36, 45, 54, 65, 78, 104, 130, 154 conductors.

WIRE GAUGES.

The following table of gauges is only a guide, the wire furnished by manufacturers being frequently heavier or lighter than the weight opposite the gauges respectively in the table. In making estimates for construction, the average weight per mile of the required gauge should be secured from the Superintendent of Supplies.

Iron wire Mile ohm at 60° Fahr. is 4500 lbs. 100% pure.
H. D. Copper wire " " " " " " 859 " " "

Birmingham Gauge	Diameter Mills	IRON		American Gauge	Diameter Mills	IRON		American Gauge	Diameter Mills	H. D. COPPER 97.95% Conductivity	
		Weight, Lbs. Per Mile	Resistance. 60° F. Ohms			Weight, Lbs. Per Mile	Resistance. 60° F. Ohms			Weight, Lbs. Per Mile	Resistance 60° F Ohms
..	...	...	....	2	258	932	4.99	2	258	1064	.825
3	258	932	4.99	3	229	729	6.38	3	229	838	1.04
4	238	787	5.97	4	204	578	8.05	4	204	665	1 32
5	220	673	6.98	5	182	460	10.11	5	182	529	1.65
6	203	573	8.20	6	162	364	12.79	6	162	419	2.09
7	180	450	10.44	7	144	288	16.16	7	144	331	2.65
8	165	378	12.43	8	128	228	20.41	8	128	262	3.35
9	148	305	15.41	9	114	181	25.71	9	114	208	4.22
10	134	250	18.80	10	102	145	32.10	10	102	166	5.28
11	120	200	23 50	11	91	115	40.47	11	91	132	6.65
12	109	165	28.48	12	81	91	51.15	12	81	105	8.36
13	95	125	37.60	13	72	72	64 65	13	72	83	10.55
14	83	95	49.47	14	64	...	.....	14	64	65	13.29
15	72	72	65.27	15	57	...	.....	15	57	52	16.78
..	...	...	.....	16	51	...	.....	16	51	42	21.15
..	...	...	.....	17	45	...	.....	17	45	32	26.69
..	...	...	.....	18	40	...	.....	18	40	26	33.63
..	...	...	.....	..	...	...	.....	19	35	20	42.58
..	...	...	.....	..	...	...	.....	20	32	16	53.63

Instruments that Comprise a Set for DYNAMO QUADRUPLEX.

1 Polar Relay, No. 63.
1 Neutral Relay, No. 88.
1 20-Ohm Relay, No. 84 (or 84½ Differential).
1 Rheostat, No. 79.
1 Quad Leak Rheostat, No. 83.
2 Transmitters, No. 73.
4 10-Ohm Sounders, No. 55.
6 Double 3-Point Switches, No. 48.
1 3-Point Switch, No. 76.
1 Table Fuse Block, No. 80.
2 3-M F. Adjustable Condensers, No. 57.
2 ½-M. F. Condensers, No. 77.
3 1/10-M. F. Spark Condensers, No. 74.
2 Resonators, No. 50.
2 Resonators, No. 51.
4 Keys, No. 52½.
1 Box ½-Ampere Table Fuses (25).
1 400-Ohm Coil, No. 67.

Instruments that Comprise a Set for DYNAMO DUPLEX.

1 Polar Relay, No. 63.
1 Rheostat, No. 79.
2 3-M. F. Adjustable Condensers, No. 57.
2 ½-M. F. Condensers, No. 77.
1 1/10-M. F. Spark Condenser, No. 74.
2 10-Ohm Sounders, No. 55.
2 Keys, No. 52½.
3 Double 3-Point Switches, No. 48.
1 Transmitter, No. 73.
1 Resonator, No. 50.
1 Resonator, No. 51.
1 Table Fuse Block, No. 80.
1 Box ½-Ampere Table Fuses (25).
1 400-Ohm Coil No. 67.

Instruments that Comprise a Set for BATTERY QUADRUPLEX.

1 Polar Relay, No. 63.
1 Neutral Relay, No. 88.
1 Rheostat, No. 79.
2 3-M. F. Adjustable Condensers, No. 57.
3 Transmitters, No. 73.
4 10-Ohm Sounders, No. 55.
1 20-Ohm Relay, No. 84 (or 84½ Differential).
4 Keys, No. 52½.
1 3-Point Switch, No. 76.
5 Double 3-Point Switches, No. 48.
2 Resonators, No. 50.
2 Resonators, No. 51.

Instruments that Comprise a Set for Direct POLAR REPEATER.

2 Polar Repeating Relays (500 Ohms), No. 63½.
2 Polar Relays, No. 63.
2 Rheostat, No. 79.
4 3-M. F. Condensers, No. 57.
8 ½-M. F. Condensers, No. 77.
6 Double 3-Point Switches, No. 48.
2 4-Point Switches, No. 47.
2 Transmitters, No. 73.
4 10-Ohm Sounders, No. 55.
1 Table Fuse Block, No. 80.
2 20,000-Ohm Leak Rheostats, No. 119.
2 Keys, No. 52½.
1 Box ½-Ampere Table Fuses (25).
4 400-Ohm Coils, No. 67.

Where required Sounder Cut-Outs and Transmitter Covers may also be requisitioned.

Instruments that Comprise a Set of HIGH POTENTIAL LEAK DUPLEX.

1 Polar Relay, No. 63.
1 Rheostat, No. 79.
2 3-M. F. Adjustable Condensers, No. 57.
2 ½-M. F Condensers, No. 77.
1 1/ 0 M. F. Spark Condenser, No. 74
2 10-Ohm Sounders, No. 55.
2 Keys, No. 52½.
4 Double 3-Point Switches No. 48.
1 Transmitter, No. 73.
1 Duplex Leak Rheostat, No. 94.
1 Resonator, No. 50.
1 Resonator, No. 51.
1 Table Fuse Block, No. 80.
1 Box ½-Ampere Table Fuses (25).
1 400-Ohm Coil No. 67.
1 3-Point Switch, No. 76.

Instruments that Comprise a Set of BATTERY DUPLEX.

1 Polar Relay, No. 63.
1 Rheostat, No. 79.
2 3-M. F. Adjustable Condensers, No. 57.
2 Transmitters, No. 73.
2 10-Ohm Sounders, No. 55.
2 Keys, No. 52½.
1 3-Point Switch, No. 76.
3 Double 3-Point Switches, No. 48.
1 Resonator, No. 50.
1 Resonator, No. 51.

Instruments that Comprise a Set of REPEATERS.

2 Repeater Relays.
2 Repeater Transmitters.
2 Keys, No. 52½.

Instruments that Comprise a MORSE SET.

1 Relay, No. 102.
1 10-Ohm Sounder, No. 55.
1 Key, No. 52½.

Instruments that Comprise a Set of HALF REPEATERS.

1 Repeater Relay.
1 Repeater Transmitter.
1 10-Ohm Sounder, No. 55.
1 Sounder Cut-out, No. 72.
2 Double 3-Point Switches, No. 48
2 Keys, No. 52½.

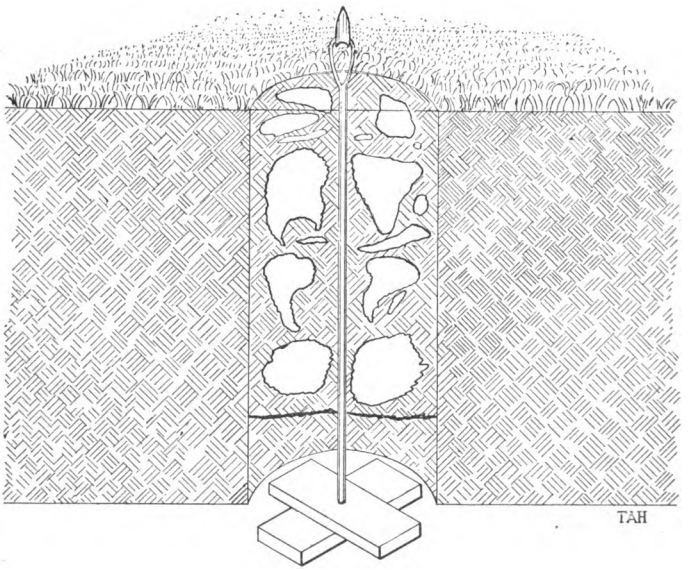
Where required Sounder Cut-Outs and Transmitter Covers may also be requisitioned.

INSTRUMENTS THAT COMPRISE A SET OF QUADRUPLEX REPEATERS WITH DIRECT-POINT POLAR SIDES.

2 Polar Relays (500 ohms) ..... No. 63½
2 Polar Relays ..... " 63
2 Neutral Relays ..... " 88
2 20-ohm Relays.....No. 84 (or 84½ differential)
2 Rheostats .....No. 79
2 Quad leak Rheostats ..... " 83
2 20000-ohm leak Coils..... " 119
4 400-ohm Coils ..... " 67
4 3-M. F. Adjustable Condensers ..... " 57
8 ½-M. F. Condensers ..... " 77
6 1/10-M. F. Spark Condensers..... " 74
8 Double 3-point Switches ..... " 48
4 3-point switches ..... " 76
4 Transmitters ..... " 73
8 10-ohm Sounders ..... " 55
8 Keys ..... " 52½
2 Resonators ..... " 50
2 Resonators ..... " 51
2 Table fuse Blocks ..... " 80
1 Box ½-ampere Table fuses (25).

INSTRUMENTS THAT COMPRISE A SET FOR HIGH PRESSURE LEAK DUPLEX DIRECT-POINT REPEATER.

2 Polar Repeating Relays (500 ohms) ..... No. 63½
2 Polar Relays ..... " 63
2 Rheostats ..... " 79
2 Duplex leak Rheostats ..... " 94
2 20000-ohm leak Coils ..... " 119
4 400-ohm Coils ..... " 67
4 3-M. F. Adjustable Condensers ..... " 57
8 ½-M.F. Condensers ..... " 77
2 3-point Switches ..... " 76
8 Double 3-point Switches ..... " 48
2 Transmitters ..... " 73
4 10-ohm Sounders ..... " 55
2 Keys ..... " 52½
1 Table fuse Block ..... " 80
1 Box ½-ampere table fuses (25).



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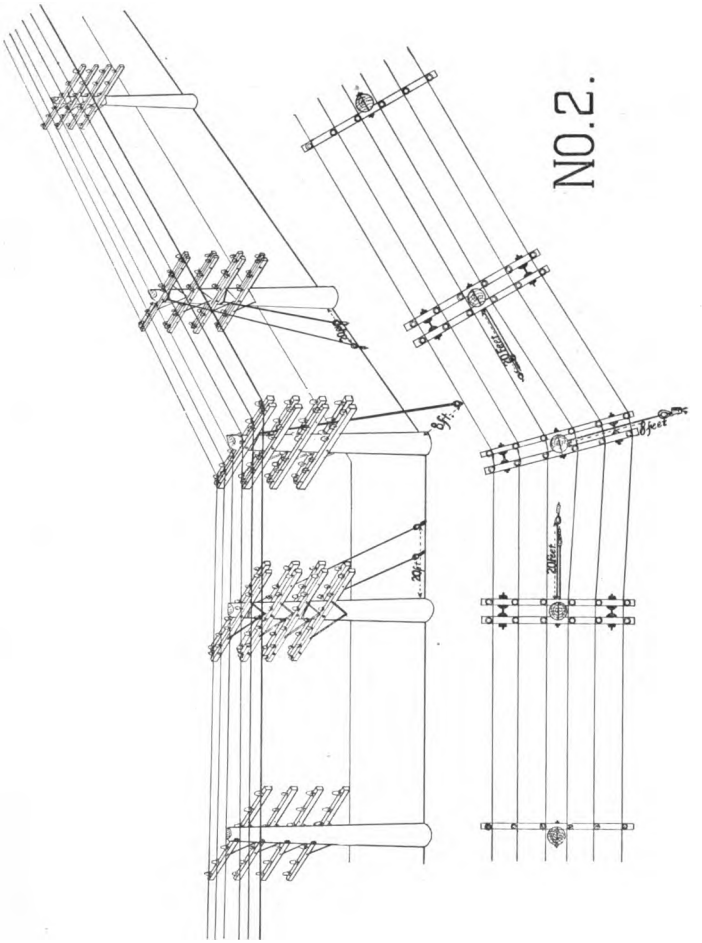

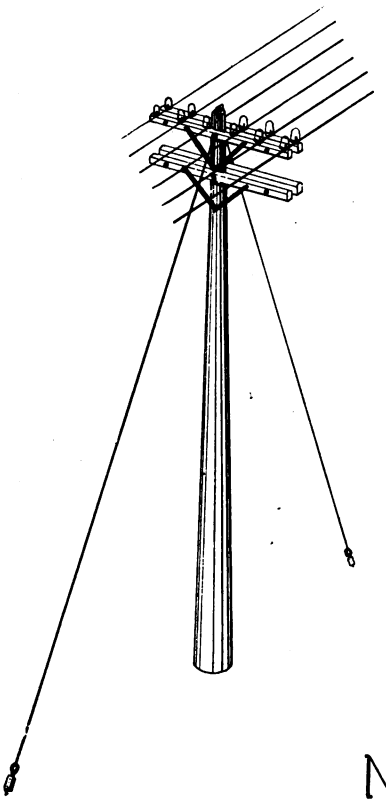

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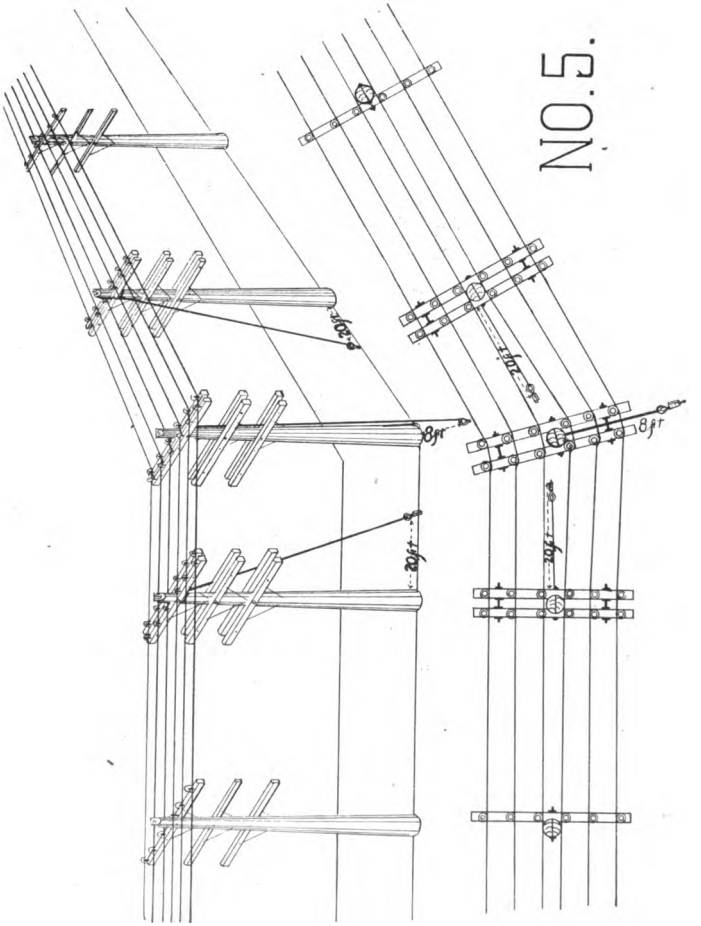

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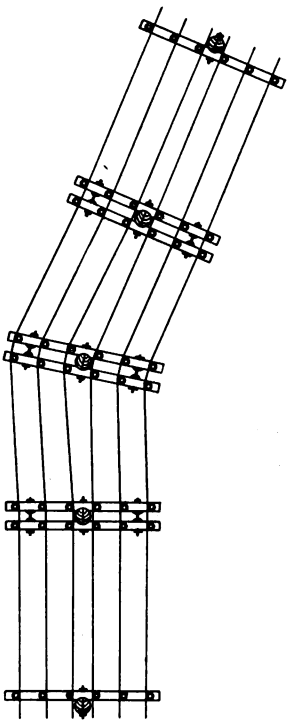


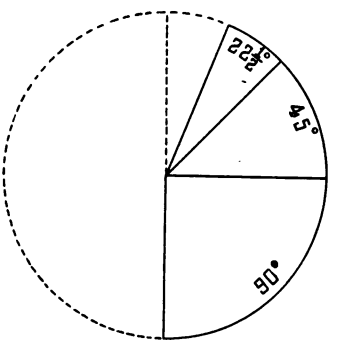
DEGREES

$22\frac{1}{2}^{\circ}$

45°

90°

$157\frac{1}{2}^{\circ}$



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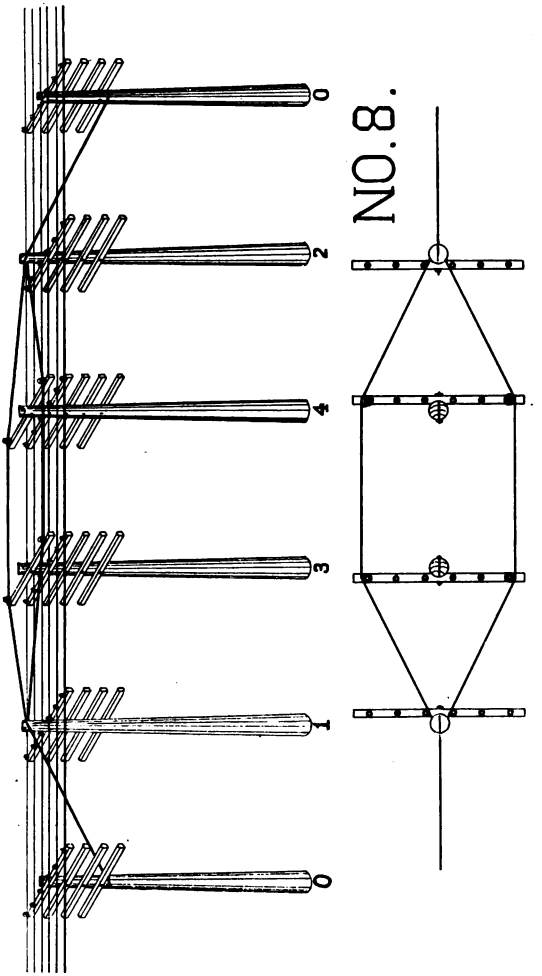

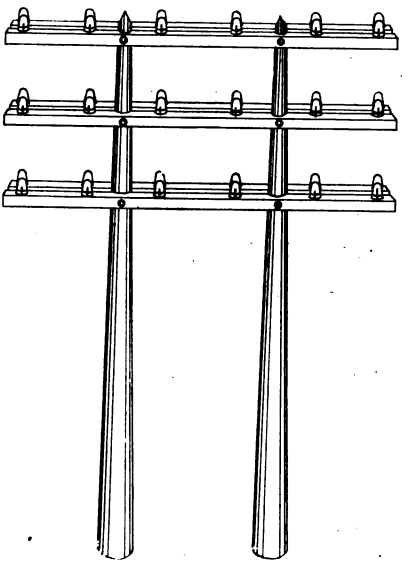

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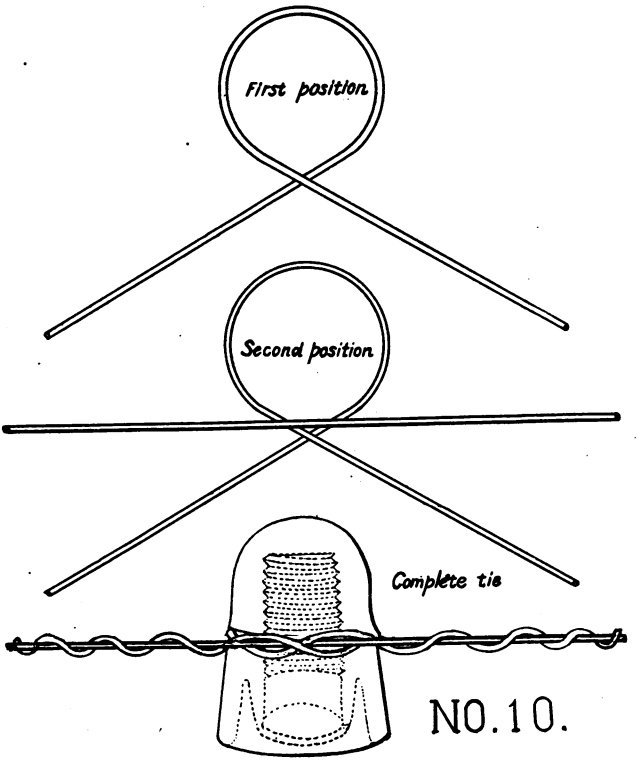
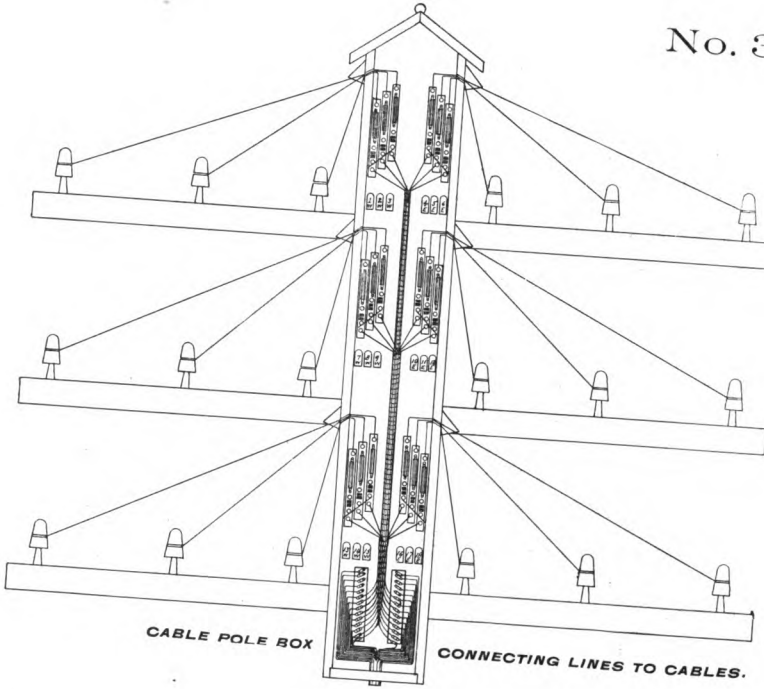


NO. 10.

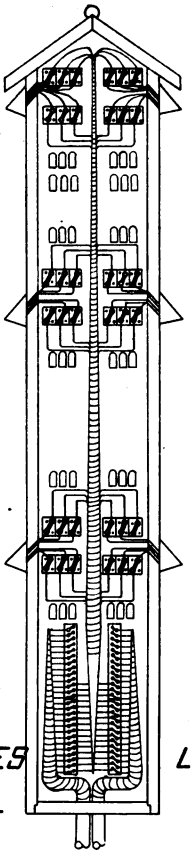
NO. 11.

No. 312



CABLE BOX SHOWING CONNECTIONS BETWEEN AERIAL AND UNDERGROUND CABLES. SUBMARINE CABLES SHOULD BE CONNECTED SIMILARLY TO UNDERGROUND CABLES, EXCEPT THAT NO JOINT AND SLEEVE IS REQUIRED ON THE SUBMARINE CABLE. UNDERGROUND CABLES TO BE TAILED OUT — TAPED — AND PAINTED. WITH INSULATING PAINT.

No. 313



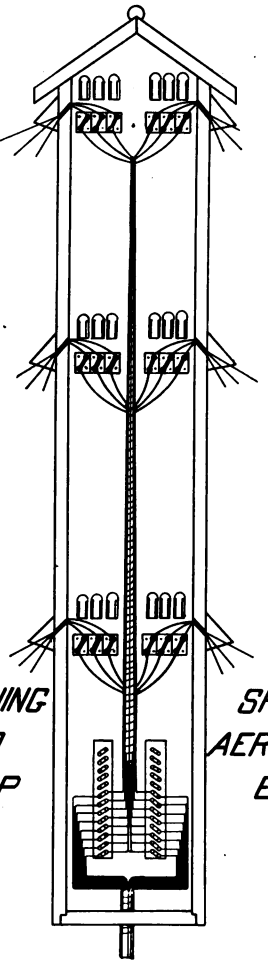
OFFICE CABLE POLE BOX

SHOWING CABLES LEADING IN AND

OUT- LOCKNUT EQUIPMENT.

NO.314

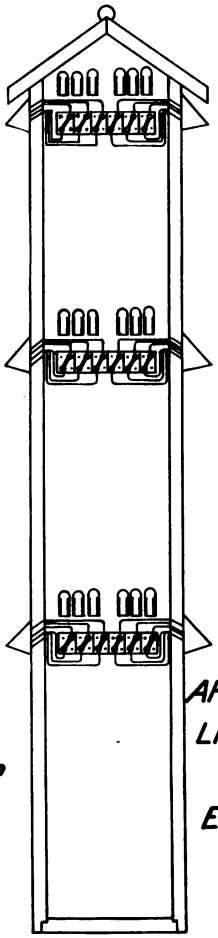
Cable and test boxes should be ordered for the number of cross arms desired. Where locknut strip equipment is used in the base of cable boxes and the space for such equipment is insufficient, extra allowance of one or more cross arms should be made in making requisitions. Test boxes are similar to standard boxes in all details except that width of box over all is 11 inches instead of 14 inches.



CABLE BOX SHOWING CONNECTED TO LOCKNUT STRIP

SHORT CABLE AERIAL LINES WITH EQUIPMENT

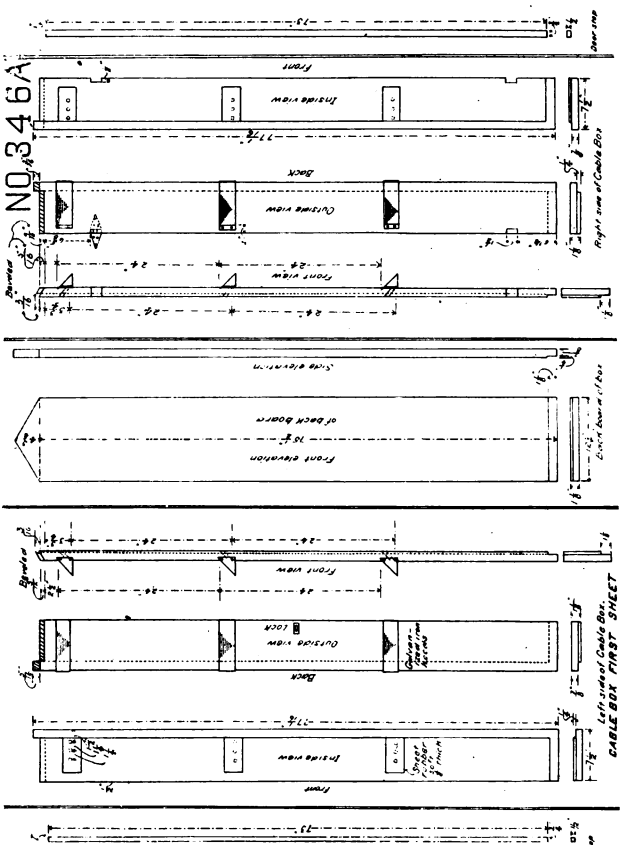
No. 315

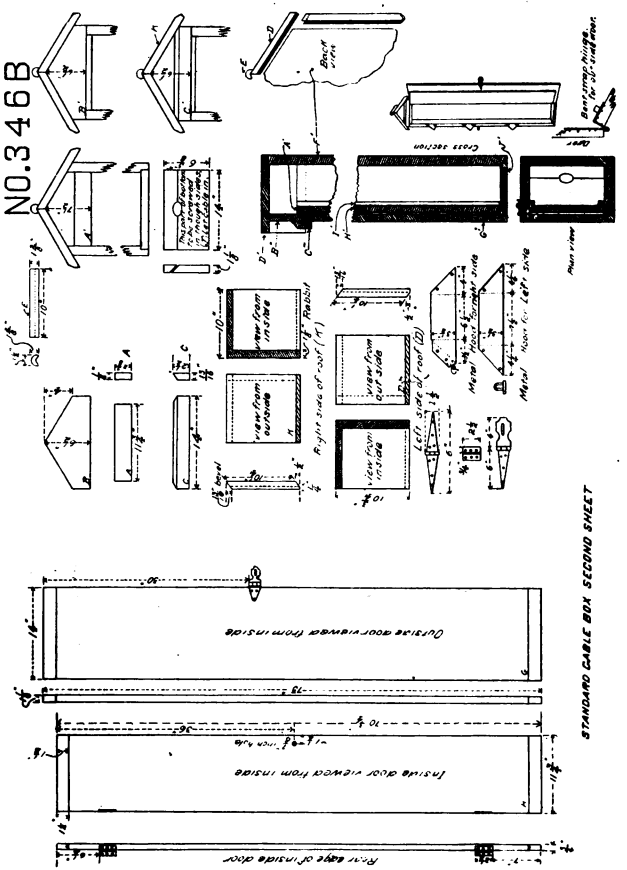


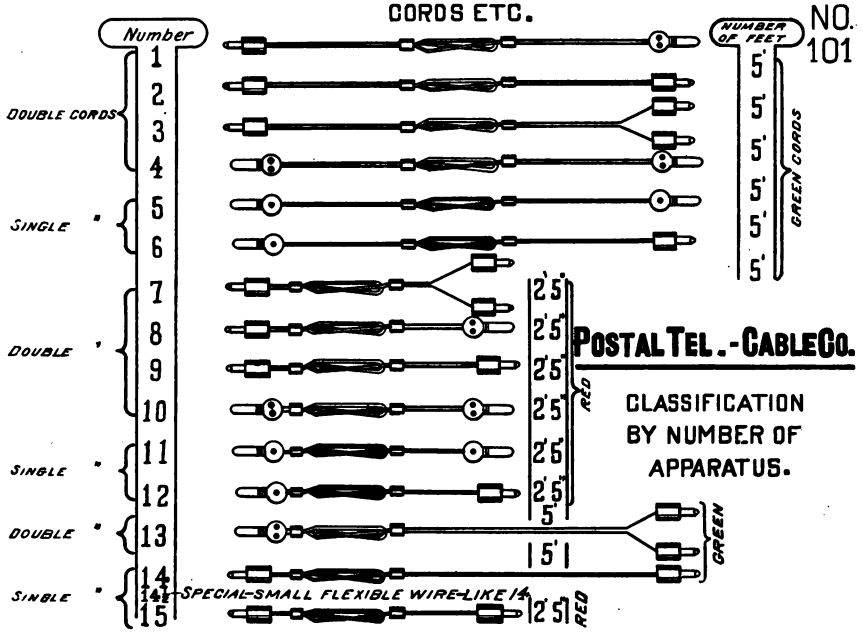
CABLE BOX
POLE ON AERIAL
LOCKNUT STRIP
CROSSARM

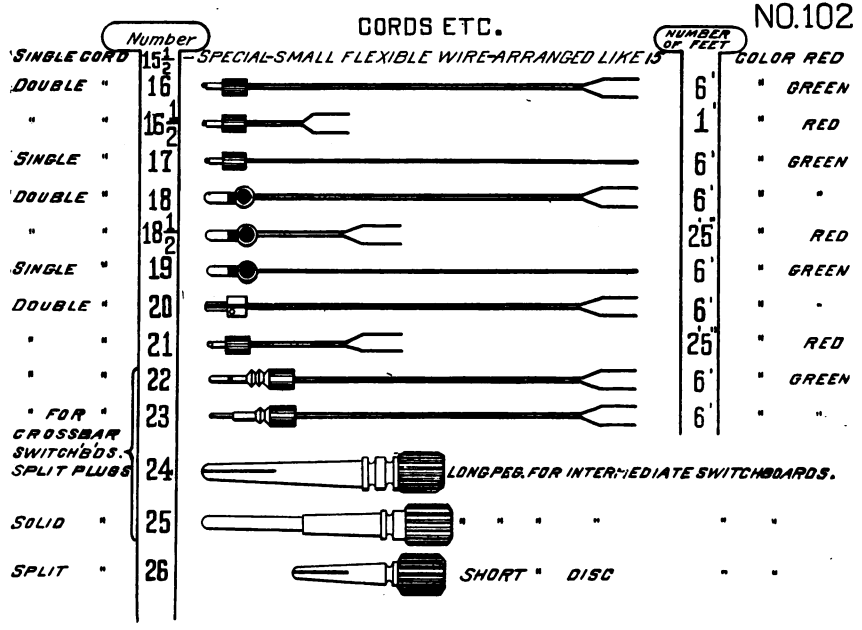
ARRANGED FOR TEST
LINES
AND DOUBLE
EQUIPMENT.

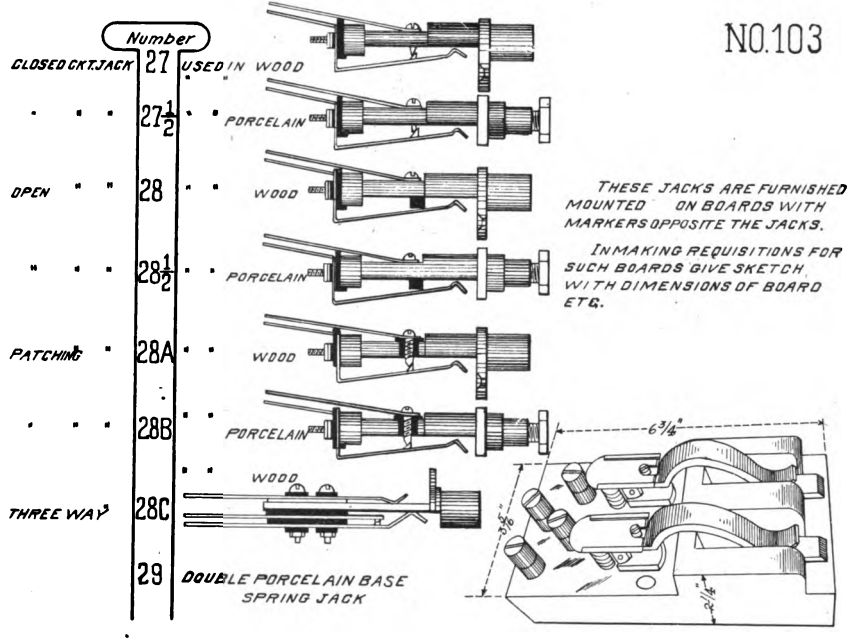
No. 316



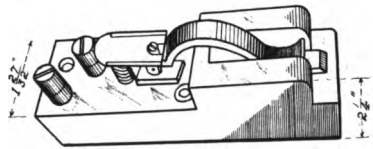








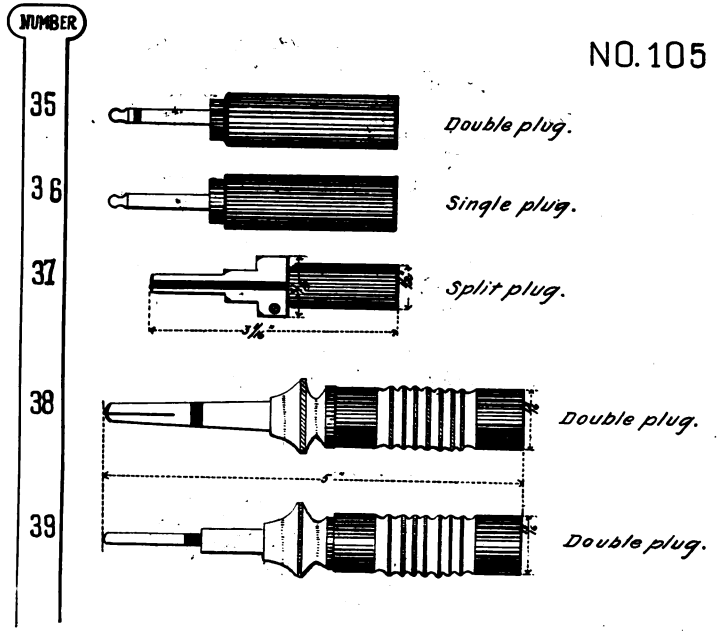
NO. 104.

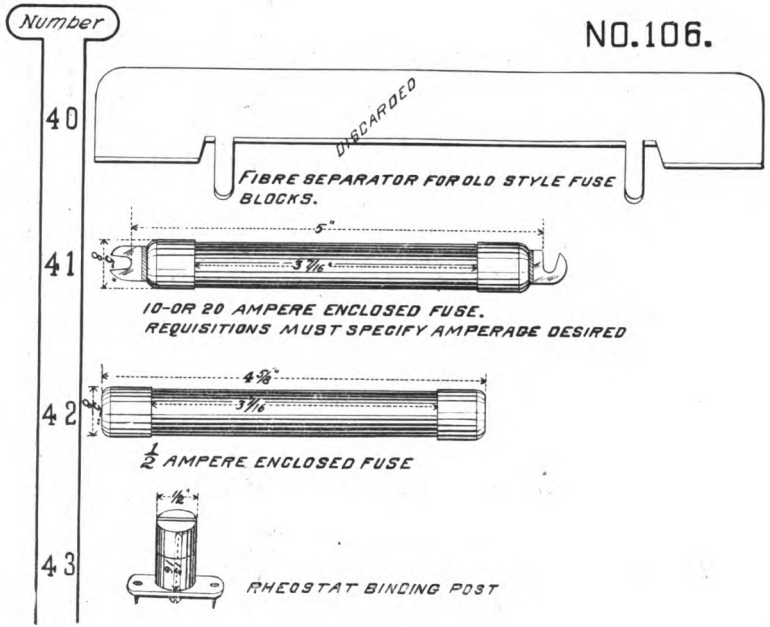


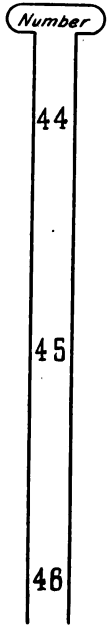
Single Porcelain Base Spring Jack

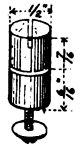
Number		
	30	
Single	31	Single wedge with marker
Double	32	Double " " "
Single	33	Single " " dot
Double	34	Double " " dots.

See also number 107

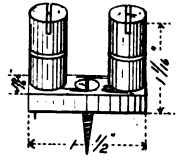




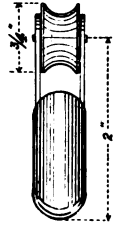




SINGLE BINDING POST

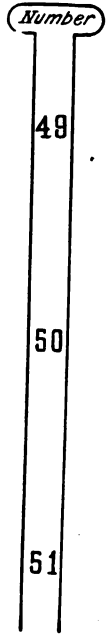


DOUBLE BINDING POST

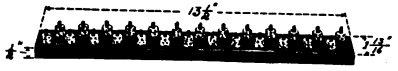


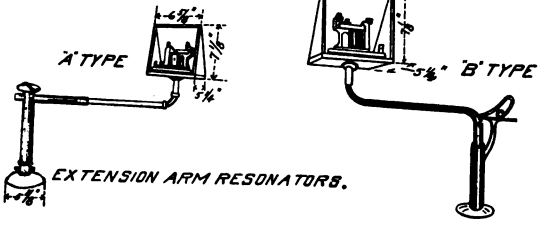
CORD WEIGHT

NO.107



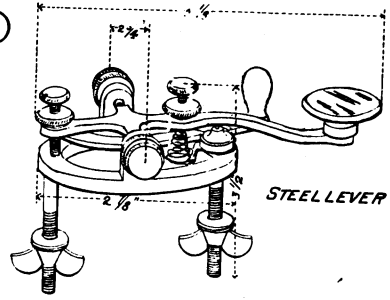
NO.109.





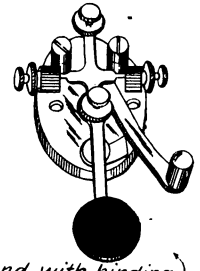
Number

52



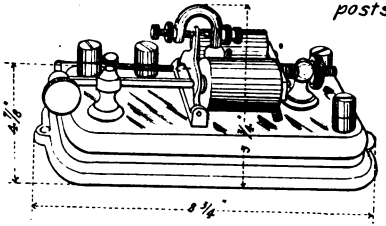
STEEL LEVER KEY.

NO. 110



$52\frac{1}{2}$ Same as the above Key but without legs and with binding posts mounted on top.

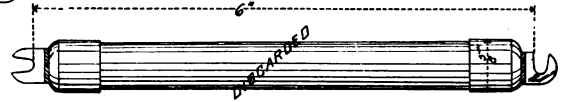
53



Morse Relay
75-150 & 250-OHMS
SEE ALSO NO. 102.

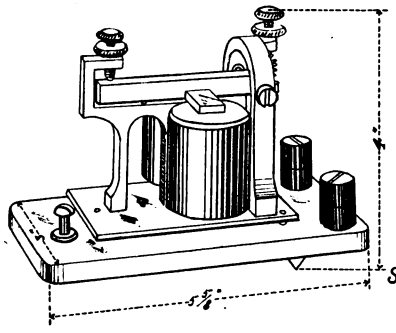
Number

54

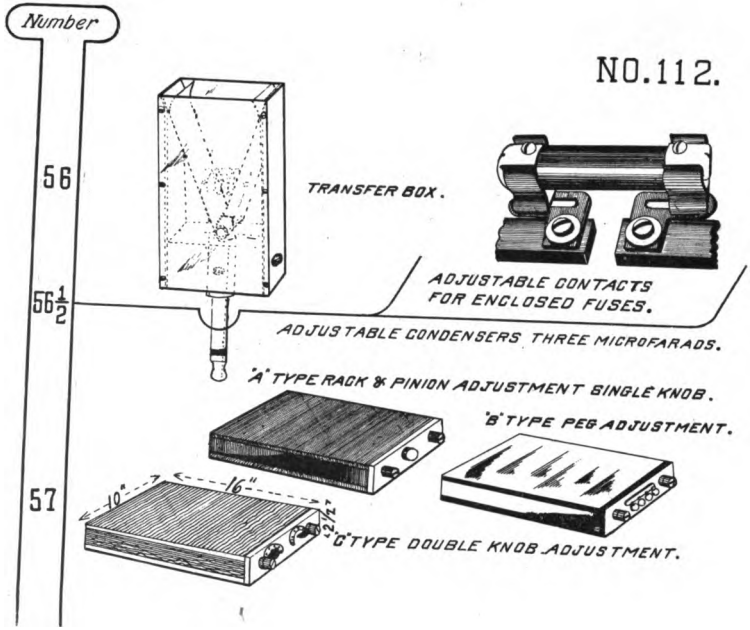


Fuse for old style block ℄ 10 & 20 Amperes
Requisitions must specify amperage desired.

55



Sounder
10 & 150 Ohms
Specify resistance required

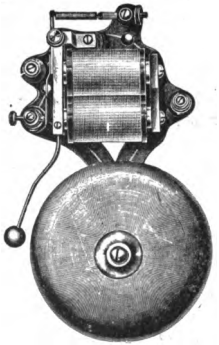


NO.113.

Number.	
58	
59	

Number.

60



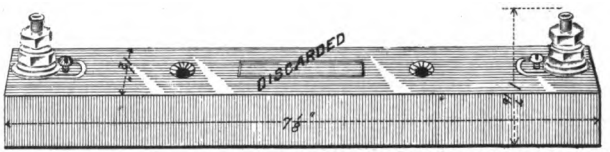
NO. 114.

SKELETON (VIBRATING) IRON FRAME BELL. (10 AND 50 - OHMS) SPECIFY RESISTANCE REQUIRED.

$60\frac{1}{2}$

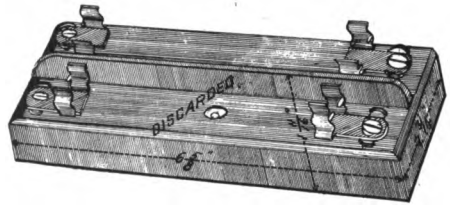
SAME AS ABOVE BUT SINGLE STROKE.

61



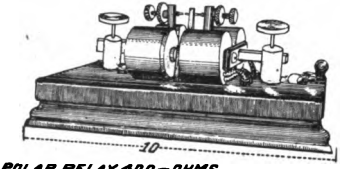
SINGLE 10 AND 20 AMPERE FUSE BLOCK. SEE ALSO NUMBERS 62-81-82. 97-105. FORMERLY KNOWN AS NO. 1. D. AND W. SINGLE.

Number



NO. 115.

62 DOUBLE HALF AMPERE FUSE BLOCK. SEE ALSO NUMBERS 61-~~81-82~~. 97-105. FORMERLY KNOWN AS NO. 2. D. &W. DOUBLE.



63 POLAR RELAY 400-OHMS.

63½ POLAR RELAY FOR DIRECT POINT REPEATERS 500-OHMS. SAME AS ABOVE.

Number

64

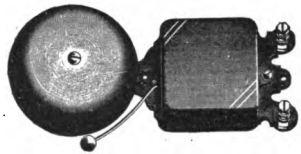
64½

65

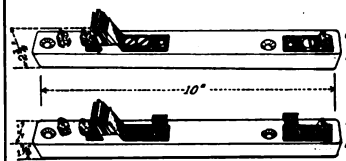
66

NO.116.

IRON BOX VIBRATING BELL
10-OHMS



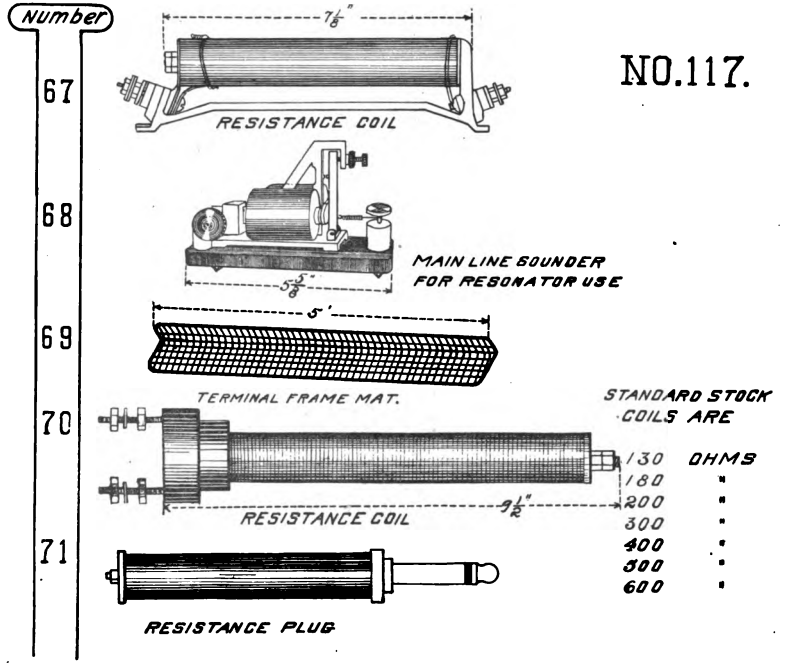
IRON BOX SINGLE STROKE BELL
10-OHMS



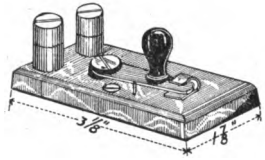
COMBINED LIGHTNING ARRESTER & FUSE BLOCK. 10 & 20 AMPERES.

COMBINED LIGHTNING ARRESTER & FUSE BLOCK. ½ AMPERE.

NO.117.

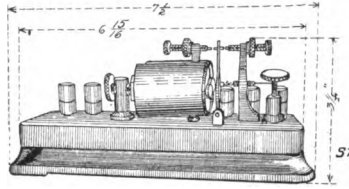


Number
72
73
74

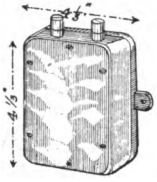


NO. 118.

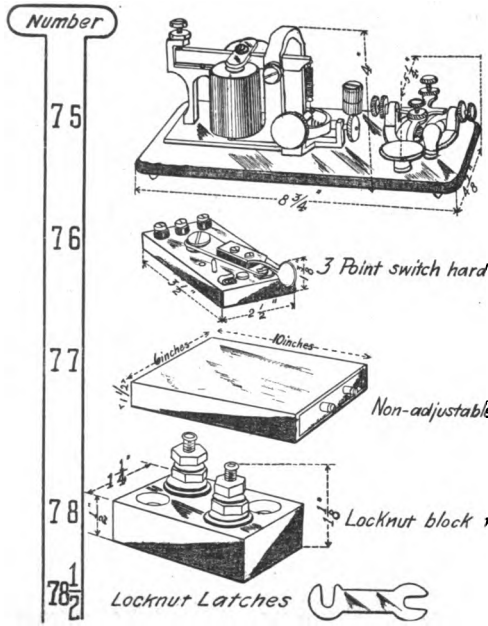
SOUNDER CUTOUT.



STANDARD TRANSMITTER.
10—OHMS.



CONDENSER $\frac{1}{10}$ M.F.



NO.119.

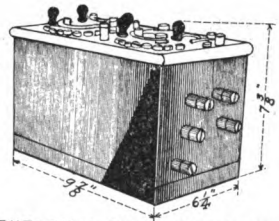
Main line sounder Key on base (K.O.B.) 150 Ohms.
See also Number 113.

Number

79

80

81



DUPLEX & QUADRUPLEX RHEOSTAT.

NO.120.

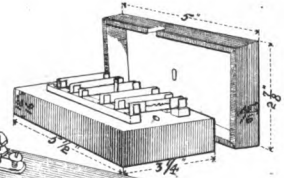
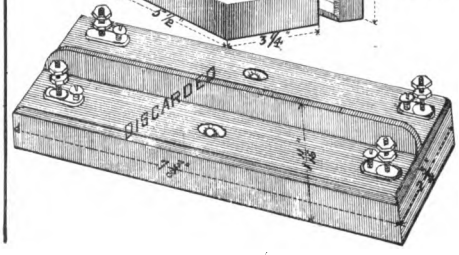
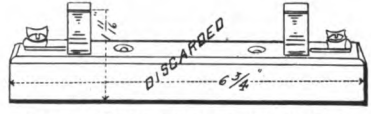
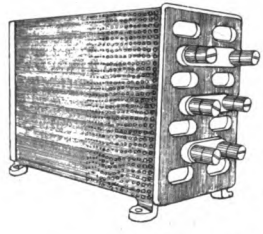
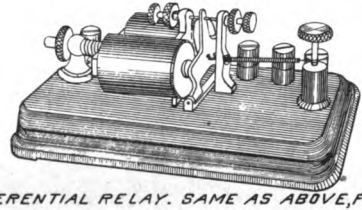


TABLE FUSE BLOCK.



10 & 20 Ampere double fuse block See also numbers 82-61-62. Formerly known as No 1 O & W.

NO.121.

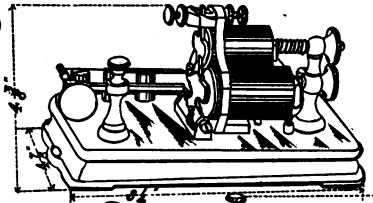
Number	
82	 HALF AMPERE SINGLE FUSE BLOCK. SEE ALSO NUMBERS 97–105.
83	 QUAD. LEAK RHEOSTAT.
84	 RELAY FOR BUG TRAP WORK (20-OHMS)
84 1/2	DIFFERENTIAL RELAY. SAME AS ABOVE, FOR BUG TRAP WORK

Number

85

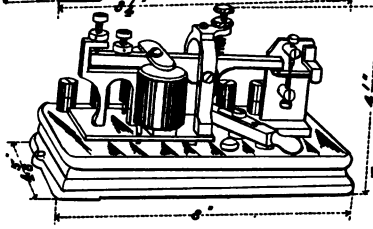
86

87



NO.122.

WEINY REPEATER RELAY
10 & 20—OHM LOCAL
MAGNETS SPECIFY
RESISTANCE REQUIRED.



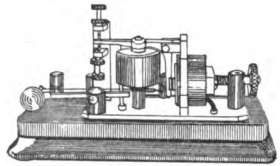
WEINY REPEATER TRANS-
MITTER.

PLUG COUPLER

NO.123.

Number

88

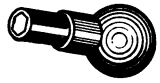


NEUTRAL RELAY

89

Reversible Wrench for hexagonal nuts.

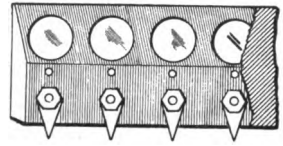
89½

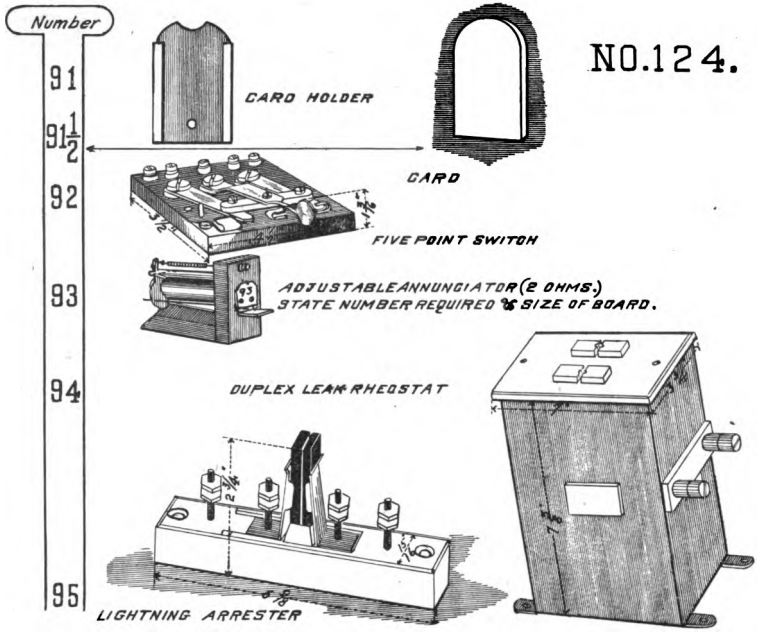


Wrench for hexagonal nuts.

90

Terminal Bar, state for number of wires required. Standard sizes 50 wires. and fifty pairs (100 wires)





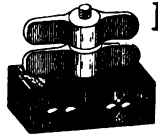
Number

96

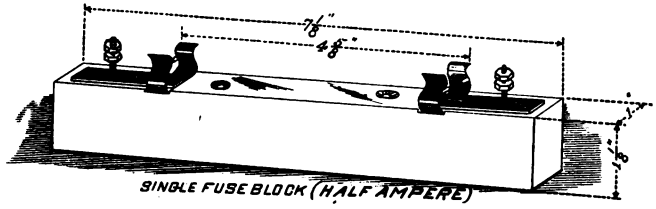
97

98

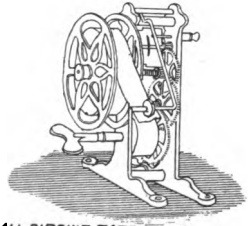
NO.125.



LINE TESTING CLAMP



SINGLE FUSE BLOCK (HALF AMPERE)

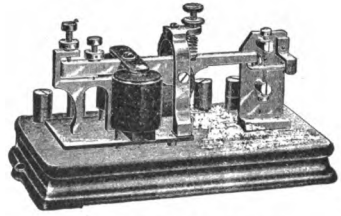


CALL CIRCUIT TAPE REEL

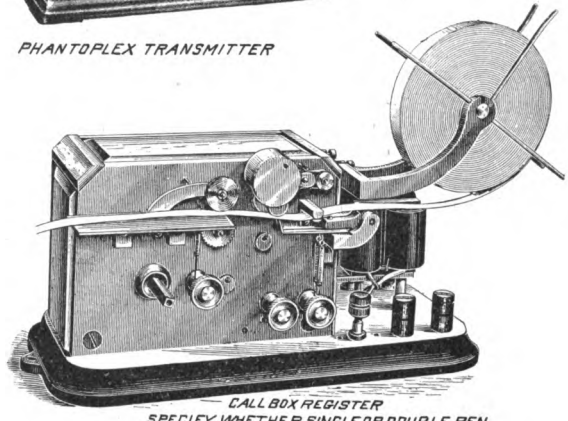
99

100

NO.126.



PHANTOPLEX TRANSMITTER



CALL BOX REGISTER
SPECIFY WHETHER SINGLE OR DOUBLE PEN

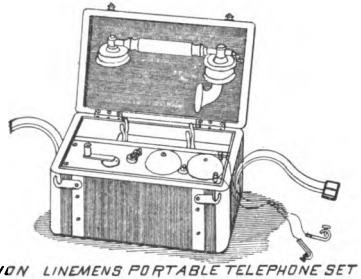
Number

101

101½

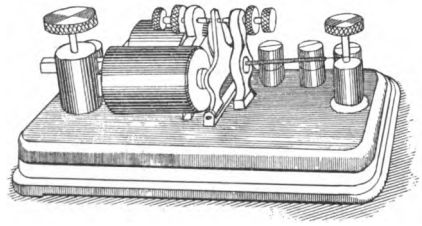
102

NO.127



STATION LINEMENS PORTABLE TELEPHONE SET
WITH SHOULDER STRAP.

PORTABLE TELEPHONE SET, (SMALL FOR HAND USE)



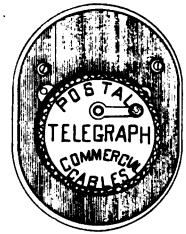
MORSE RELAY RACK AND PINION ADJUSTMENT.

Number

103

104

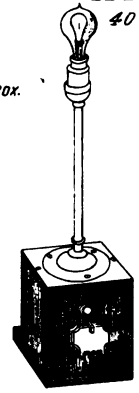
105



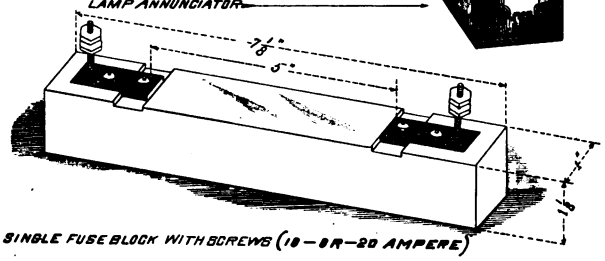
MESSENGER CALL BOX.

NO.128.

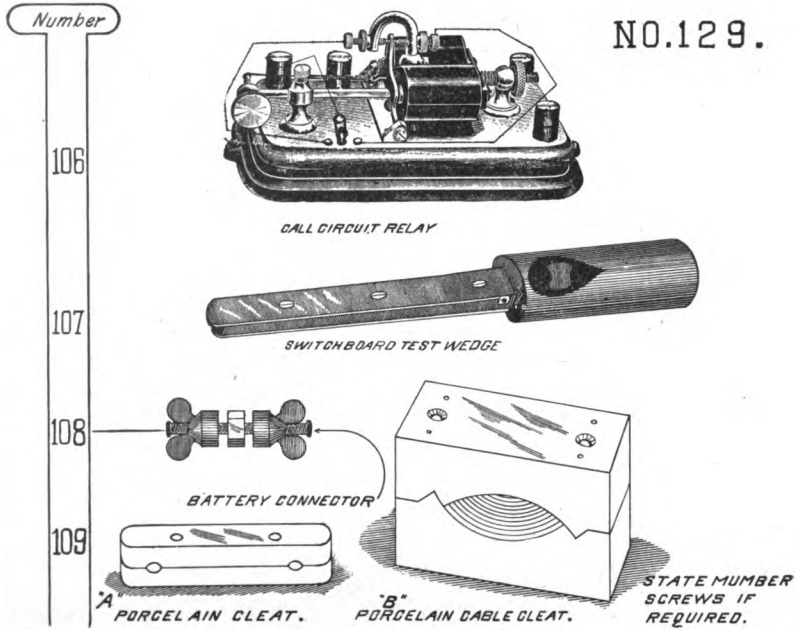
40 Volt LAMP



LAMP ANNUNCIATOR



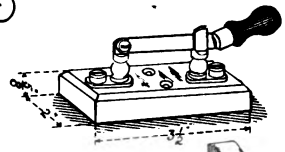
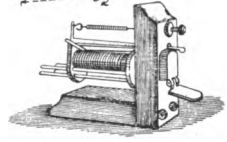
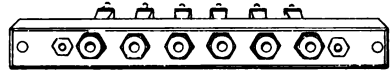
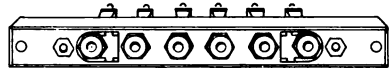
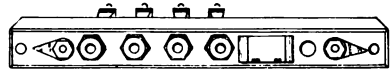
SINGLE FUSE BLOCK WITH SCREWS (10—8R—20 AMPERE)



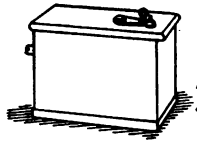
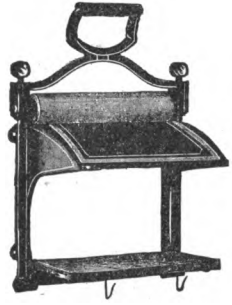
NO.130.

Number	"A"	
110	"B"	PORCELAIN TUBES
111		MULTIPLEX LIGHTNING ARRESTER
112		GROUNDING PLUG
113		MAIN LINE SOUNDER (K.O.B.)

NO.131.

Number		
114		GROUNDING KNIFE SWITCH
115		DIFFERENTIAL ANNUNCIATOR (20 OHMS.)
116		TABLE BAR WITH SIX NUMBER 28½ JACKS.
117		SWITCHBOARD BAR SEE PRINT NO. 301.
118		TERMINAL BAR. SEE PRINT NO. 311.

NO.132.

Number	
119	 LEAK RHEOSTAT 20,000-OHMS
120	SWITCHBOARD CARD HOLDER   CARD
121	SWITCHBOARD CARD
122	 MESSAGE COPYING PRESS 
123	TABLE GALVANOMETER

NO.133.

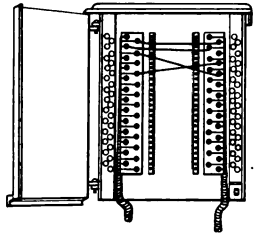
Number

124

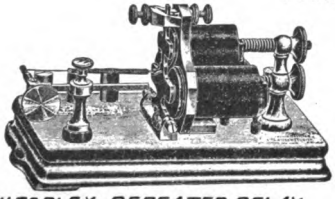
125

126

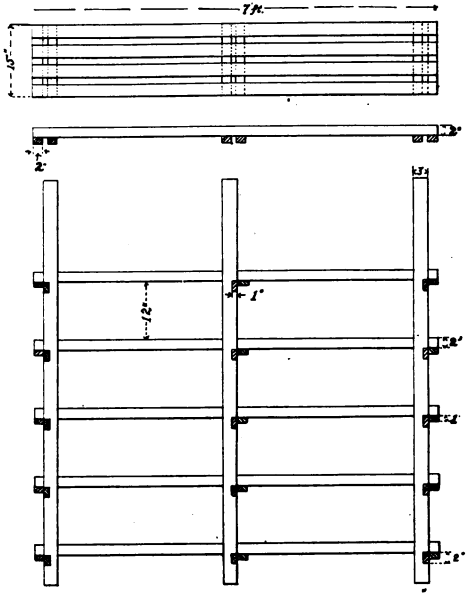
METALLIC PERPETUAL CALENDAR



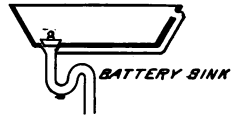
IRON TERMINAL BOX, LOCKNUT & MARKER EQUIPMENT



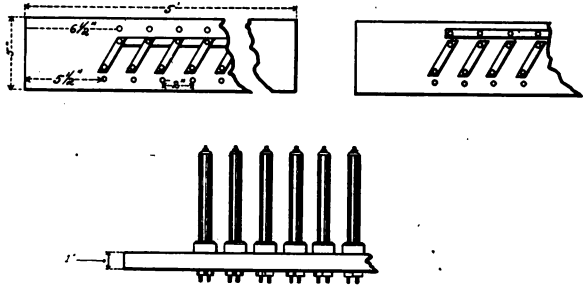
PHANTOPLEX REPEATER RELAY



BATTERY STAND

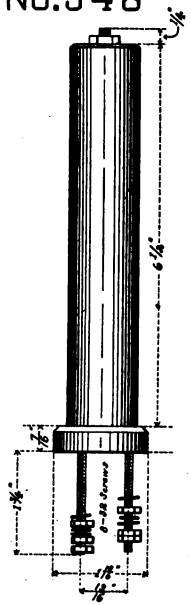


NO.310

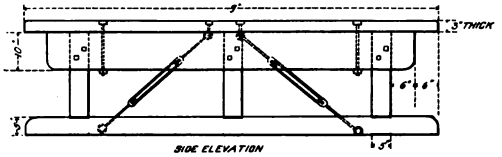


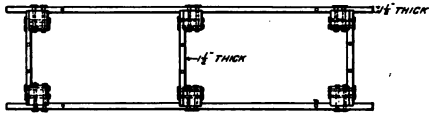
COIL BOARD

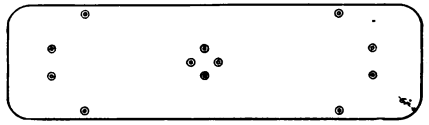
NO.348

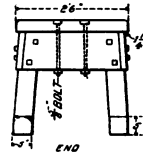


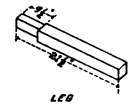
NO.344

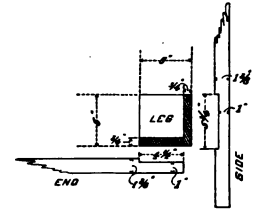


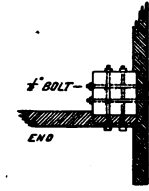






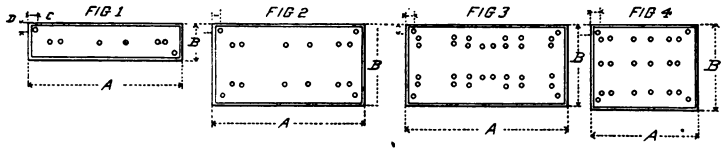






DYNAMO BENCH FOR FOUR MACHINES

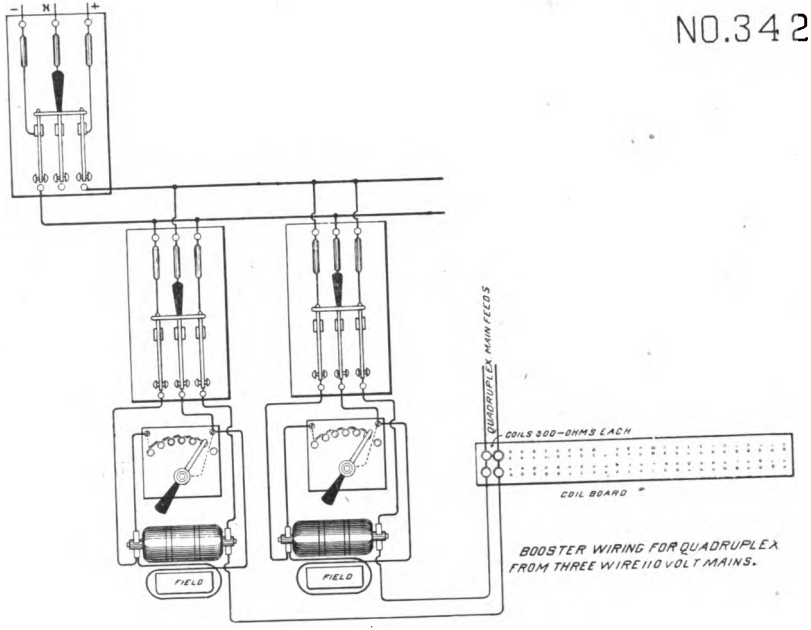
NO.343



AMP		FIG	A	B	C	D
35	SPSTF	1	1¼	2⅝	⅛	⅛
"	DPSTF	2	1¼	4⅝	⅛	⅛
"	DPDTF	3	1¾	3⅛	⅛	⅛
"	3PSTF	4	1¼	6	⅛	⅛
50	SPSTF	1	1⅝	2⅝	⅛	⅛
"	DPSTF	2	1⅝	5	⅛	⅛
"	DPDTF	3	1¾	6	⅛	⅛
"	3PSTF	4	1⅝	6⅛	⅛	⅛

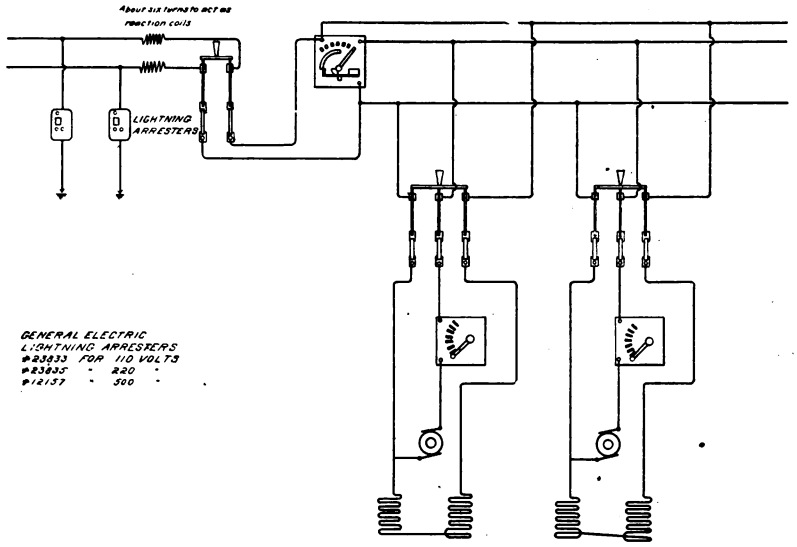
SIZE OF SLATE & LAYOUT OF CORNER HOLES OF STYLE A HILL SWITCHES, FITTED FOR TYPE A D&W FUSES ORDER BY NUMBER AND VOLTAGE.

NO.342



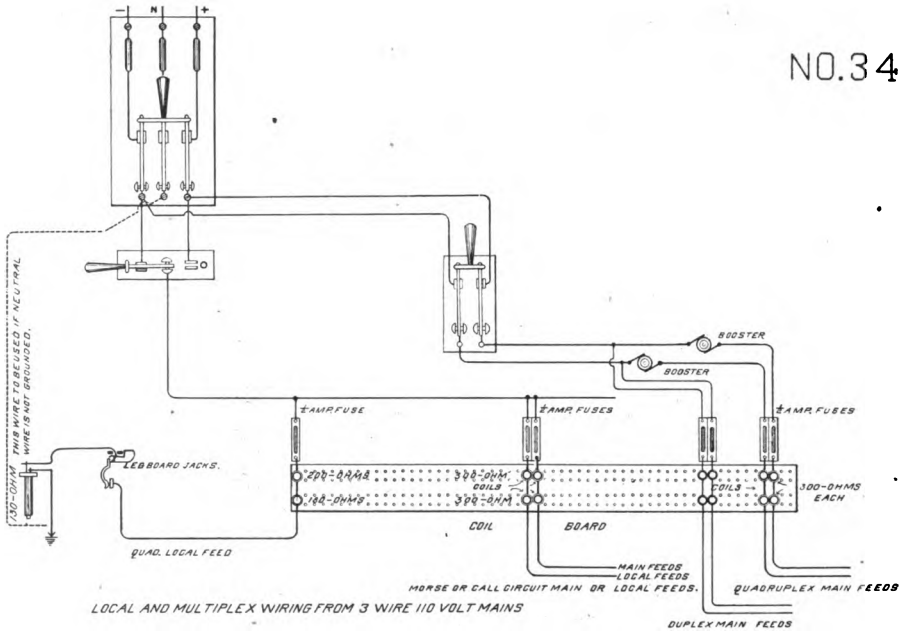
BOOSTER WIRING FOR QUADRUPLEX
FROM THREE WIRE 110 VOLT MAINS.

NO.340



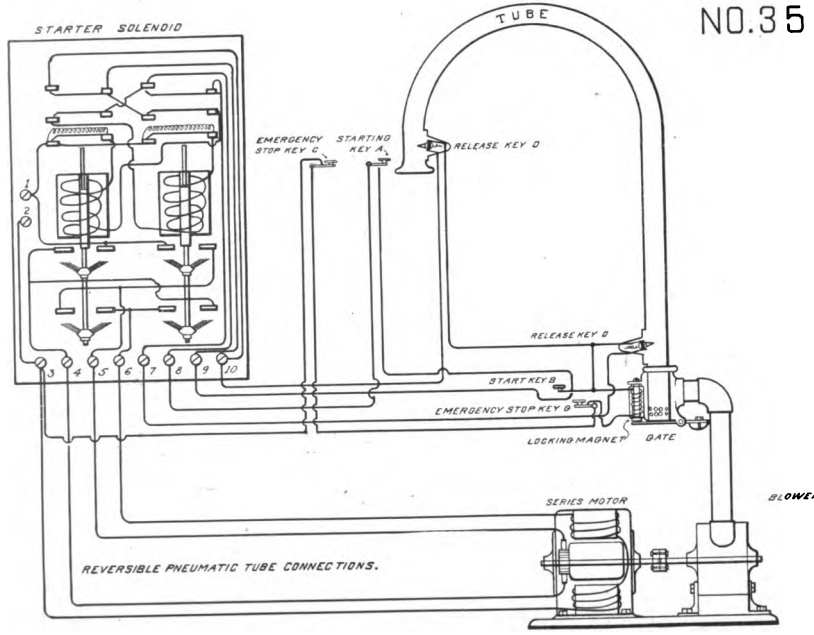
MOTOR UNDERLOAD SWITCH AND LIGHTNING ARRESTER CONNECTIONS.

NO.341

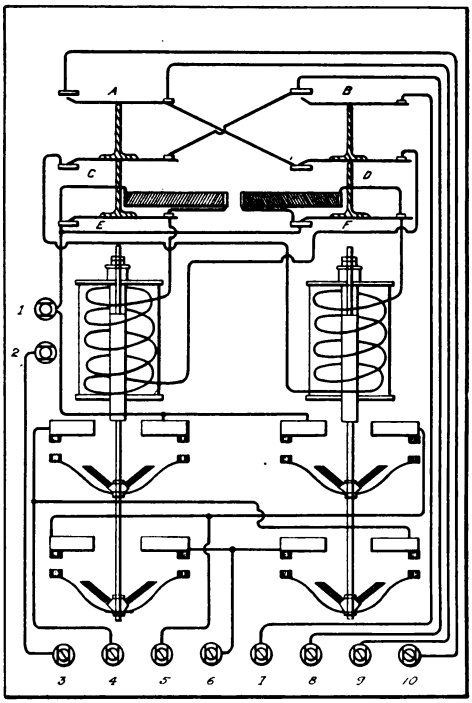


LOCAL AND MULTIPLEX WIRING FROM 3 WIRE 110 VOLT MAINS

NO.352



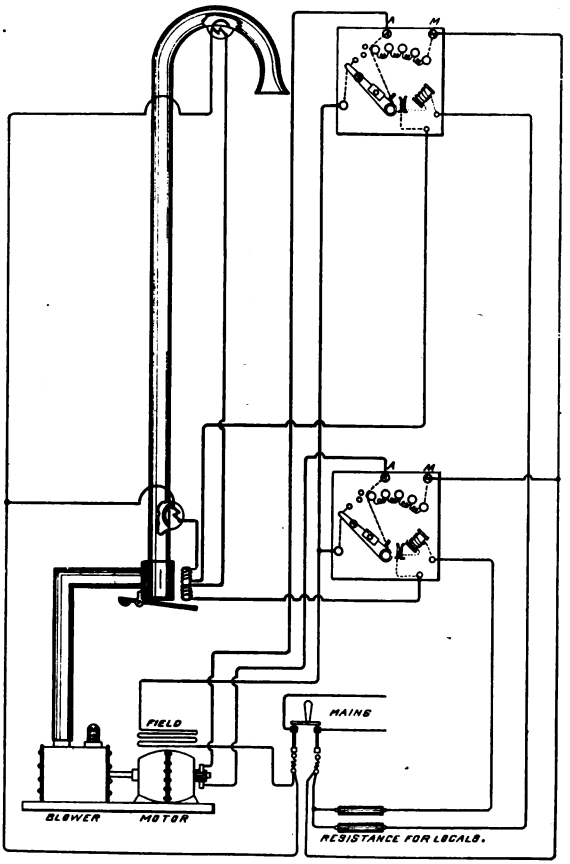
(TRANSFER TUBE CO., N. Y. SYSTEM NO. 8)



MOTOR SOLENOID SWITCH FOR REVERSIBLE PNEUMATIC TUBE

A B SOLENOID SELF LOCKING SWITCHES
C D SAFETY OPENING SWITCHES
E F RESISTANCE COIL SWITCHES TO REDUCE HOLDING CURRENT
(TRANSFER TUBE CO NY. SYSTEM NO.8.)

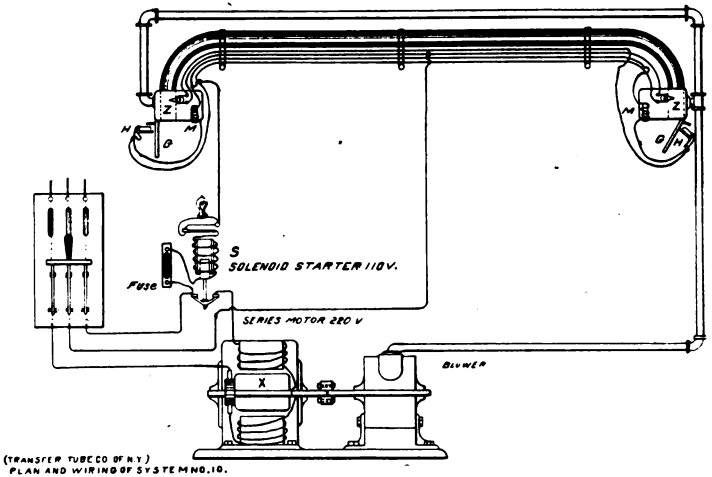
NO. 353



NO. 354

REVERSIBLE PNEUMATIC TUBE CONNECTIONS.

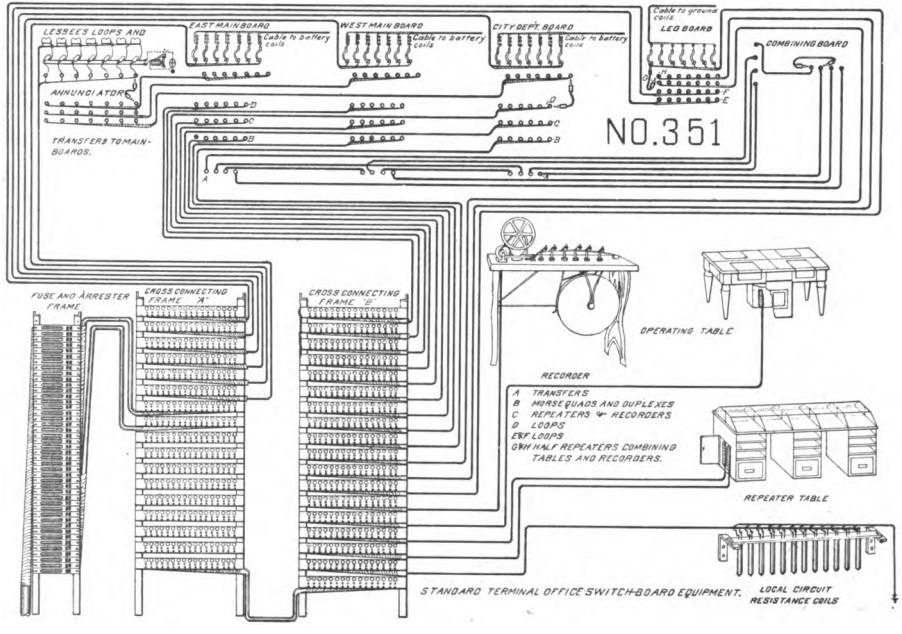
(TRANSFER TUBE CO., N. Y. SYSTEM NO. 3)



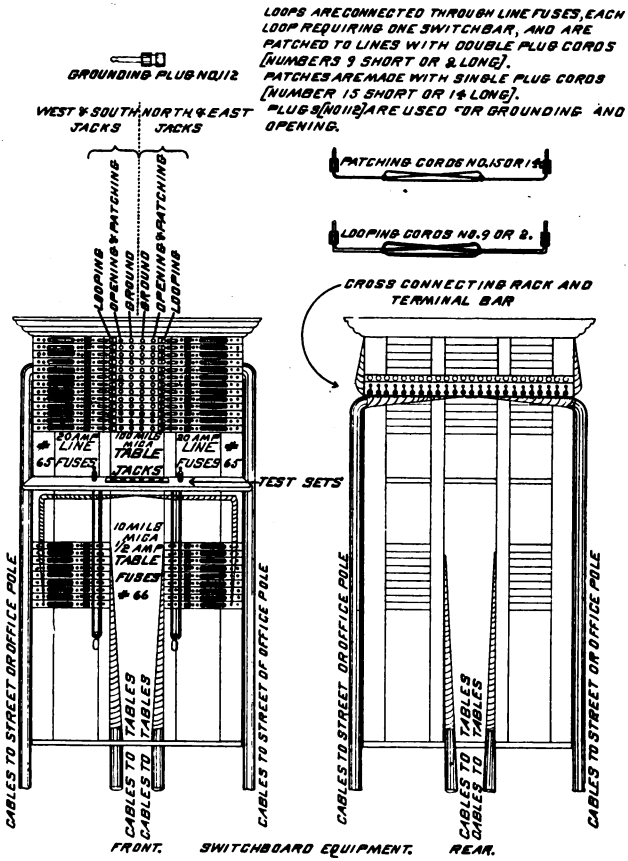
(TRANSFER TUBE CO OF N.Y.)
PLAN AND WIRING OF SYSTEM NO. 10.

The closing of the gate "G" opens the valve which admits air from the compressed air pipe to the transfer tube. It also closes the contacts "H" of a circuit which includes magnet "M" and solenoid "S." Magnet "M" holds the gate "G" closed by attraction solenoid "S" starts the compressor motor "X." When the carrier reaches the release key "Z" at the distant station, the circuit is momentarily opened with the result that gate "G" falls open, breaking the circuit at "H" and shutting down the motor. The current carried by the signal wires in the cable clamped to the tube is approximately two-fifths of an ampere, or enough to hold the solenoid armature and the gate in position. The current is operative only during the transmission of carriers.

NO.356.

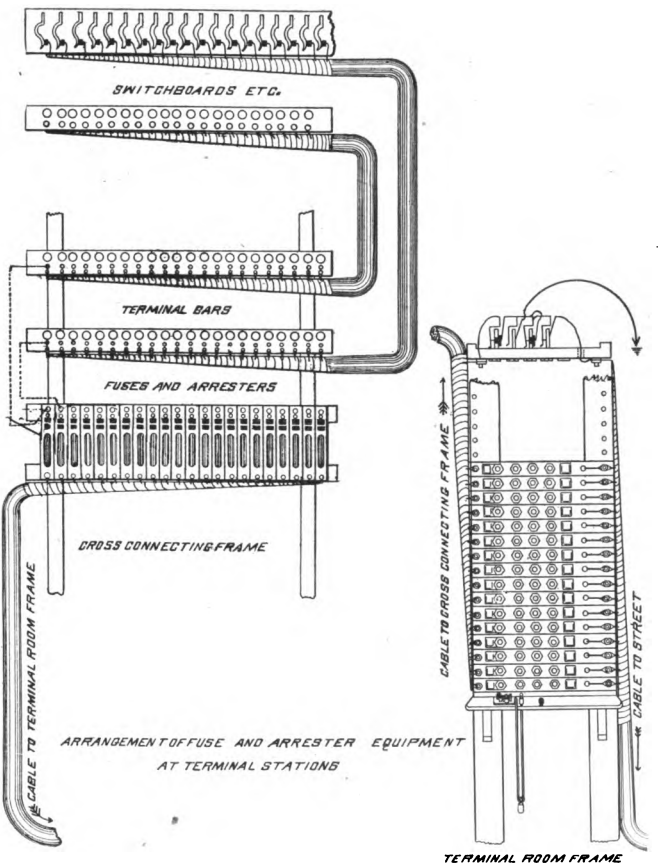


No. 302

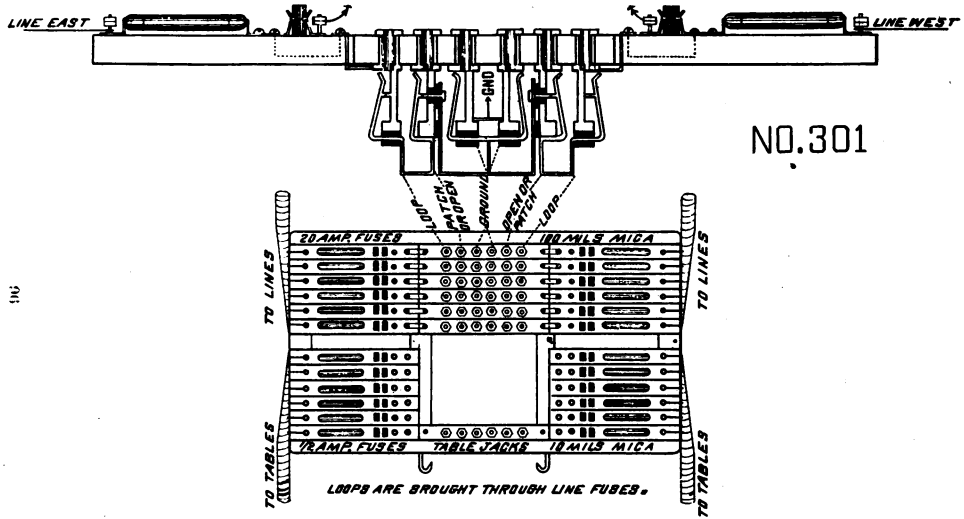


STANDARD SWITCHBOARD EQUIPMENT FOR INTERMEDIATE OFFICES OF FROM SIX LINES UP.

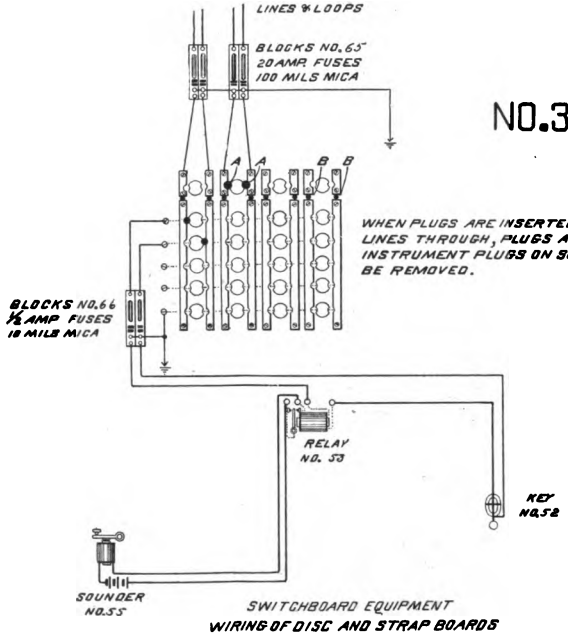
No. 311



ARRANGEMENT OF FUSE AND ARRESTER EQUIPMENT AT TERMINAL STATIONS

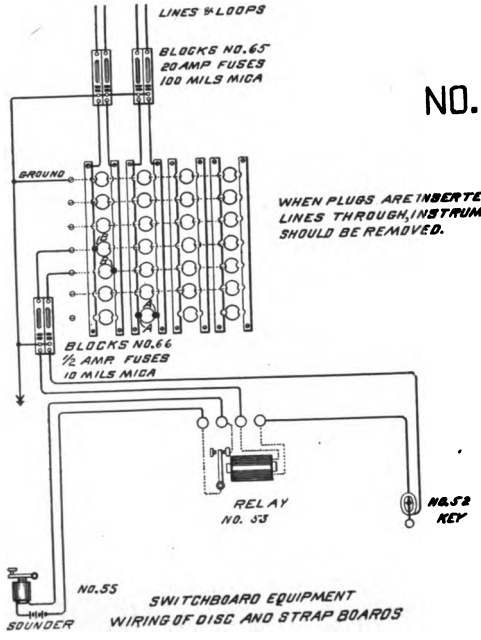


STANDARD SWITCHBOARD EQUIPMENT FOR OFFICES HAVING NOT OVER SIX LINES.



NO. 303 A

SWITCHBOARD EQUIPMENT
WIRING OF DISC AND STRAP BOARDS

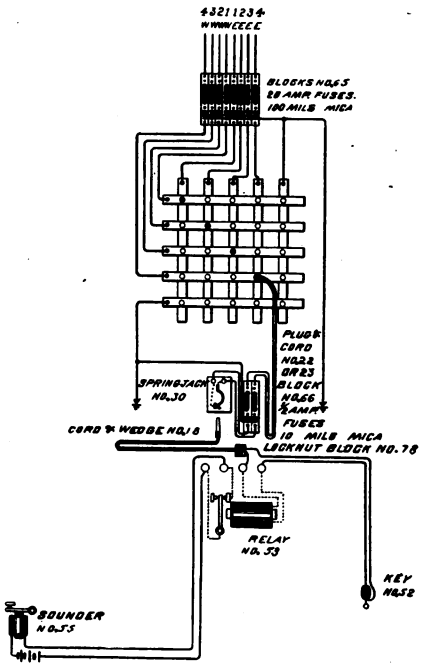


NO.303B

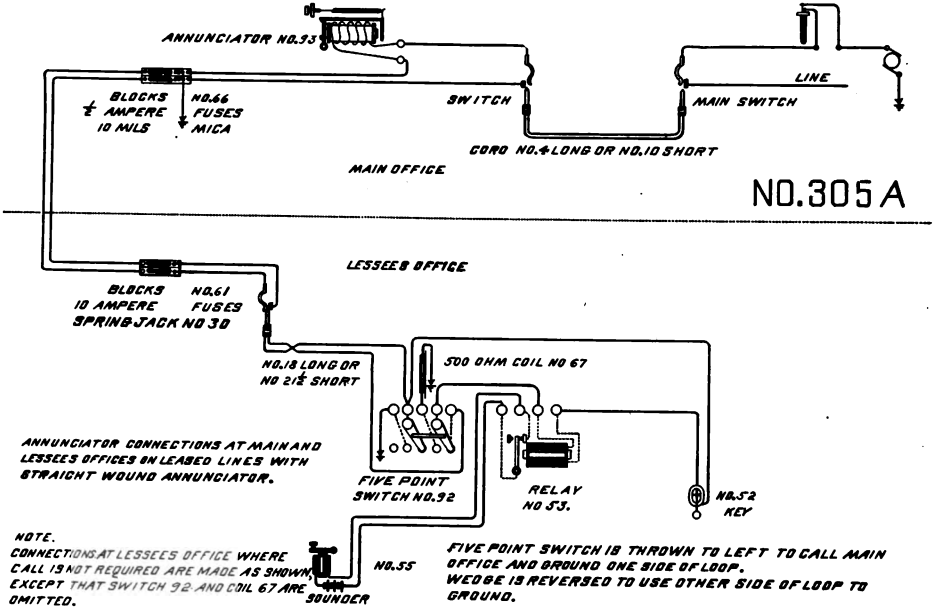
WHEN PLUGS ARE INSERTED AT A-A TO CUT LINES THROUGH, INSTRUMENT PLUGS AS AT BB SHOULD BE REMOVED.

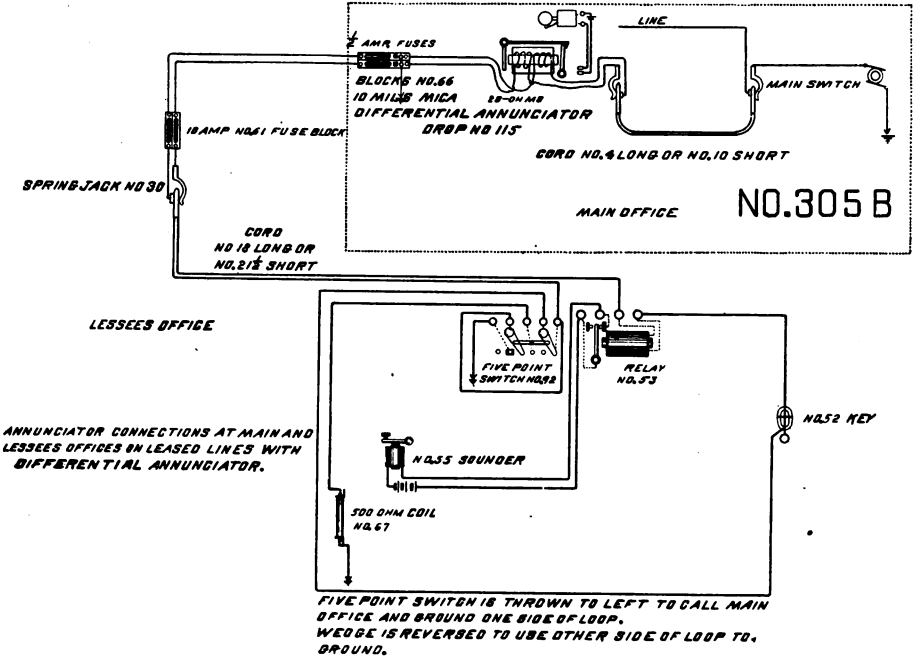
SWITCHBOARD EQUIPMENT
WIRING OF DISC AND STRAP BOARDS

No. 304

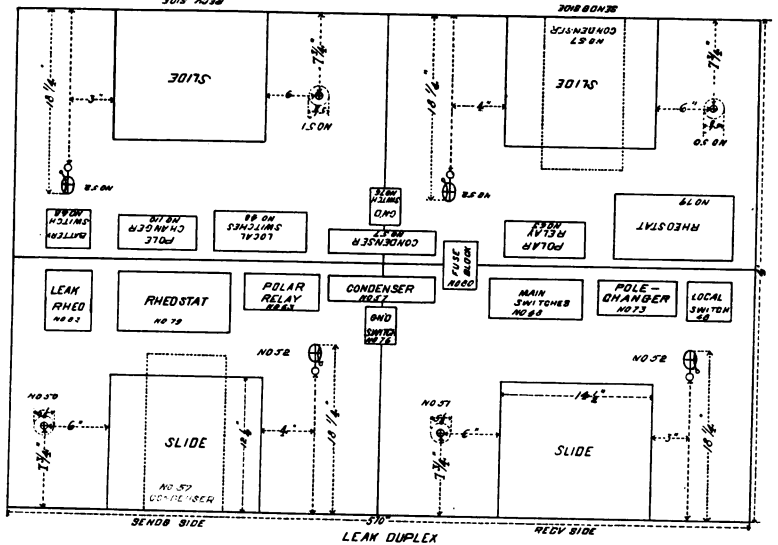


SWITCHBOARD EQUIPMENT
WIRING OF CROSSBAR BOARDS



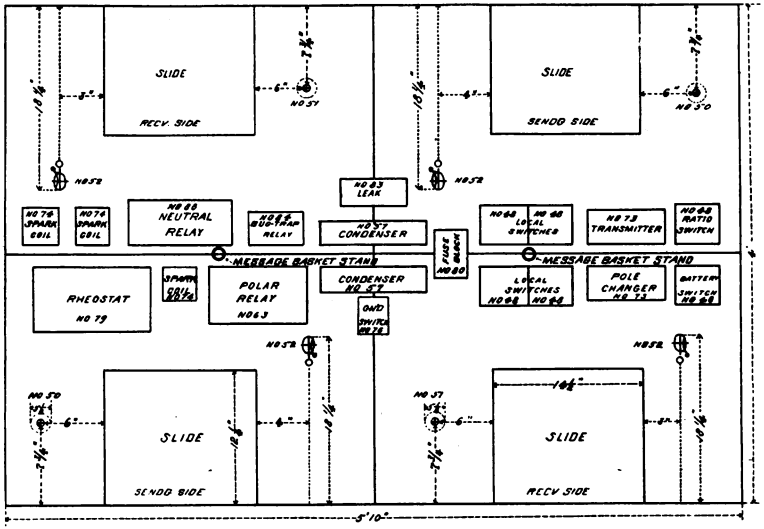


NO.325

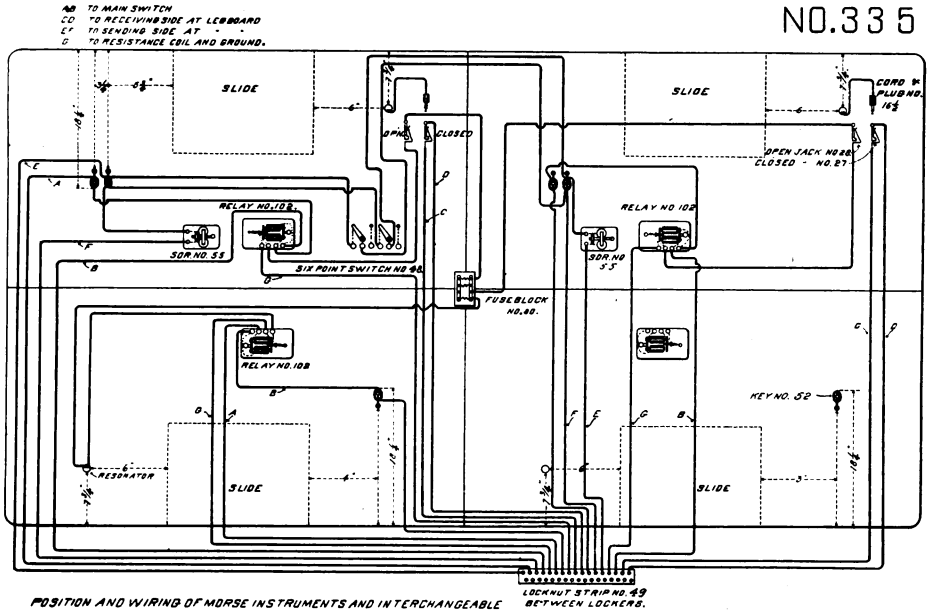


HIGH PRESSURE LEAK DUPLEX — GRAVITY BATTERY AND REGULAR DUPLEX

POSITION OF INSTRUMENTS ON TABLE _

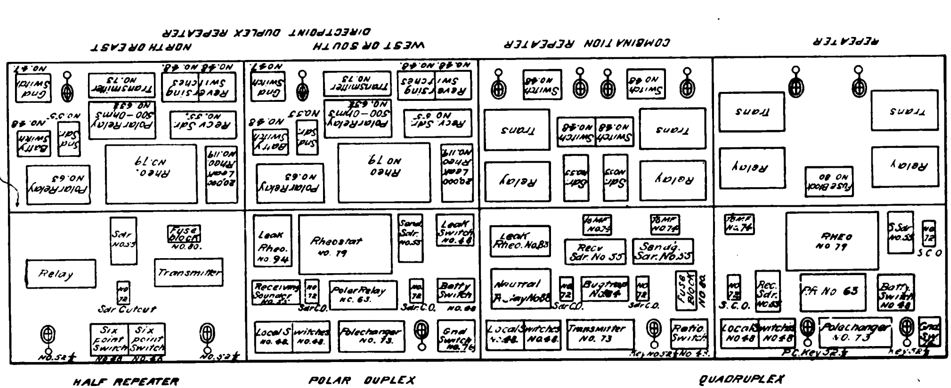


POSITION OF QUADRUPLEX INSTRUMENTS ON QUARTETTE TABLE.



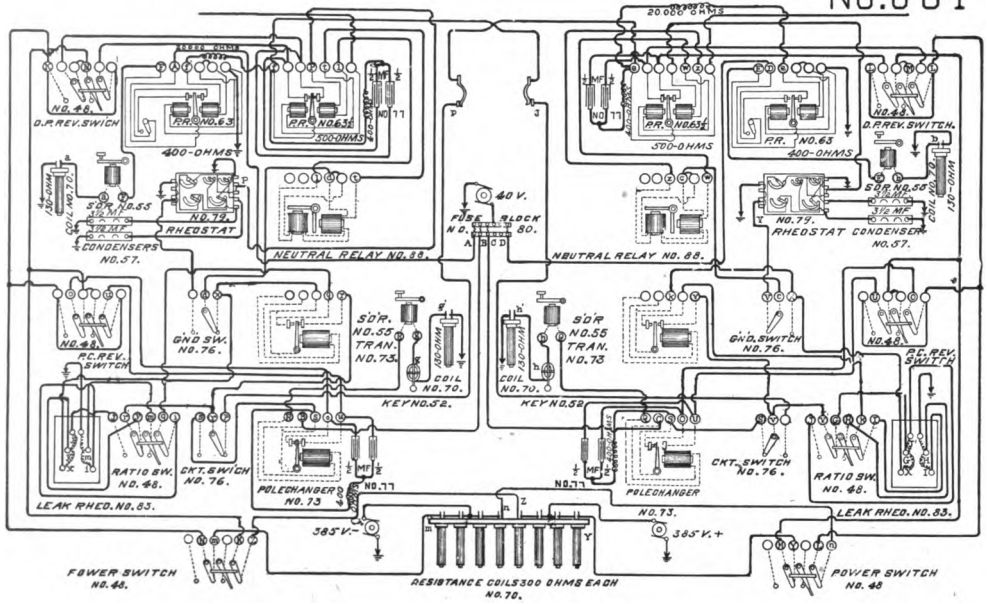
POSITION AND WIRING OF MORSE INSTRUMENTS AND INTERCHANGEABLE OPERATING SETS UPON QUARTETTE TABLE.

NO.329

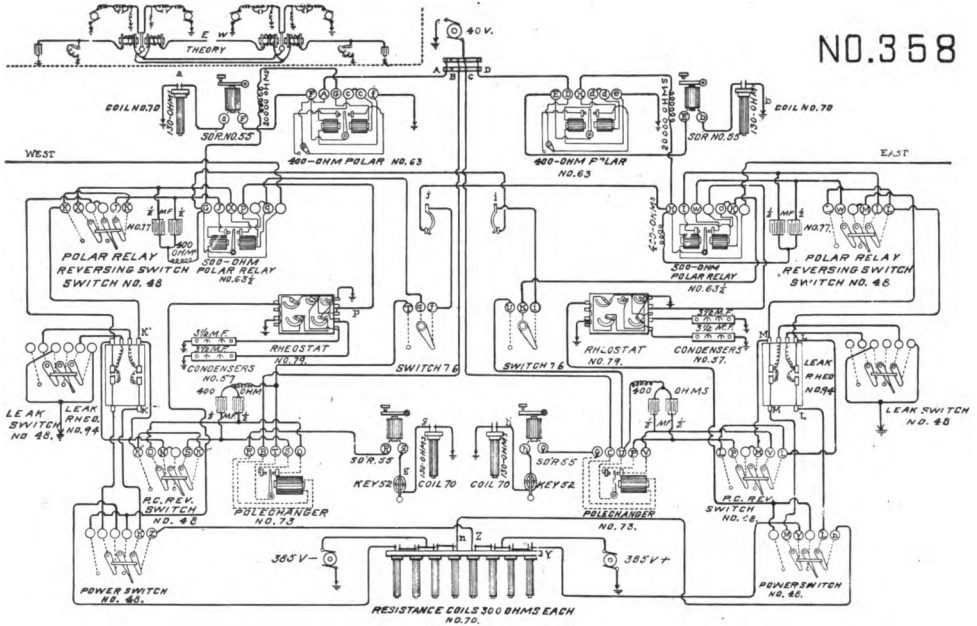


POSITION OF INSTRUMENTS ON REPEATER TABLE

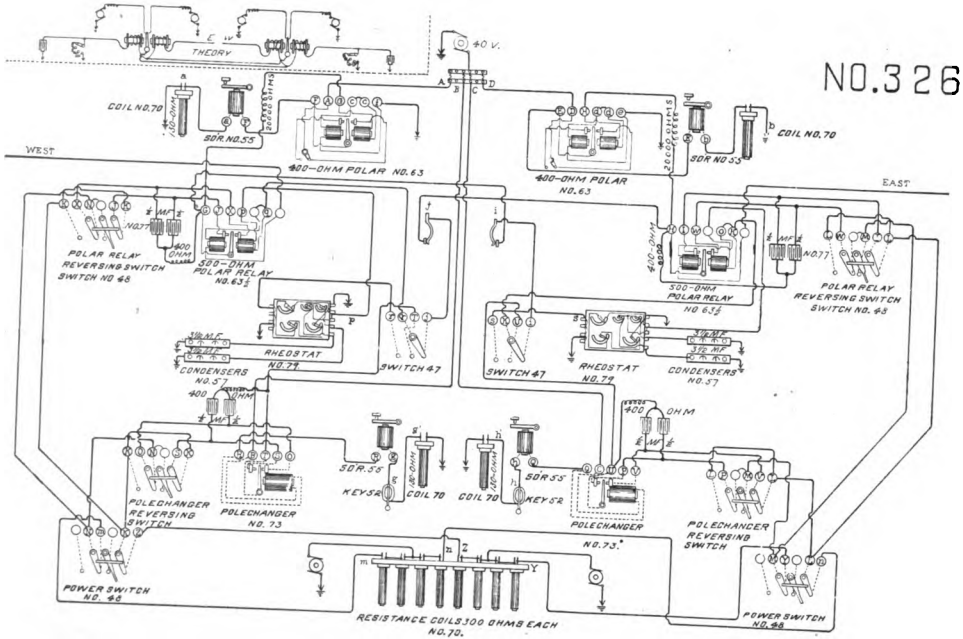
Fuse block and small condensers may be placed upon face of back partition.



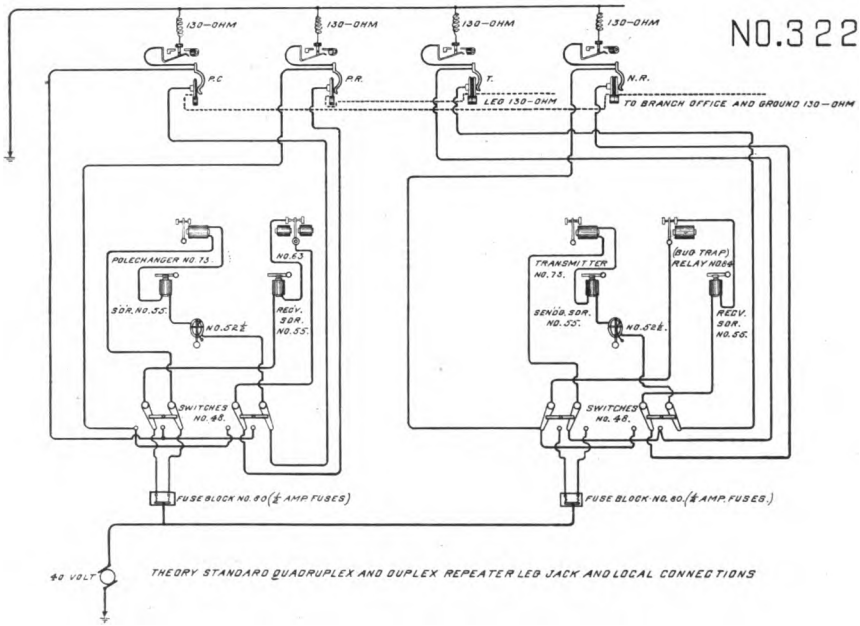
QUADRUPLEX REPEATERS WITH DIRECT POINT POLAR SIDES



HIGH PRESSURE LEAK DUPLEX DIRECT POINT REPEATERS

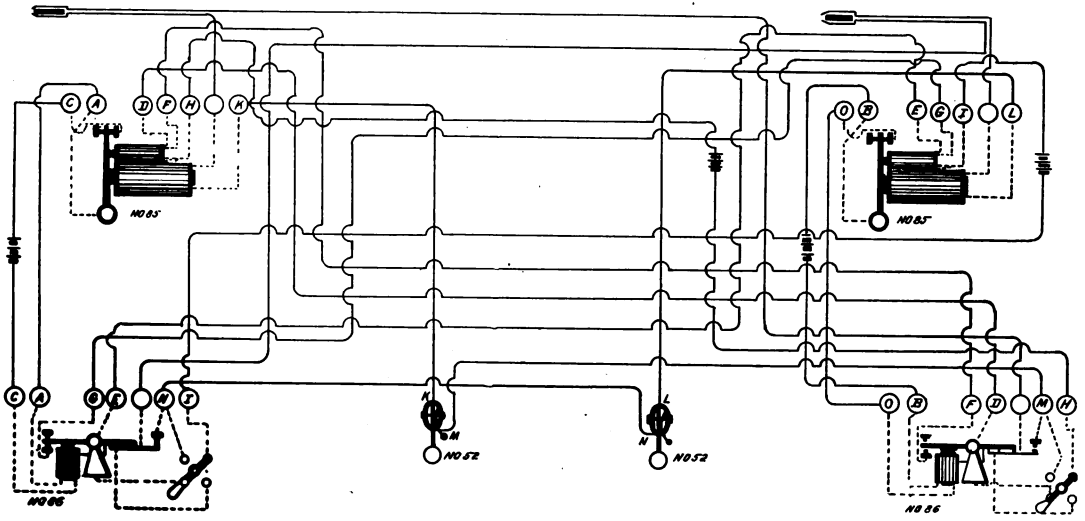


POLAR RELAY DUPLEX REPEATER

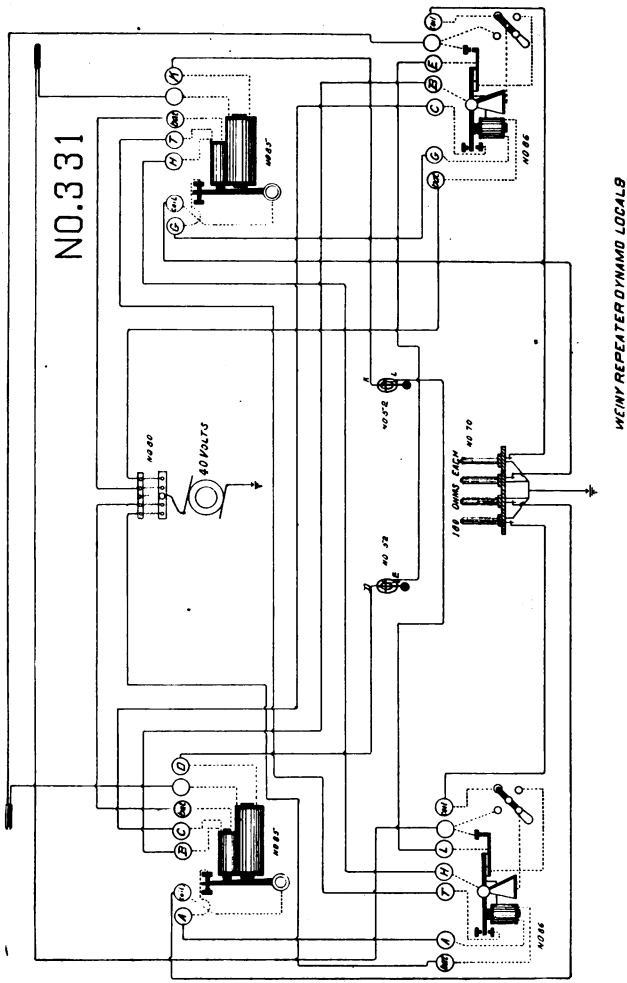


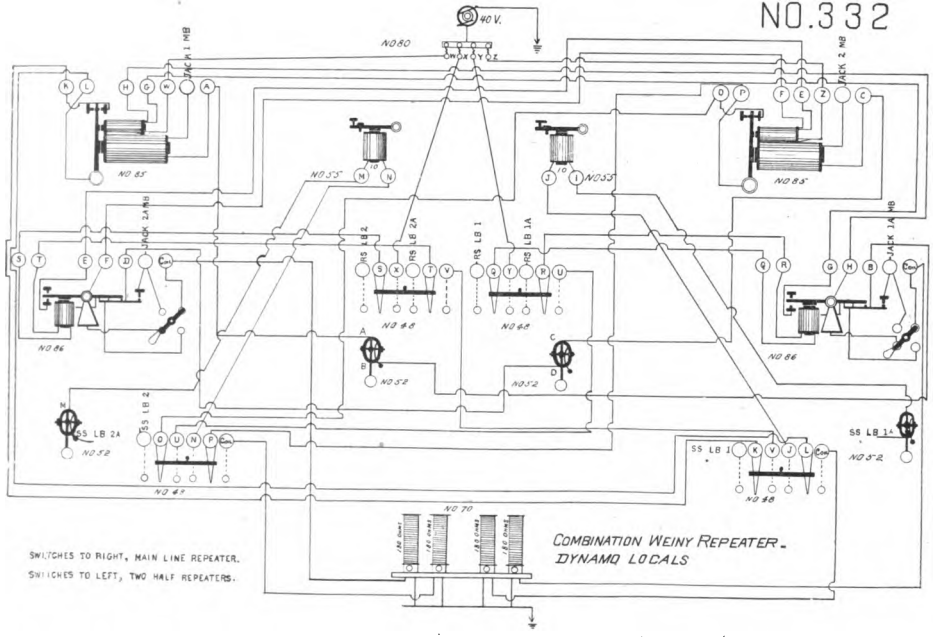
THEORY STANDARD QUADRUPLEX AND DUPLEX REPEATER LEG JACK AND LOCAL CONNECTIONS

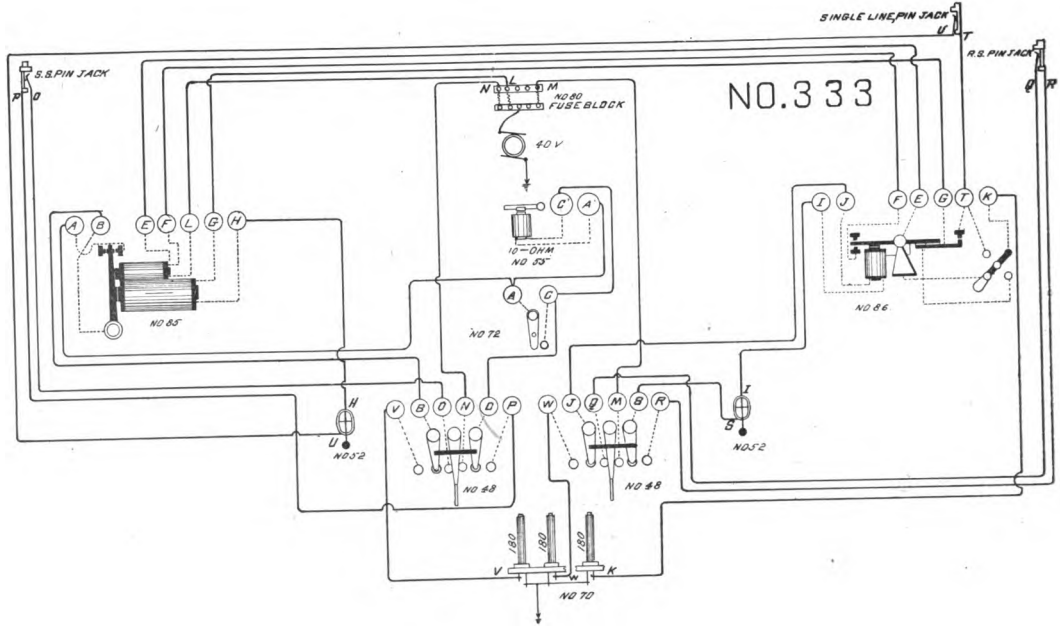
NO.330



WEINY REPEATER WITH BATTERY LOCALS

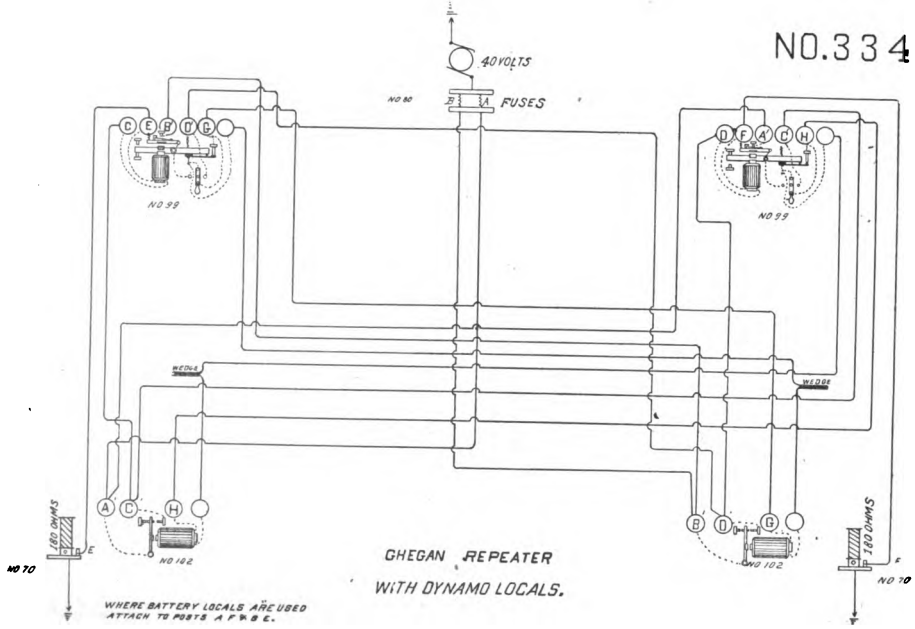


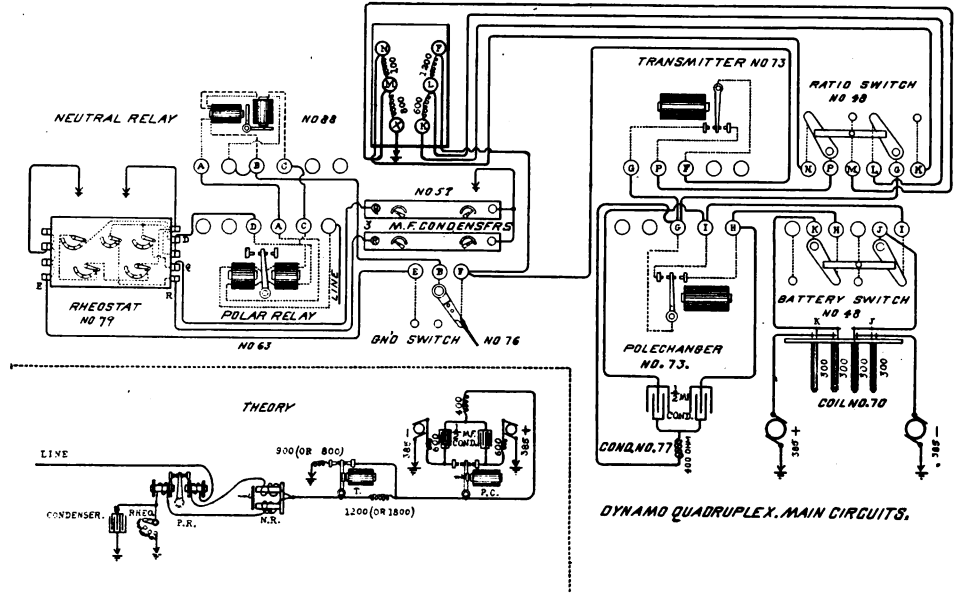




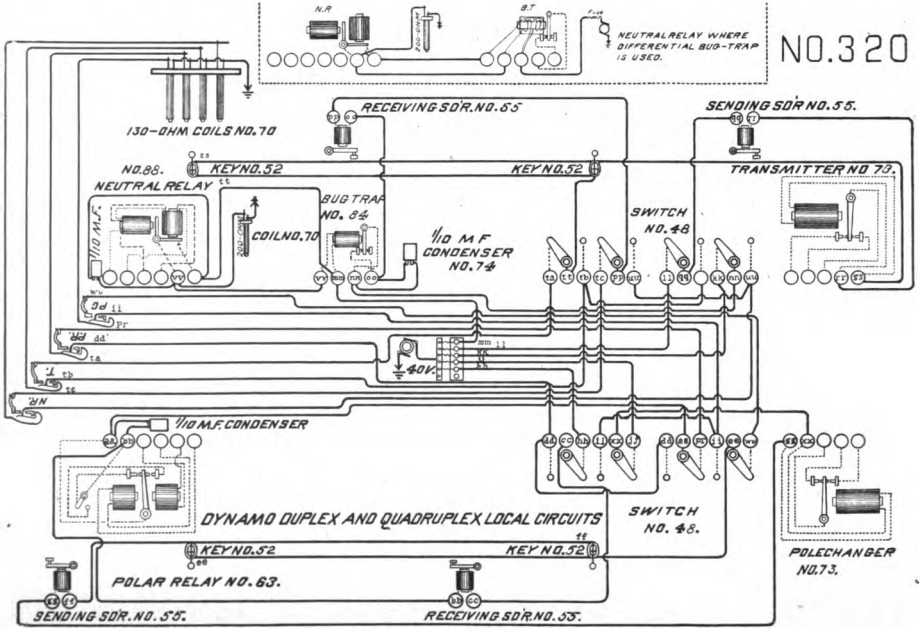
HALF WEINY REPEATER— DYNAMO LOCALS

NO.334

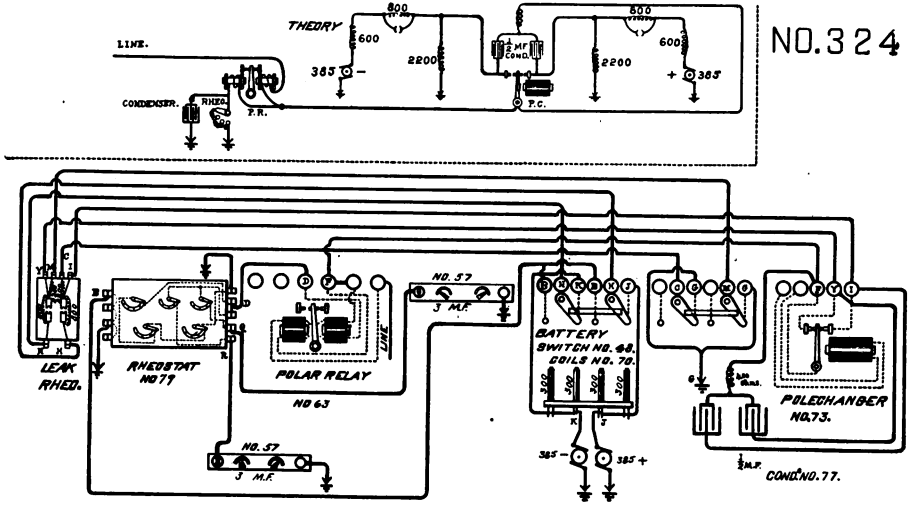




DYNAMO QUADRUPLEX. MAIN CIRCUITS.



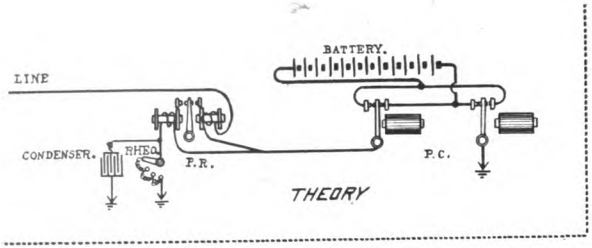
NO. 324



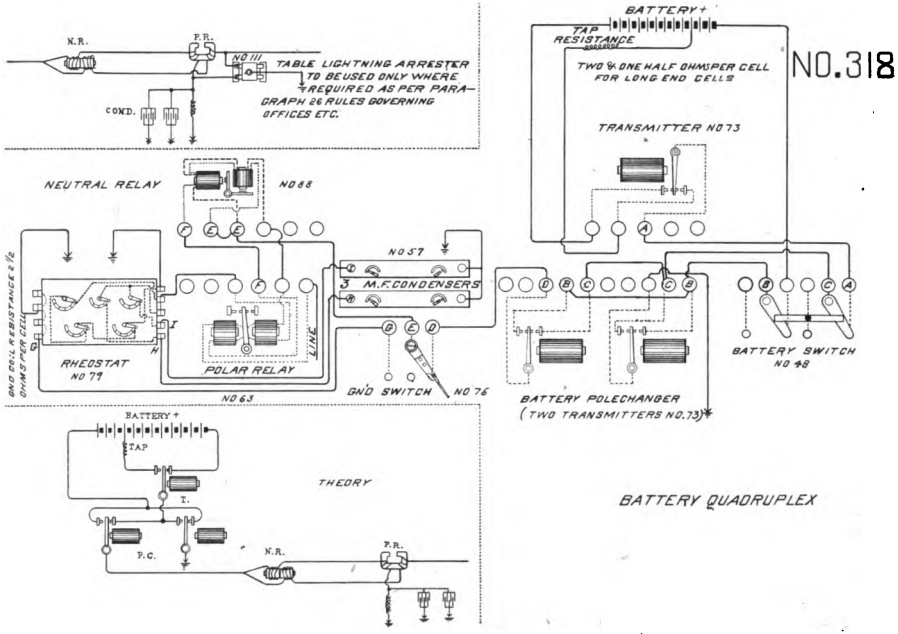
DYNAMO LEAK DUPLEX, MAIN CIRCUITS.

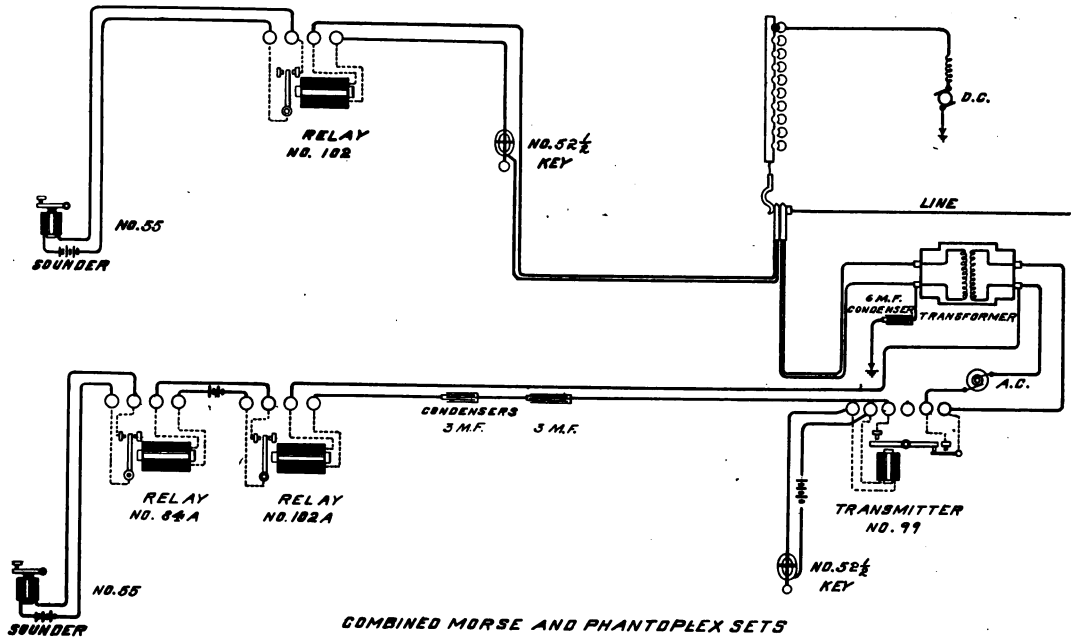
WHERE DUPLEXES ARE OPERATED FROM LOW PRESSURE MACHINES, THE LEAK RHEO. & SWITCH ARE OMITTED & WIRES ARE RUN DIRECT FROM N to 1 and N to Y.

NO.323

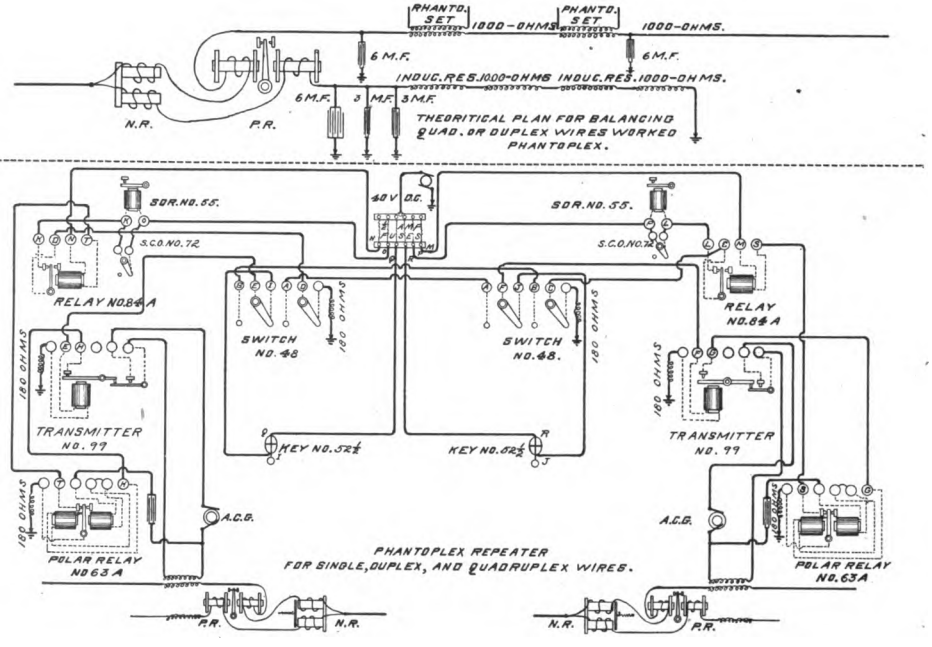


BATTERY DUPLEX, MAIN CIRCUITS

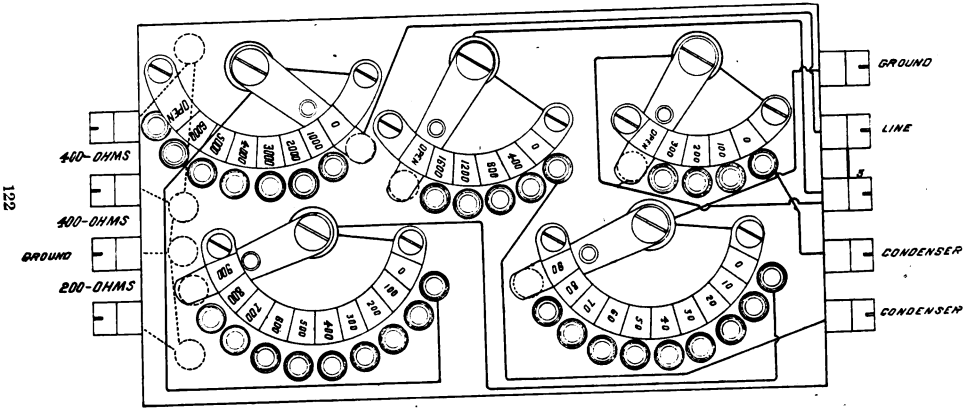




COMBINED MORSE AND PHANTOPLEX SETS

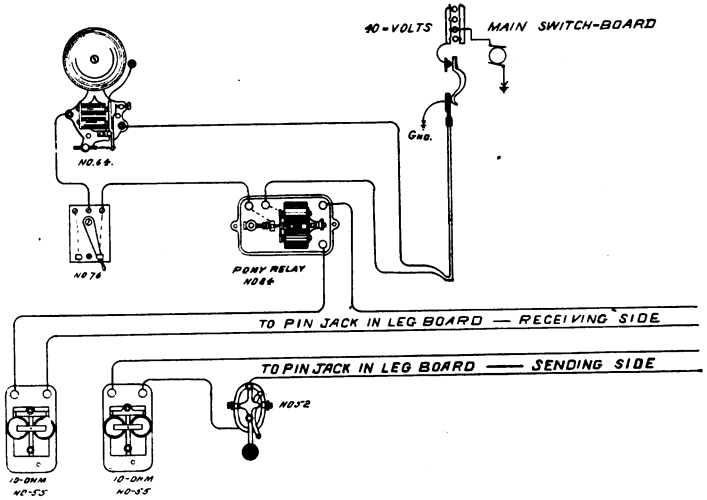


NO.349



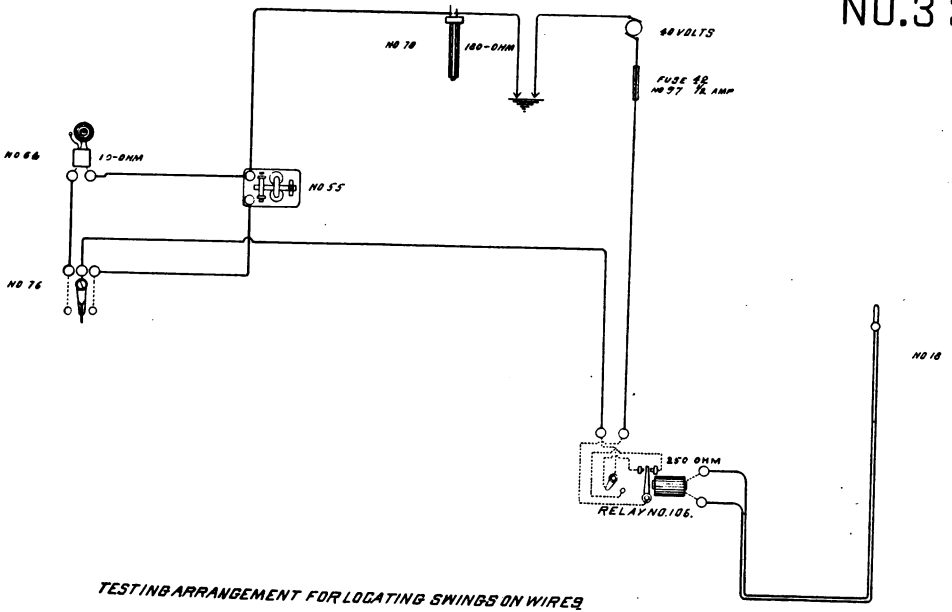
QUADRUPLEX & DUPLEX RHEOSTAT.

NO.339



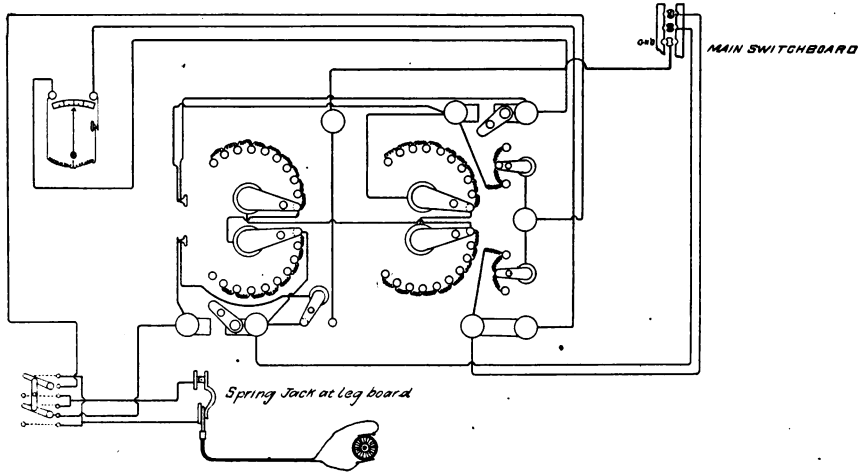
CALL BELL
(SECOND SIDE OF QUAD)
RINGS ON OPENING OF DISTANT KEY.

NO.337

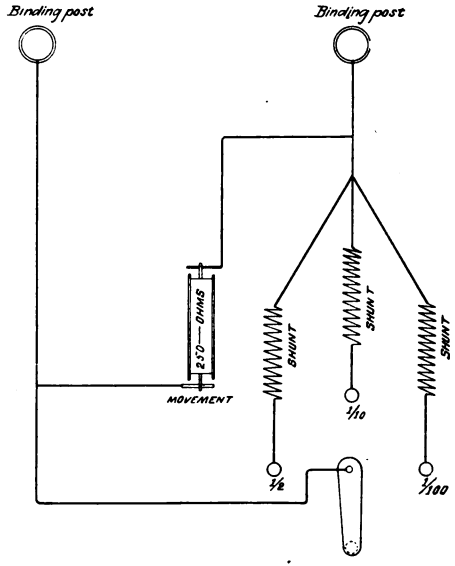


TESTING ARRANGEMENT FOR LOCATING SWINGS ON WIRES

NO.347

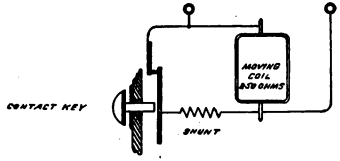


WHEATSTONE BRIDGE CONNECTIONS

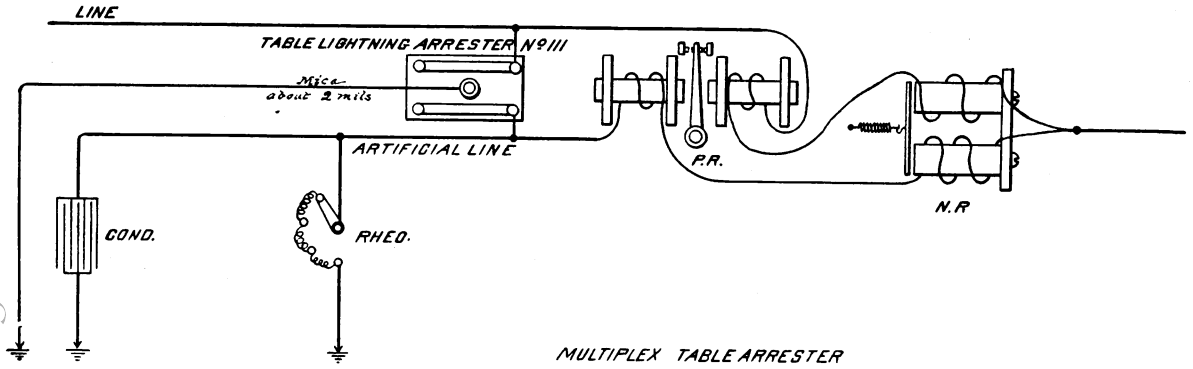


POSTAL STYLE WESTON GALVANOMETER

NO. 350



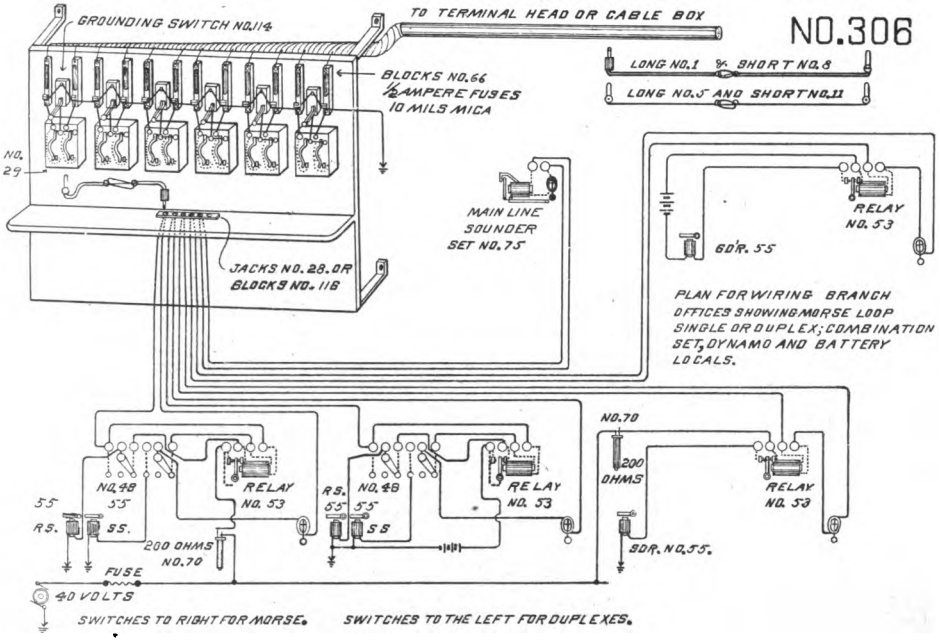
NO.317



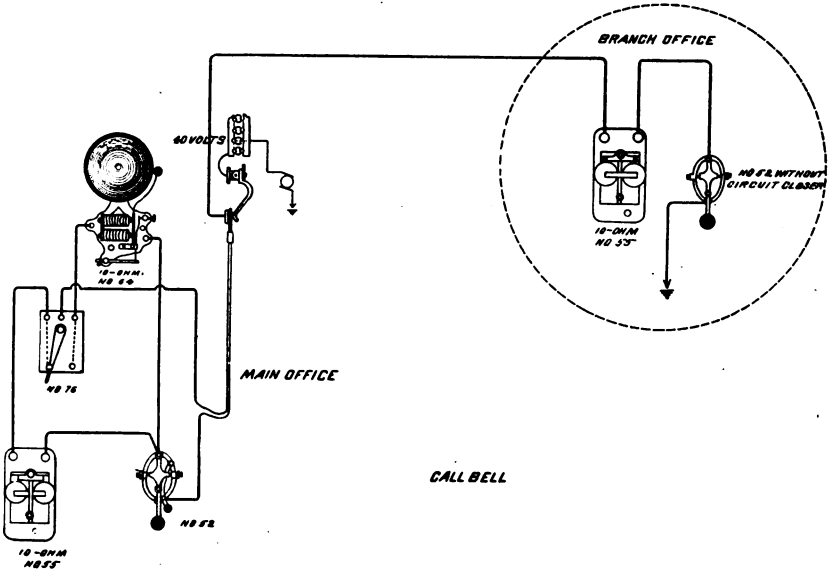
MULTIPLEX TABLE ARRESTER

No 345

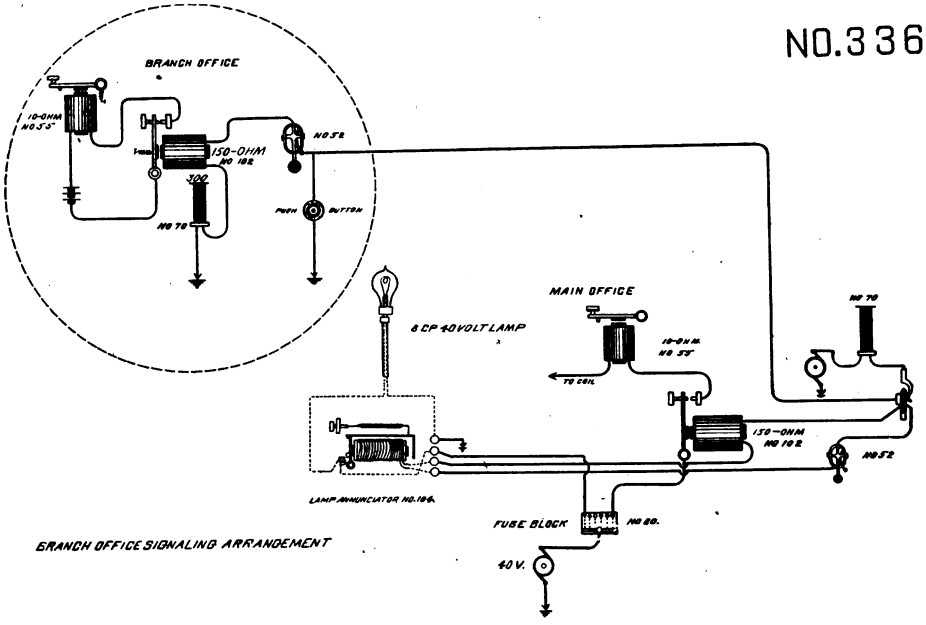
STANDARD PLAN FOR LIGHTING OPERATING ROOMS



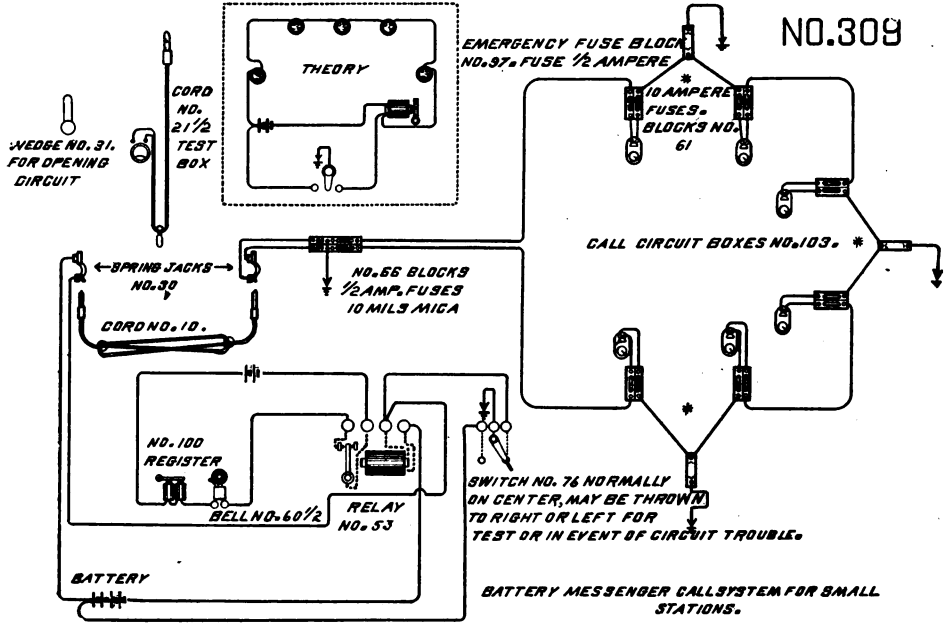
NO.338

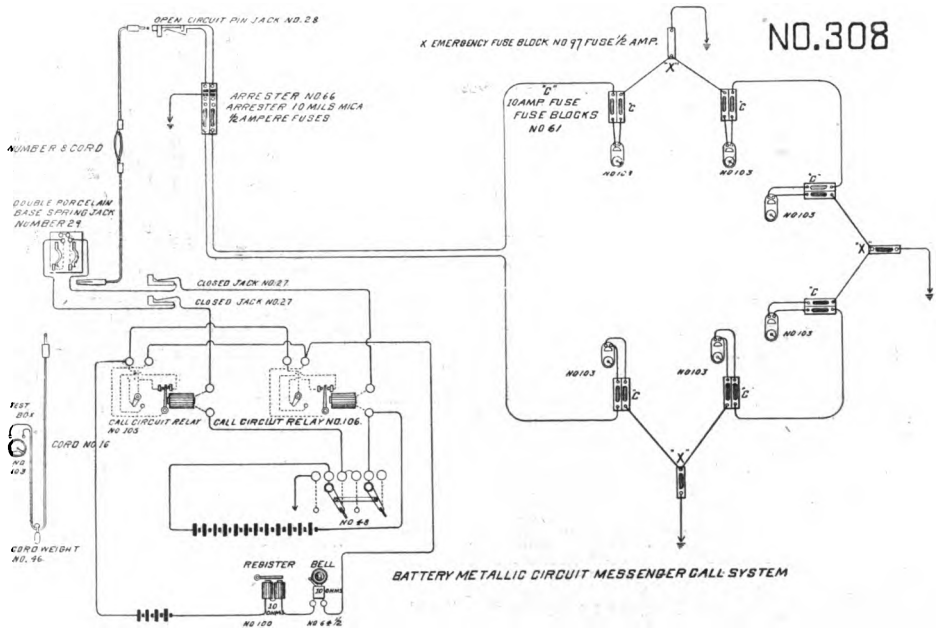


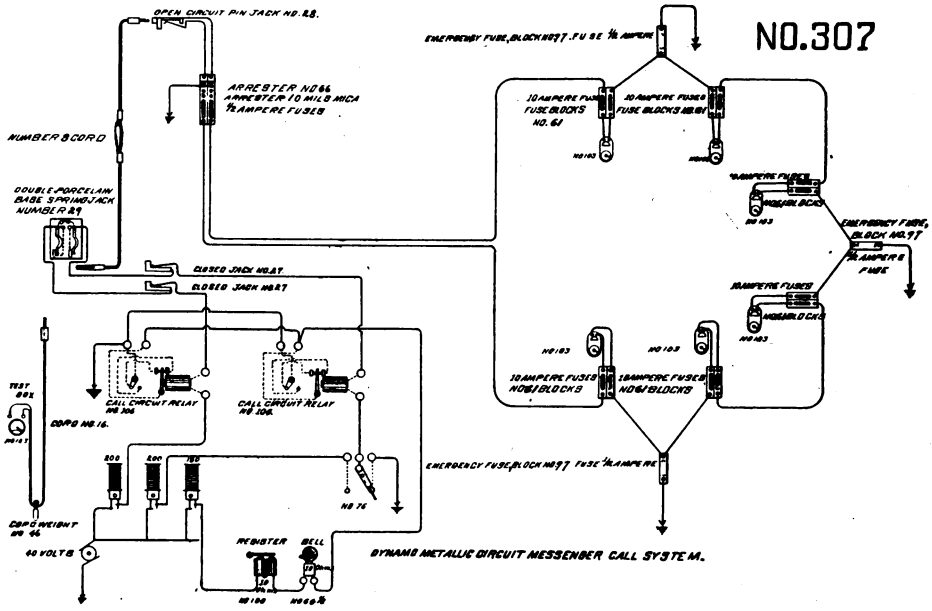
NO.336

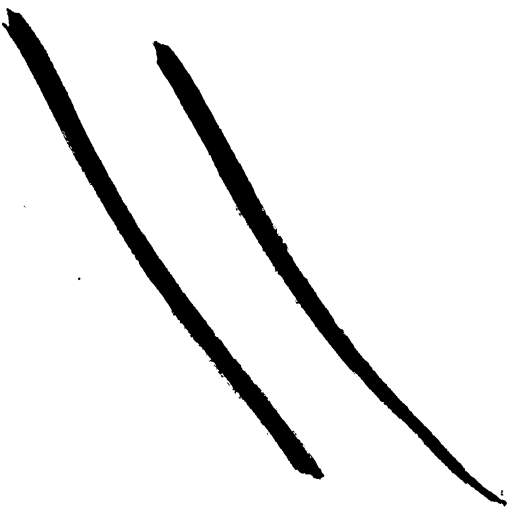


BRANCH OFFICE SIGNALING ARRANGEMENT









THE DRUNTE CO., LTD.

253 BROADWAY, NEW YORK

Willard L. Candee, Manag[illegible]n'l Supt.
H. Durant Cheever[illegible]retary