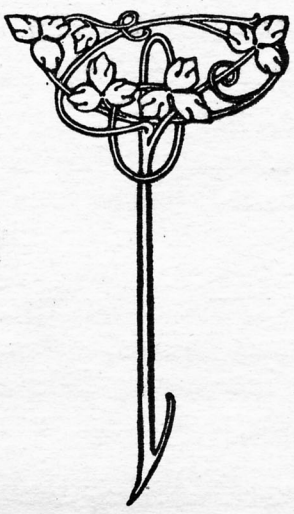
Secrets *of* Service

ON

Rural Telephone Systems

By **H. N. FARIS**



Price $1.00

NOTICE

Sixth Edition

THE Kellogg Switchboard & Supply Company have arranged for the distribution of a limited number of these exceedingly helpful bulletins believing that the widest spreading of these very practical ideas will not only aid the manager and all who have to do with line construction but will be a distinct aid to Kellogg equipment because the "Service of the Telephone Proves the Worth of the Line."

The author of this bulletin, as nearly every telephone man knows, is a practical worker in this wonderfully interesting field and the illustrations are all photographs of actual line conditions.

Our Catalogue No. 1A on line supplies, contains an exceedingly practical listing of tried, worth-while material. Send for it.

Kellogg Switchboard & Supply Company

Kansas City Mo. **CHICAGO, ILL.** **San Francisco Calif.**

Makers of Standard Telephone Equipment

PREFACE

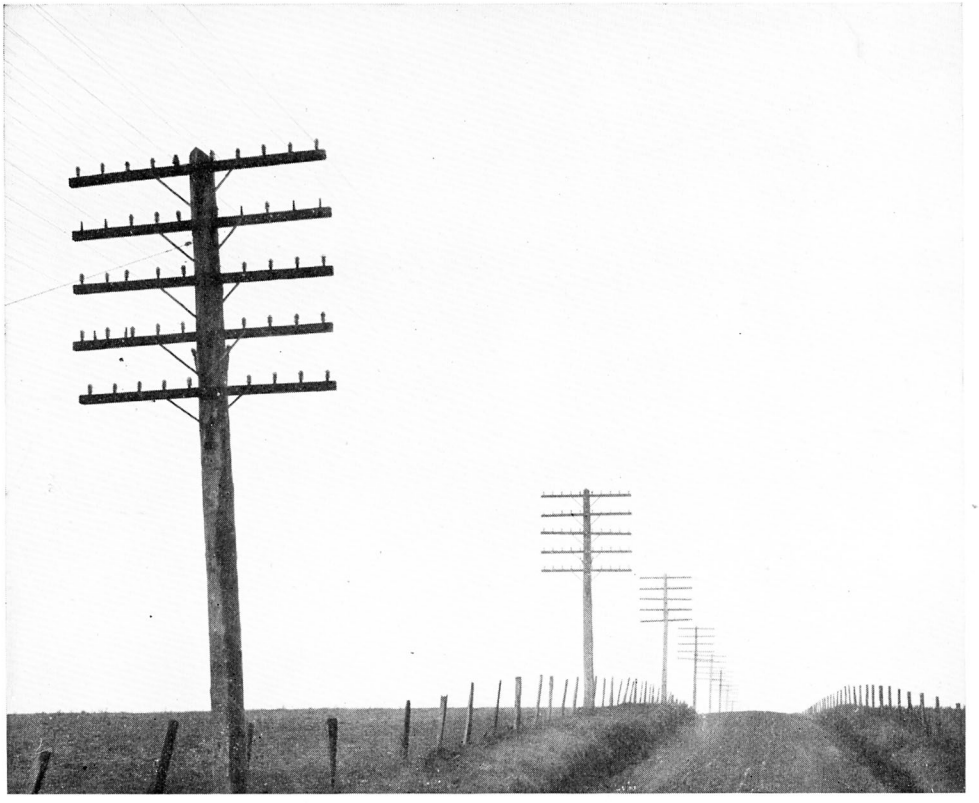
AS the telephone business becomes older and more mature many of the problems of the earlier years are settling themselves. Especially is this true with respect to the vexatious questions that naturally arose a few years ago when nearly two millions of American farm homes suddenly wanted telephones at about the same time.

Need of Rural Lines Overlooked by the Early Bell Companies

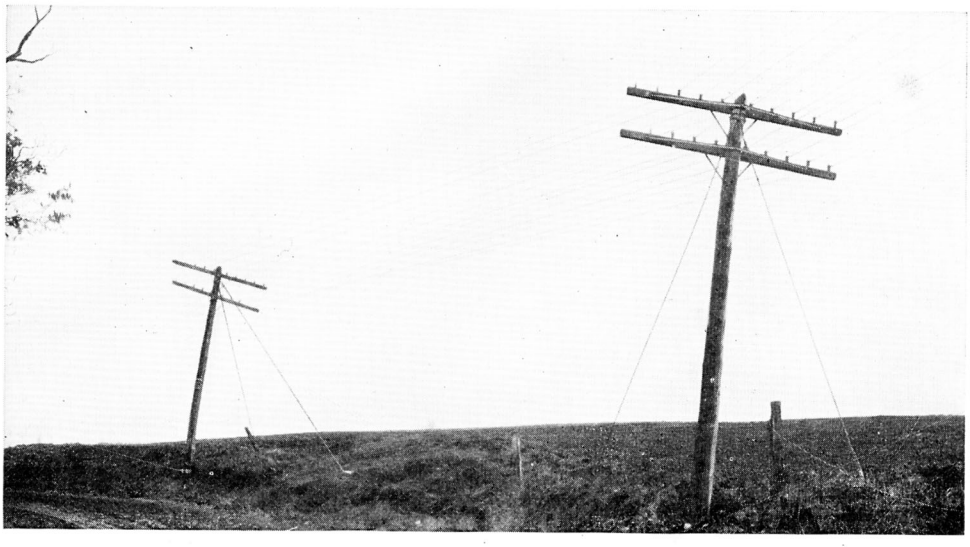
Although the "BELL" Companies started giving large city service in the late seventies more than twenty years elapsed before any general and widespread interest was shown in the rural telephone proposition. In fact, prior to the expiration of the fundamental Bell patents in 1893 rural lines were absolutely unknown. Within two years thereafter telephone equipment of Independent manufacture became available. The building of Independent Exchanges in towns previously considered too small was well under way by 1898 and about 1900 witnessed the first extensive activity in the building of rural lines.

Shortage of Capital for Rural Development

At the time the great need of the Independent telephone man was working capital, as everyone had encountered a development far exceeding his expectations. The farmer demanded



A perfect section of straightaway lead.



Section of farm lead on sharp curve along winding country road. Note proper use of back braces, pole protection plates, guy hooks, side, head and storm guys.

service at a time when the exchange owner was struggling to keep up with the growth of the city plant and build his share of the system of Independent long distance lines that were rapidly spreading over the country. With but few exceptions the farmers would have had to wait years for telephone service, so as a perfectly natural result they organized for the building of rural lines where exchanges were already established and for the building of both exchanges and rural lines where the territory was yet undeveloped.

So far all was well, but the demand for more than a million telephones, to be purchased for the most part by those wholly without previous telephone experience, brought into being a horde of telephone manufacturers building equipment to "sell," catering to "farm trade only" and making a specialty of organizing and selling mutual companies. The mutual organization was and is all right, and it would probably have been impossible to finance the country's telephone development in any other manner. Likewise, legitimate promotion and assistance to mutual companies by manufacturers was and is all right, provided there be no misrepresentations concerning the cost of building and operating and provided the manufacturer does not discourage, but urges the fullest co-operation with local exchanges.

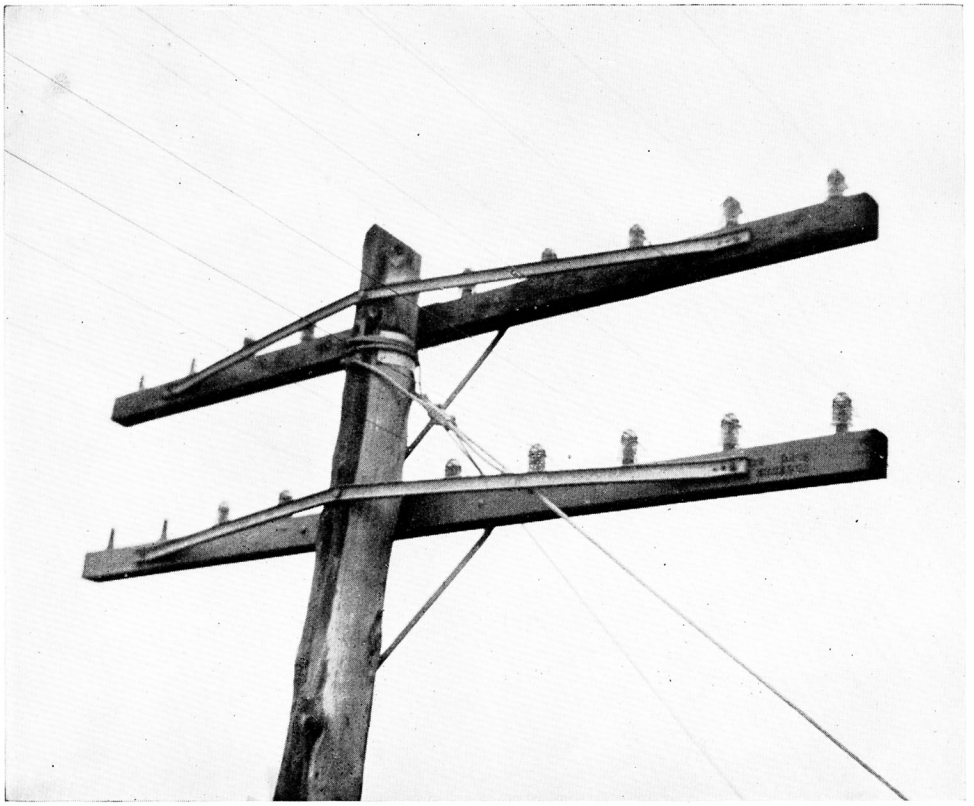
In most cases, however, manufacturers making a specialty of mutual promotion believed it profitable to help stir up strife, and the bitter and costly warfare that arose between mutual companies organizing for service alone and exchange owners to whom the telephone business was a means of livelihood, is certainly to be regretted.

In some cases exchange owners fought the idea of mutual farm companies from the first, and wanted to build and own all the lines and telephones in their county, and wanted the farmers to wait for service until they could get the money to build the lines, though the complete telephone development of their county might have taxed the combined capital of its strongest banks.

Such conditions rendered co-operation impossible and instead of getting together with the exchange owner, the mutual companies were often forced to obtain their advice from manufacturer promoters who were too often prone to "whoop things up" for an opposition exchange.

The Promoter Spreads Fake Ideas

It was from these promoters that early mutual companies got their ideas that building an exchange represented a trivial investment per telephone over and above the cost of the "box" itself; that grounded lines were just as good for all practical purposes as metallic, and that any



Close view of one of the poles in curved section of line. The only improvement would have been to use double groove glass and place wires in lower groove on these curves.

system could be operated for a few cents per telephone per month by a "Central" and a lineman which jobs could both be advertised and let to the lowest bidder.

This sort of argument sold switchboards and telephone equipment and swelled the commissions of promoting salesmen, but it likewise filled much of the country with cheap equipment and cheaper construction and resulted in a general commercial war, the effects of which will not be effaced in a generation. Millions of dollars have been lost through the purchases of inferior equipment, and tens of millions through the decreased value of resulting service.

But, as stated in the beginning, these problems are rapidly solving themselves. The mutual companies often starting out in the honest belief that telephone service costs almost nothing to produce, have found out their mistake, and the exchange owner operating for a living profit, sees where the exercise of greater patience and diplomacy and the taking of mutual organizations more completely into his confidence would have overcome the flowery assurances of the promoter; given the mutuals the benefit of better equipment, and permitted co-operation to take the place of warfare. Telephone warfare has been found as costly as other kinds of strife, and the new idea is one of "getting together." The mutual company no longer desires to put out of business the exchange operating for profit, and the exchange owner now wants to see mutual companies secure good and efficient service.

Rebuilding—Problem of the Hour

The great present need is to get all telephone properties, and rural lines in particular, into better physical condition so that more efficient service can be given and at less cost for main-

A powerful argument for two-pole corners.

tenance. Telephone development in most communities has progressed until the point of saturation is nearly reached, and **rebuilding** rather than **building** is the problem of the hour.

Scores of booklets have been written on "HOW TO **BUILD** RURAL TELEPHONE LINES," but this present work is the first ever produced telling "HOW TO **REBUILD** OLD RURAL LINES" and maintain the rebuilt line in best working condition.

And when one has been taught how to rebuild old lines, any description as to how new ones should be built is wholly superfluous, since all principles of good construction as applied to new work, are necessarily brought out in the subject of rebuilding.

The error of cheap construction has been a common one and believing the following matter will be of great interest, this work has been produced in the hope that it may result in a general betterment of telephone service.

The Principles of Good Building

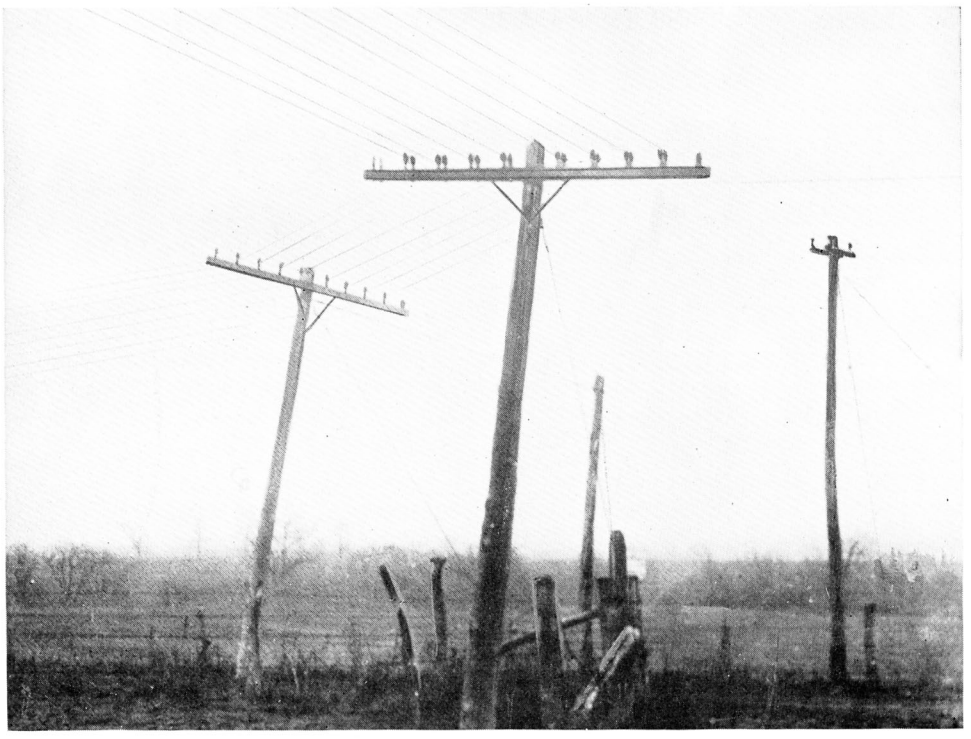
Value of Uniform Maintenance

THE photographs of both good and bad construction as shown on these pages are so complete and so nearly a treatise in themselves that limited descriptions will suffice and the reader will not be burdened unduly.

Successful and economical management of any telephone property demands that all existing construction be disturbed as little as possible until it is entirely worn out and ready for replacement.

The best rule to follow in an entirely run down and worn out plant is to get it in shape and then quit fussing with it. Companies continually doing "temporary work" always have high operating costs and are never able to pay adequate dividends. The problem in any new work or rebuilding is to so plan the construction that it will all wear out at about the same time so that unnecessary "patch work" will be avoided, always bearing in mind the high percentage of the labor item to the total cost.

There is a biblical injunction against the folly of putting "new wine in old bottles," which is certainly applicable to the folly of putting new fir cross arms, which will endure for a generation, on old poles possessed of but a few years' life. The excess labor cost of placing these arms on standing poles and then moving them to new poles would go a long way toward buying new poles in the beginning. The moral is, that all construction should be left alone as nearly as possible



An excellent two pole corner showing back brace single cross arm holding to position better than double cross arm not back braced.

until it can be completely rebuilt and the worse condition old construction is in the less labor it deserves to have spent on it.

The average farm line lead built ten or twelve years ago now presents a sorry spectacle and already needs a complete rebuilding, but where it is necessary to get further service out of the old poles the problem in most cases is merely one of providing new corners.

Importance of Substantial Corners

Almost any old snags will support the straightway sections of a line provided the corners are good ones and well guyed. The first matter in connection with fixing up an old line is to make sure the route it follows is the proper one to retain when the line is to be completely rebuilt.

The bad corners on the present line which are usually of the square or "buck arm" type must be replaced with new corners of the two pole type since one of the fundamental requirements of all toll and country lines is that all joints and splices **be kept under strain.** It is almost impossible for joints in first-class iron wire, out in the country, to develop high resistances and it is wholly impossible for them to develop cutouts, provided they are kept under line strain. If, however, buck arm corners with slack jumpers are employed, the joints in the jumpers not being under strain, are likely to become loosened by the tremor of line vibration and cause serious trouble most difficult to locate.

Two pole corners completely overcome these possible electrical troubles and are much better from a mechanical standpoint because they relieve the arms and pins of all "dead ended" strains. Contrary to the general notion it is not absolutely necessary to use double arms on two pole corners. Six pin arms and longer should be provided with a back brace or an extra pair of ordinary cross arm braces used as back braces to prevent the arms from twisting out of position. As well built two pole corners involve a labor expense frequently exceeding the material cost, the material used in their construction should always be the most durable that can be obtained.

Selection and Preparation of Poles

Poles used at corners should not be smaller than 6″ 20's for eight wire leads and less while 7″ 25's should be used on ten wire leads and heavier. Six inch 20's can always be had without noticeable difference in cost by cutting back good stocky 5″ 25's, and 7″ 25's can be obtained in like manner by cutting back 6″ 30's. Thus many companies desiring stocky poles order them 1″ smaller but 5 feet longer and cut them back to the length needed. The increased cost of the longer poles is trivial and when railroad crossings, trees and low places in the line are encountered the longer poles come in very handy. Poles for corners should always have the butts tank treated with hot Carbolineum to 18 inches above the ground line. The roof and gains should also be given Carbolineum treatment and on corners, at least, it is urgently recommended that cross arms and pins be treated with Carbolineum as well.

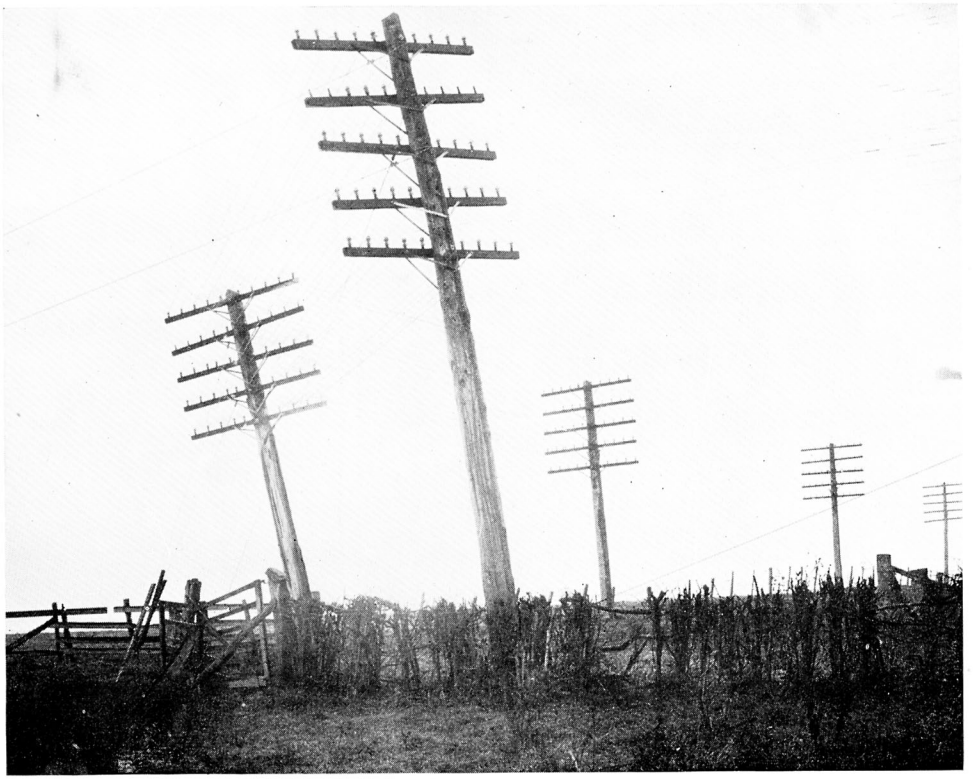
Hardware Requirements

Use hot galvanized pole line hardware of approved patterns, together with double galvanized Siemens Martin guy strand, also use regular guy rods and Carbolineum treated anchor logs, together with galvanized shims and J hooks to prevent guy strand from cutting the pole or creeping down and you will have a corner that will endure from 25 to 40 years without further attention or expense for maintenance.

Locating Bad Joints

With good corners as a foundation it is an easy matter to put the rest of the line in condition for good service. The next work ordinarily is that of pulling slack, but before this is done or the old wire disturbed in any way, it is well to drive over the line, or rather drive under it, and test all joints with the aid of two cane fish poles, a pair of dry cells and an inexpensive ammeter or battery gauge. When a joint is found which fails to pass current freely it should be cut out but before condemning, it is well to test a six inch section of the line wire on each side of it.

If the line wire tests show free passage of current, it is evidence that a good connection will be secured when the old one is cut out, but if it is found impossible to make contact readily with the line wire itself, it will be necessary to sandpaper the wire ends before making the new splice. In doing this care must be taken not to remove all of the remaining zinc coating for if the iron



A perfect two pole corner except that on ten pin arms regular back braces should have been used instead of employing ordinary braces as back braces

itself be exposed, the new joint will corrode very rapidly unless soldered, and generally speaking, line wire which has become so rusted as to require soldered joints is only fit to use for pulling in a piece of new wire.

It frequently happens that a company using B. B. wire of good quality has at different times been caught without it and has had to use ordinary hardware wire for urgent extensions and in many cases it is only necessary to locate a few miles of this wire with the simple fish pole and ammeter test to double the efficiency of the service when all pieces of this inferior wire have been weeded out.

The reason for testing joints before pulling slack is that bad joints in slack line wire are likely to become good when the wire is pulled up tight and gradually go bad again. If tl ese joints are located and cut out before pulling slack or disturbing the wire in any manner, a good working line is assured.

Testing Old Poles Before Climbing

Before climbing old poles to remove ties for pulling slack, it is well to test them with a pike as many accidents have occurred where poles weakened by neck rot at the ground line have broken off and fallen with the lineman as soon as the last supporting tie wire was removed. Poles so nearly gone that they can be cracked with a pike must be cut off and reset or bolted and lashed to a reinforcing post set immediately beside them in cases where the line wires cannot be lowered.

Where a large amount of old line is to be overhauled no great amount of ingenuity is required to construct a pole pulling device by which old poles can be pulled, cut off and lowered into the same hole without untying the line wires. And this is advisable, for at road crossings and where the line cannot be lowered, the old poles are rarely worth reinforcing and should be replaced with permanent poles as at corners.

Removing Ties and Pulling Slack

When taking off tie wires preparatory to pulling slack, it is well to examine the line wire closely whenever loose ties are found, for under such ties the line wire is frequently worn by vibration until it must be cut and respliced to insure staying up in cold weather and times of storm.

The best method of pulling slack is to get in the center of straight sections and pull both ways. On cross arm leads, two men should work together on opposite ends of the arm to avoid pulling arms on corner poles out of line. On bracket lines care must be taken to drive brackets tight when removing ties or the wire will bind between the bracket and the pole making it impossible to pull long stretches at a time.

In tying in after pulling slack, new ties should be used and applied in the same manner as on new wire.

As already mentioned, it does not often pay to replace old cross arms on old poles and even when additional wires must be strung it is better to "knob" them on to the old poles or even under the old cross arm, than to put a new arm on short lived old poles.

With a brace and screw driver bit, knobs can be attached more rapidly than brackets and removed with equal ease and rapidity when the old line finally comes down.

Attention to Drop Wires and Spurs

When the main lead has been overhauled, all spurs and side lines should be given like treatment and every foot of the wire put under strain by changing to two pole corners and cutting in test connectors for convenience in locating trouble when spurs leave the main line and where "drop wires" go to subscribers' telephones.

These drop wires must be carefully gone over the same as the rest of the line and on metallic circuits it is recommended that at least one of the two wires be insulated, as far more short circuits on metallic country lines occur at the subscribers' premises, than on all the mileage in the line itself.

Ground Rods

On grounded lines particular attention must be given to the ground rod which is rarely of adequate size or proper material.

A ground rod to give good results should be hot galvanized and not smaller than ½ inch in diameter by 6 feet long and driven into permanently moist earth. A one-inch galvanized pipe is even preferable as it can be filled with water and plugged to prevent evaporation and so insure good results in even the dryest weather. If a galvanized windmill tower happens to be on the premises, the drop wire should run from the pole line to a strain insulator or circuit breaker on the tower and thence to the house while the ground wire should be returned to the tower and dead ended and the "tail" of the dead end secured under one of the galvanized nuts to guard against a loose connection.

The idea in bringing the line wire to the tower on its way to the telephone is to give any direct strokes of lightning a chance to jump to the tower at the circuit breaker gap. This arrangement affords a practical and non-troublesome lightning arrester and makes it perfectly safe to use a long ground wire.

In attaching the ground wire to the ground rod, a perfectly tight twist is preferable to a poorly soldered connection. Before a ground rod can be soldered, it must be heated until solder will run freely or the solder will merely mould around the cold rod affording the poorest kind of a joint. One of the best methods is to submerge the joint in a pot of molten solder until hot; then remove, rapidly flux the joint and pour on molten solder with a ladle. (Ground rods can now be purchased with soldered tail wires and this is recommended for most companies.)

Ground rods already in service can easily be pulled if they are first bent over and twisted until loose. Previously soldered rods can then be driven in their places and the old ones soldered in the shop after a number have been accumulated.

If left in service, use a tightly twisted connection of No. 12 wire as a powerful blow torch is required to heat a ground rod in service, so that even a good "wiped joint" can be secured.

A well constructed rural line. Note Carbolineum treated butts and gains.

Copper to Iron Connections Must Be Soldered

The connections that must be soldered when overhauling an old rural line are those between the copper wires leading to the telephone and the line and ground wires which are usually of iron. If dissimilar metals, such as iron and copper, are left unsoldered, a battery action will be set up whenever the connection is moist and this will rapidly cause corrosion and the formation of a dry powder between the two dissimilar wires.

Copper to iron joints should never be opened for testing without resoldering at the time and if soldering facilities are wholly lacking, the joint should be protected from moisture by tinfoil and tape until it can be soldered. The best method of soldering such joints is to use a large and extremely hot iron with wire solder and noncorrosive paste, or, if the wires be first well sandpapered, rosin core solder can be used. Be sure to leave ample space between the turns of copper on the iron wire so the solder can get in between the turns and become well "sweated" to the iron.

Interior Wire

Interior wiring should be carefully overhauled and all except rubber covered and braided copper wire should be removed. Just as little interior wire as possible should be used and where the telephone is mounted on an outside wall it is preferable to run the line wire half way around the house, if necessary, rather than run interior wire for the same distance inside.

When a hole can be bored immediately behind or above the telephone, short rubber covered wires with **saturated** braid over rubber, can be run directly from the telephone binding posts to the line and ground wires outside. Where a considerable amount of interior wire is necessary, No. 19, rubber covered, dry braided and twisted, should be run from the telephone to a junction block just inside the entrance of the building. This simple and inexpensive junction block affords a convenient test connection between the dry braid interior wire and the saturated braid rubber covered wire which should be used through the wall and out to the line and ground connections. When saturated braid wire is used, it is not essential to provide separate holes for each wire or to use porcelain tubes in entering the building but whenever it is desired to dispense with the junction block and run the dry braid wires outside, separate holes must be provided for each wire and the use of tubes is then recommended.

Where twisted pair drop wire is used on metallic circuits, such wire should first be dead ended on a knob outside the house and the tail of the dead end brought through the wall to the telephone or to a junction block where it is necessary to use dry braid interior wire in reaching the telephone.

Instrument Inspection

Overhauling the old telephones on the line is a subject in itself. However, we will venture to suggest that the telephone be looked over to determine the proper operation of the hook switch and to make sure that the automatic cut-out on the generator always operates, regardless of the position the crank may be stopped in, as bent cranks or loose generator mountings sometimes cause the crank to bind in certain positions and so fail to operate when released. A careful oiling of the four generator bearings will be of great assistance in keeping the generator in good condition indefinitely.

Lightning Protection

As a great deal of the trouble on all rural lines is caused by lightning, this book would be incomplete without a discussion of the subject.

It is recommended that no other arrester be used in connection with telephones equipped with carbon and metal disc arresters but it is advisable to use a lightning rod on each pole where a subscriber's drop wire leads off. We further recommend that on cross arm leads this ground wire be carried across the face of the arm and that tie wire tails be left pointing toward it. Experience has proven that this effectively prevents arrester smutting on grounded lines where such trouble has heretofore been considered unavoidable.

It is also possible to provide a drain for direct strokes on the outside of the house by terminating line and ground wires on knobs about three inches apart and bending the dead end tails of the two wires toward each other with a half inch air gap between the points. The amount of lightning passing these outdoor spark gaps will never cause the slightest damage to the interior wiring or to the telephone itself, if the latter is properly wired and fitted with a disc type arrester.

High Tension Current Safeguards

Country lines running out of towns having high tension electric light wires, which are in some danger of contact with them, were formerly thought to require tubular fuses between the carbon arresters and the line. These fuses were quite troublesome and when they did blow in connection with high tension crosses, they simply cut off their own telephone and let the high tension current go after the next one up the line. The modern and effective way of protecting farm lines against such currents is to put a sensitive metallic vacuum arrester on the line at the Central office. Although its electrodes are nearly one-fourth of an inch apart, this arrester is as sensitive as one one-thousandth of an inch of air gap, or about five times as sensitive as the ordinary carbon mica arrester. It has a high current carrying capacity and can maintain same for a sufficient time to burn iron line wires in two at the point of contact with the high tension circuit or, in other words, the iron line wire automatically "cuts itself down" if there be a vacuum arrester near by.

It is recommended that all rural lines be equipped with these vacuum arresters at the Central office and at the nearest telephone on each side of crossings with high tension transmission lines in the country.

No Ground At Telephone on Metallic Lines

On metallic circuits, it is recommended that no grounds be used at the telephone either in town or in the country. On metallic country lines, lightning rod wires should be provided on all poles and cross arms where drop wires lead off to telephones, and vacuum arresters should be used at the Central office and on both sides of crossings with high tension circuits in the country.

The arresters on the telephones can be left bridged **across** the metallic circuit as a protection to any high tension voltage that might be encountered **across** the circuit but when connected in this manner, the telephone arresters are absolutely unaffected by earth-seeking foreign current, such as lightning. Carbons, therefore, remain free from smut year in and year out and in the language of one of the enthusiastic users of the new system, "the telephone millennium has arrived."

In dispensing with grounds at the subscribers' premises, due precaution should be taken not to mount the telephone where the user's person will be in contact with a hot water radiator or other grounded metallic objects, and this precaution must always be observed regardless of the

protection used, for there will always be those who persist in using country lines during the most severe storms.

In the case of metallic farm lines using grounding keys to call Central secretly, a ground must, of course, be retained at the subscribers' telephone. In such cases we recommend the use of vacuum arresters at each telephone so that all lightning discharges, both induced and direct, will be drawn off without smutting the carbon arresters.

The advantages of getting rid of all grounds at the telephone on metallic circuits are so great that we recommend no systems requiring grounds at the telephones be used on new work, as most manufacturers are prepared to furnish telephones for calling Central secretly on metallic lines without the complication of a ground at the telephone and the expensive maintenance which such systems have always involved.

Faults Corrected—Service Good

When corners have been rebuilt, weak posts in the line reset, joints tested and bad ones cut out, slack pulled, subscribers' drops overhauled, ground rods made right, inside wiring overhauled and the lightning arrester question put on a sensible basis, even the worst country lines will give good service and at minimum cost for new material. When the poles in the straightaway stretches of the line finally rot or go down in a sleet storm, it will be the simplest matter in the world to set new poles with new arms and transfer the wire, thus securing a standard line at minimum labor expense and without sacrificing a particle of the useful life in the old equipment.

And it is indeed surprising how nearly this method is applicable to all country lines now in bad condition. It is simply a question of making the corners right so that the wires can be kept properly pulled up and the straightaway stretches of the line will almost take care of themselves.

The futility of two pin cross arms. Had first two wires been put on brackets a six pin arm could have been installed without difficulty when the other three wires were needed. This picture also shows the folly of setting poles too shallow, of not roofing the top to shed water properly and of weakening wood pins by a "reinforcing" bolt in center.

Material for New Work

Poles

FOR country lines, we recommend the use of cedar poles bought on the latest quality specifications adopted by the Northwestern Cedarmen's Association, and known as the N. W. C. A. Standard Specifications, which are as follows:

Standard Specifications of White Cedar Poles

1. Live Timber—All posts and poles shall have been cut from live, green growing Northern White Cedar timber.

NOTE.—The test of live timber is to whittle a shaving from the sapwood. If the sap is white, the timber was live when cut, no matter how discolored the piece may be on the outside.

2. Limit of Maximum Defects—No post or pole shall contain both the maximum crook and the maximum butt rot.

3. Percentages of Maximum Defect—Not more than 10% of the number of pieces of any lot or shipment shall contain the maximum crook or butt rot.

4. Variation in Sizes—If not to exceed 2% of the pieces in any lot or shipment are below the minimum size, and there is an equal number of pieces as large as the minimum of the next larger size, the shipment shall be considered as conforming to these specifications so far as size is concerned.

5. Method of Measuring Tops—Minimum size of tops shall be as shown in Table No. 1. Diameter shall govern top sizes for lengths shorter than 16 ft., and circumference shall govern top sizes for lengths 16 ft. and longer. EXCEPTION:—For sawed posts see Table No. 1.

6. Lengths—Any post or pole 7 ft. to 18 ft. inclusive, may be either two inches longer or two inches shorter than its specified length. Any pole 20 ft. and longer may be short of its specified length one-half an inch for each five feet of its length, or it may be six inches longer than its specified length.

7. Manufacture—All posts and poles shall be peeled, and knots closely trimmed.

8. Knots—Knots are permitted if sound, smoothly trimmed and do not plainly impair the strength of the pole or post.

9. Short Kinks—Short kinks not permitted. (See figures 7 and 8, inside back cover page.)

10. Rot—(a) Sap or skid rot not permitted.

(b) Poles 16 ft. and longer having minimum top sizes of the dimensions required, must have sound top. Poles 16 ft. and longer having tops one inch or more in circumference above the minimum top sizes, may have one pipe rot not more than one-half inch in diameter. Posts or poles 7 ft. to 14 ft. inclusive, pipe rot is permitted.

(c) Butt and ring rot combined shall not exceed 10% of the area of the butt.

(d) SAWED POSTS: Rot in butt not to exceed 10% of area of the butt. Rot on face of five-inch halves shall not exceed an average of one-half inch, if running the entire length of the post; one inch if for only one-half of the length; and one and one-half inches if for only one-fourth of the length.

Rot on face of six-inch halves shall not exceed an average of one inch, if running the entire length of the post; two inches if for only one-half of the length; and three inches if for only one-fourth of the length.

Rot on face of seven-inch halves shall not exceed an average of one and one-half inches, if running the entire length of the post; three inches if for only one-half of the length; and four inches if for only one-fourth of the length.

Rot on corners of quarters shall not exceed an average of half an inch in depth if for entire length of post; one inch for half of the length; and one and one-half inches for one-fourth of the length.

11. Twist—Winding twist permitted unless very unsightly and exaggerated.

12. Cat Faces—Cat faces permitted if sound, and if their distance from the top of the pole is not less than 20% of the length of the pole on 30 ft. and shorter poles, and 25% on 35 ft. and longer poles.

13. Discoloration—Discoloration not considered a defect under these specifications.

14. Crook or Sweep—1. Posts or poles 7 ft. to 14 ft. inclusive, one-way sweep not exceeding maximum shown in Table No. 2 is permitted. 2. Poles 16 ft. and longer.

(a) BELOW GROUND LINE: Sweep not to exceed diameter of butt. (See figures 5 and 6, inside back cover page.)

(b) ABOVE GROUND LINE: Reverse sweep, and two-way sweep, meaning a sweep in two planes allowed providing line drawn from center of pole at top to center of pole at ground line (see Table No. 2) does not leave the pole at any point. One way sweep allowed not to exceed maximum shown in Table No. 2.

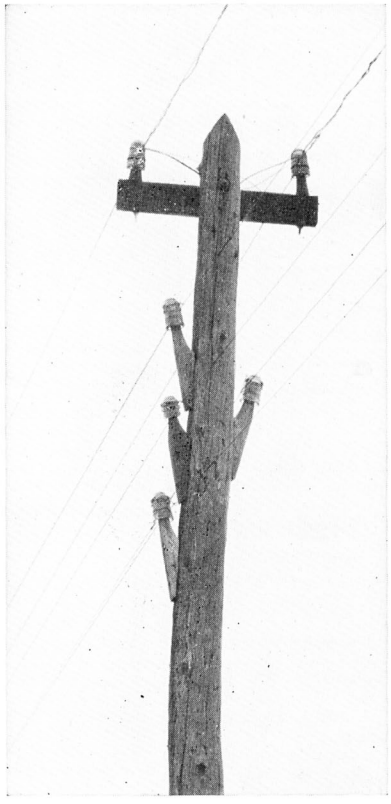
15. Explanation of Term "Ground Line"—The meaning of the term "Ground Line," as used in these specifications, shall be as shown in Table No. 2.

TABLE NO. 1. Minimum Top Sizes

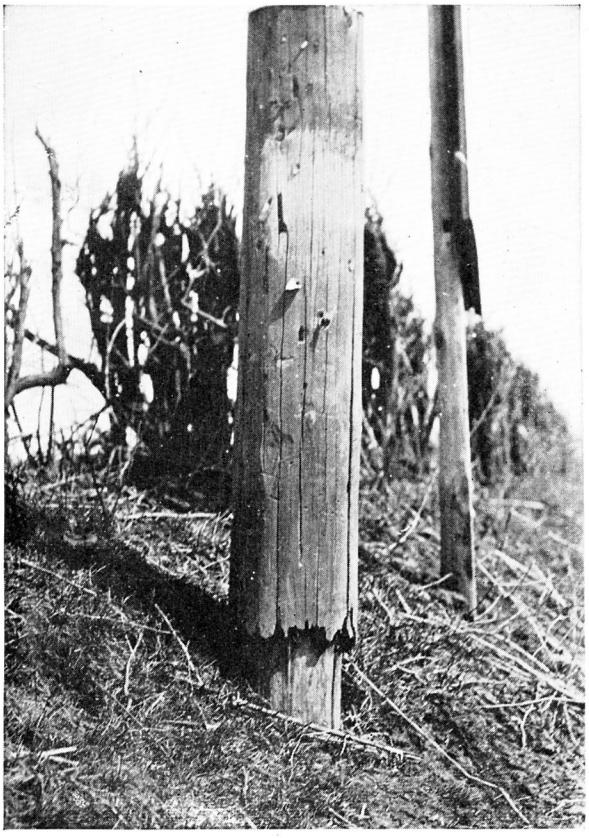
Designated Size	Lengths Shorter than 16 ft.—Diam.		Lengths 16 ft. and Over—Circumf'ce	
	Green and Watersoaked	Seasoned	Green and Watersoaked	Seasoned
2 inches.....	2 inches	1¾ inches	.....	.....
3 inches.....	3 inches	2¾ inches	.....	.....
4 inches.....	4 inches	3¾ inches	12½ inches	12 inches
5 inches.....	5 inches	4¾ inches	16 inches	15 inches
6 inches.....	6 inches	5¾ inches	19½ inches	18½ inches
7 inches.....	7 inches	6¾ inches	23 inches	22 inches
8 inches.....	8 inches	7¾ inches	25 inches	24 inches
9 inches.....	9 inches	8¾ inches	28 inches	27 inches

TABLE NO. 2. Sweep and Ground Line

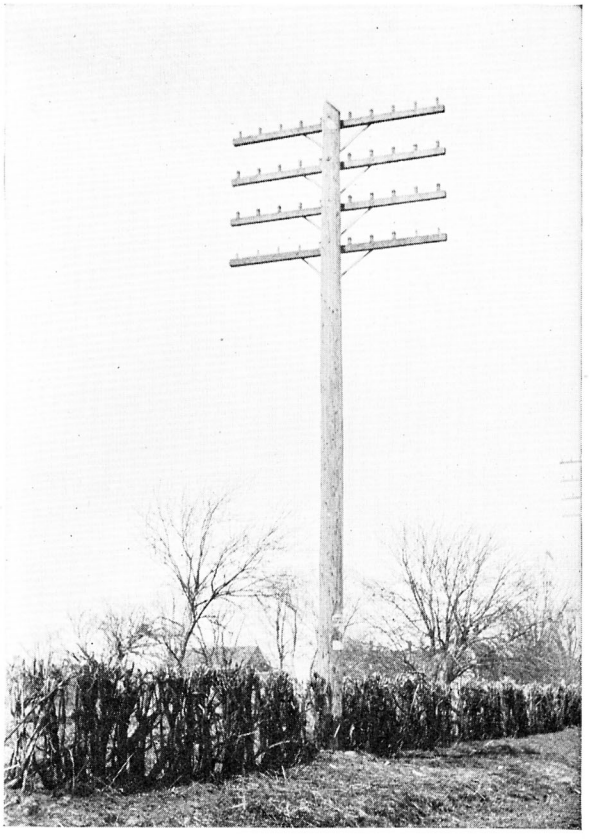
Lengths	Maximum Sweep	Between Points	Ground Line
7 ft. to 14 ft., inc.	4 inches	Top to butt	
16 ft., 18ft. and 20 ft.	4 inches	Top to ground line	4 ft. from butt
25 ft.....	5 inches	Top to ground line	6 ft. from butt
30 ft.....	6 inches	Top to ground line	6 ft. from butt
35 ft.....	7 inches	Top to ground line	6 ft. from butt
40 ft.....	8 inches	Top to ground line	6 ft. from butt
45 ft.....	9 inches	Top to ground line	6 ft. from butt
50 ft.....	10 inches	Top to ground line	6 ft. from butt
55 ft.....	11 inches	Top to ground line	6 ft. from butt
60 ft.....	12 inches	Top to ground line	6 ft. from butt
65 ft.....	13 inches	Top to ground line	6 ft. from butt
70 ft.....	14 inches	Top to ground line	6 ft. from butt



The metallic iron circuit operated fairly well until after it was transposed in the manner indicated, after which the service was barely commercial.



Showing effect of "Neck-rot" wholly preventable by Carbolineum treatment.

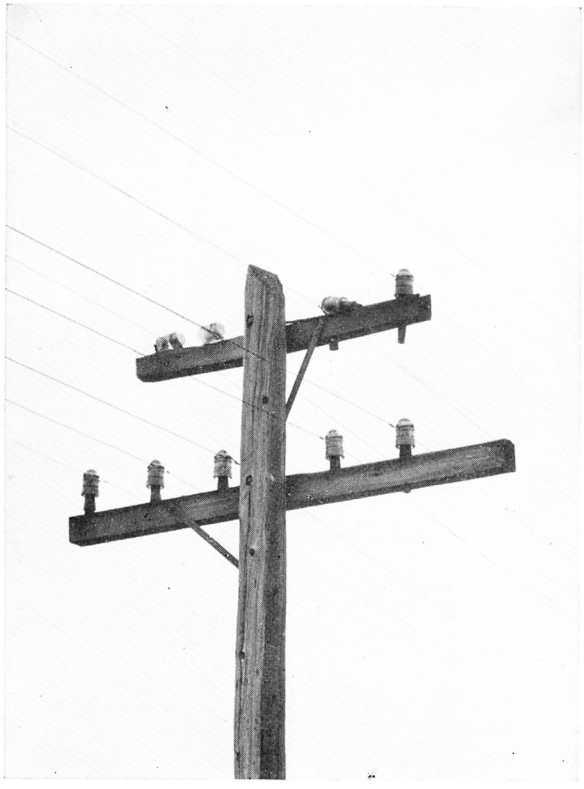


Carbolineum treated pole set same length of time showing no signs of "Neck-rot" whatever.

Handling and Preparation of Poles

For exchange construction where poles are to be shaved and painted, many prefer to purchase the large Northern cedar poles under more rigid specifications or to use Western or Mountain cedar, which is perfectly straight. The Western poles have very little taper and in order to secure ample strength for exchange work nothing smaller than 8-inch tops should be used. Great care should be taken in unloading as cedar poles are easily cracked or broken by being dropped. Inexperienced men have frequently broken a dozen or fifteen poles in a single car through the shiftless practice of cutting the stakes and letting them fall. The poles first disturbed must be placed as skids and the remainder of the load gently rolled down them and kept up off the ground so they will not rot but will continue to season until used.

Poles should always be gained and bored for cross arms and roofed where unloaded from the car and before being hauled out on the line. Place the small end on the buck, allow the pole to assume its natural position, with the curvature sagging down, and cut the gain on the top or inside of the pole's curve. The bolt hole should be bored with a car bit to take a $\frac{5}{8}$" bolt. The top gain may be cut to considerable depth but if the poles are to be arranged for more than one arm, no gain below the top one should be cut more than half an inch deep. This is to avoid unnecessarily weakening the poles.



Top arm is yellow pine with oak pins, lower arm (only one year younger) is fir with locust pins.

Carbolineum Treatment

Pole butts, roofs and gains should invariably be treated with hot Carbolineum before they leave the pole yard. Carbolineum treatment will fully double the life of any seasoned pole by retarding neck rot at the ground line. Good poles are becoming scarce and with constantly increasing prices the setting of untreated poles is little short of an economic crime. Poles must be dry and well seasoned to allow the Carbolineum proper penetration. The best method consists in dipping the pole butt into a caldron of hot Carbolineum for 10 or 15 minutes while hung with block and tackle from a "gin pole."

A simpler but less effective method consists in placing a long shallow pan under the pole butt and pouring the hot Carbolineum over the surface with pails. The drippings are, of course, caught and reheated. Brush treatments are practically a waste of time. The entire pole butt should be treated to a point about 18 inches above the level ground line so as to afford room for banking up after the pole has been set.

Government statistics show that only about 10% of poles used in this country are butt treated, and being alarmed at the rapid depletion of the cedar forests, the Government has prepared some bulletins on the importance of pole treatment which will be sent to interested parties on request.

It has been proven that open tank treatment with boiling Carbolineum increases the life of cedar fully 100%, and as the cost of such treatment rarely exceeds 15% or 20% of the cost of the pole, the setting of untreated poles is an extravagance no company or individual can afford.

A number of the more reliable pole companies now have treating plants and are prepared to butt treat poles as they are loaded for shipment. They keep poles for treatment under tarpaulins in bad weather, but on account of the danger of dampness making the treatment ineffective, the larger pole users prefer to do the treating themselves, at times when they know the poles are dry and thoroughly seasoned.

Poles for exchange use should always be shaved in the pole yard until the soft blotting paper portion on the outside of the pole has been removed above the point where the Carbolineum treatment leaves off. This should be done after the butts have been treated and when exchange poles are to be painted, a priming coat should be applied in the pole yard and the final painting done after the construction is finished.

Cross Arms: For best construction, both city and country, we recommend the use of yellow fir cross arms which are absolutely straight grained and in an entire carload of which it is unusual to find a knot as large as a dime. These arms have shown wonderful lasting qualities when put up unpainted and there is no doubt their lasting qualities may be made practically indefinite by dipping them in hot Carbolineum.

It used to be argued that treatment of any kind for fir cross arms was unnecessary because the untreated arms would last until the average pole was put out of business by "neck rot." But Carbolineum treatment having put an end to "neck rot" and cross arms having advanced in cost even more than poles, it behooves us to make cross arms as near everlasting as possible by the hot dip Carbolineum treatment.

In the extreme south and east portions of the United States where freight from the Pacific Coast makes fir arms too expensive for use on ordinary lines, yellow pine arms offer a very

The futility of two pin arms, oak pins and attempting to do without cross arm braces. Note the paralleling power transmission line which is forcing a cleanup of telephone conditions and the adoption of metallic and phantom circuits wherever it appears.

satisfactory substitute, provided the pine arms are first well seasoned and then dipped in hot Carbolineum before use, as has been recommended in the case of the fir arms. A tank and dripping pan for even ten pin arms can be constructed very cheaply and the labor of treatment amounts to practically nothing per arm.

Telephone cross arms are made in two principal sizes, one of which is known as the "telephone" arm which is 2¾″ x 3¾″, with 10″ pin spacings, while the so-called "standard" arm is 3¼″ x 4¼″, with 12″ pin spacings. As perhaps 90% of all telephone companies have never purchased any but telephone size arms the term "standard" for the larger arm has become a misnomer and a better distinction would be "telephone" arms and "standard long distance" arms, as the heavier arms are always used on long distance toll leads to secure the greater spacing between the two wires of the metallic circuit, which reduces "capacity" losses on long copper lines by 30%.

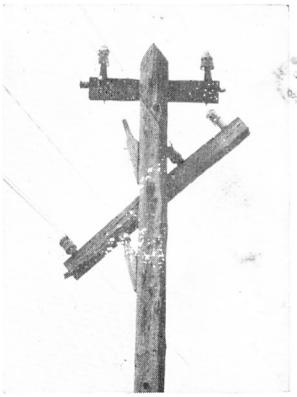
Pins: The lighter or telephone arms are regularly bored for 1¼″ wood pins. The heavier or long distance arms will come bored for 1½″ wood pins unless 1¼″ pins are specified which should always be done as the 1¼″ pin, if of locust or hedge, will be as strong as the arm, which is unnecessarily weakened when bored for 1½″ pins. This larger boring is really a relic of the old days when only oak pins were used and in the light of present experience there is no excuse for the use of oak pins when locust or hedge pins with their greater strength and superior lasting qualities can always be had at so slight an increase in the first cost.

Pins should always be dipped in hot Carbolineum before being driven into the arm as this prolongs the life and strength of the pin and tends to overcome the tendency of hedge pins to check or split at the top and make it difficult to screw on an insulator after the pin has been without one for several years.

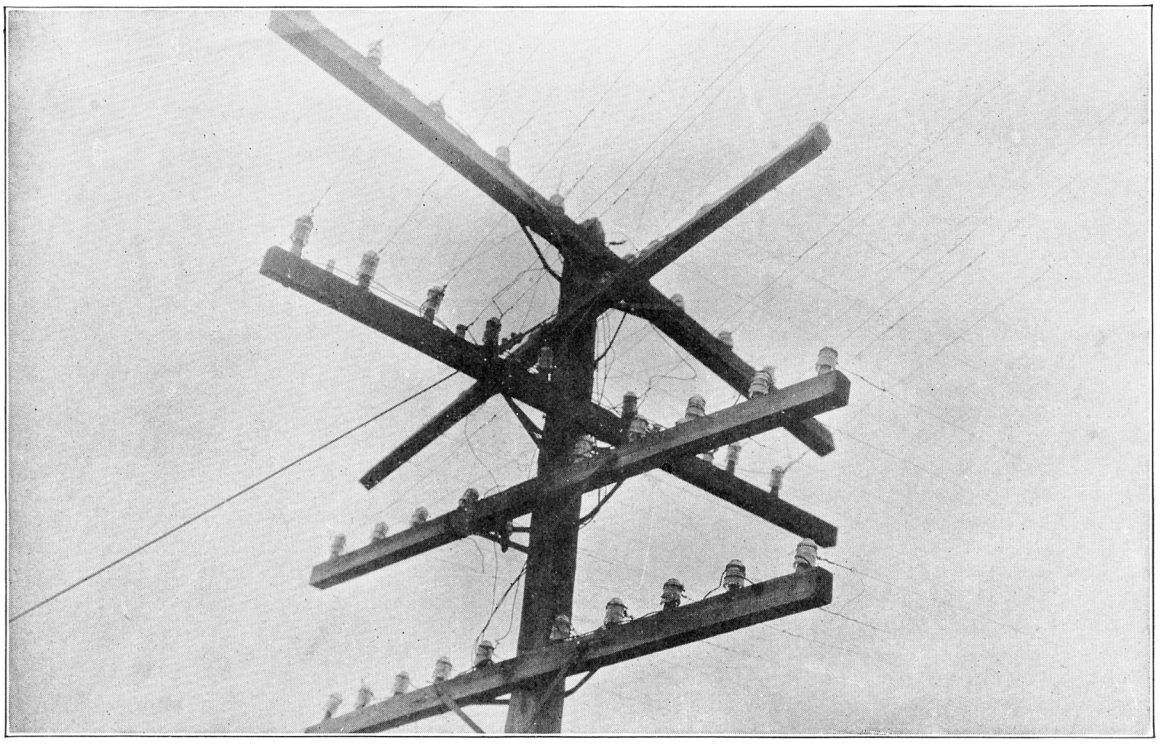
The question is often asked why the steel pins with hardwood tops, which have been used exclusively in telegraph work for many years, have not been used to greater extent by telephone

companies. Steel pins have never been adopted by long distance telephone companies for copper toll circuits because of the fact, or tradition, as the case may be, that the presence of steel pins would increase the tendency of copper lines to cross talk and render it more difficult to overcome this by transposition, also that the steel pins would offer a slight impedance to the voice current. But it has since been discovered that such distributed impedance is a benefit rather than a detriment and thousands of dollars are being spent to secure such impedance for long copper lines in the form of "loading coils."

There is no doubt but that the use of wood pins and the weakening of cross arms by the large borings necessary to accommodate same, smacks somewhat of the wood shoe age but with the present high cost of wood top steel pins to fit standard telephone insulators and the necessity of ordering telephone cross arms bored "special" for steel pins, they are not likely to come into general use until the demand for them is far greater than at present.



A two pin arm placed where a ten pin was soon needed. Note the porcelain knobs and botched up patch work done at heavy labor expense.



One of the causes of poor exchange service.

Selection of Pole Line Hardware

POLE line hardware on new work should always be galvanized by the hot dip process and should easily pass the standard test of four one-minute immersions in a saturated solution of copper sulphate commonly called blue vitriol.

The piece under test should be wiped dry after each immersion, and after the fourth one-minute dip it should appear uniformly black. Any deposits of bright reddish copper would show that the galvanizing had been eaten away and the naked iron exposed. This is the same test that BB telephone wire and double galvanized Siemens Martin strand should always be required to pass.

Braces: For cross arms these should be of a stiff quality of steel, and of such length that when bolted to the cross arms they will meet exactly at right angles on the pole. 2¾″ x 3¾″ arms as ordinarily bored require 22″ braces which are regularly made in two different weights, 1″ x 3-16″ and 1 7-32″ x 7-32″. For 6 pin arms and shorter, the lighter brace is amply heavy, and while the larger size for 8 and 10 pin arms is perhaps advisable for heavy wire, most excellent results can be had by adopting the lighter brace as standard for all telephone arms on straightaway work.

For corners, the lighter braces may be doubled, thereby securing a pair of 1″ x ⅜″ x 22″ braces to keep the arm at right angles to the pole while a back brace keeps the arm from twisting. This may be a special one-piece back brace or a pair of 1 7-32″ x 7-32″ x 26″ regular cross arm braces may be used as back braces by bolting them behind the arm 20 inches from the center and using a 4″ lag screw where they meet behind the pole. This is considerably cheaper than regular cross arm back braces, but it is recommended that when 26″ braces are used as back braces they should also be used in front, being bolted to the arms 17 inches from the center close inside the second pins and lagged where they meet on the face of the pole.

Standard long distance arms as regularly bored require the use of 30″ or 32″ braces but this is needless extravagance. For straightaway work, it is recommended that in ordering such arms, boring for brace bolts be specified 17 inches from center of arm so that regular 26″ braces can be used. These braces are made in two weights, 1 7-32″ x 7-32″ x 26″ and 1¼″ x ¼″ x 26″. The former is believed to be amply heavy for all straightaway work and can be doubled on corners if deemed necessary at less expense than special corner braces and back braces provided for this work.

Anchor Rods: These should always be well galvanized, fitted with galvanized thimbles and should not be lighter than the following:

For permanent bracket lines ½″ x 6′ or heavier.
For not over one cross arm ⅝″ x 6′ or heavier.
For two cross arms or more ¾″ x 8′ or heavier.

Rods and bolts with cut threads should be fully up to diameter specified. Rods and bolts having the "rolled up" threads may be slightly under the specified diameter except at the threaded portion. Tests on cut thread rods always show the threaded end to be the weak spot and the use of rolled up threads is the only method of overcoming this difficulty.

Bolts, etc.: Bolts, washers, lag screws, shims, hooks, guy clamps, and all other pole line hardware should have galvanizing of standard hot dip quality and should be used as indicated in views of standard construction shown herewith.

Strand: Guy strand of the ordinary grade has no place in the best and most durable telephone construction as it is only single galvanized and not uniform in strength and is sure to rust out long before the best grade of iron line wire. It is therefore recommended that only double galvanized Siemens Martin strand be used for the important work of holding corners secure in time of storm when the giving way of a single corner may set storm guys to snapping and pull down several miles of poles. By using this better grade of strand, safety is assured

Nothing soldered, main office ground broken loose and they claimed the new board was no better than the old one. One of thousands of examples of conditions that must be made right before good service can be expected.

and the strand will last indefinitely as will the rest of the double galvanized wire and hardware involved.

Requirements of Line Wire

Rural line wires should always be genuine BB double galvanized soft iron wire. It should be required to stand the Blue Vitriol test for galvanizing already described, should be soft and pliable and the galvanizing should not scale off in the necks of twisted joints. No. 12 BB should stand between 30 and 40 complete twists in a six-inch length before breaking.

Proper Size of Line Wire

About 95% of all existing country lines are constructed of No. 12 wire and this size will undoubtedly remain the standard. No. 10 BB has occasionally been used for long farm and short toll lines but in view of the part phantom circuits will play in the future, it is advisable to keep all wire to standard gauge and grade, therefore, the adoption of No. 12 BB is recommended for all rural lines hereafter.

There may be some cases where the use of No. 10 BB is advisable on short toll lines but in general, when distance becomes too great for No. 12 BB and the phantom circuits (equivalent to No. 9 BB) that can be derived therefrom, it is time to use No. 10 hard drawn copper, which after all is the only wire to be considered for any substantial portion of a real long distance talk. A No. 9 metallic iron circuit has been frequently strung affording only one toll circuit where the same weight of wire in No. 12 would have afforded three circuits including the derived phantom instead of only one.

For exchange work No. 14 BB wire is the only kind to consider where it is necessary to use bare wire between cable terminals and subscribers' premises. Open wire leads in small exchanges

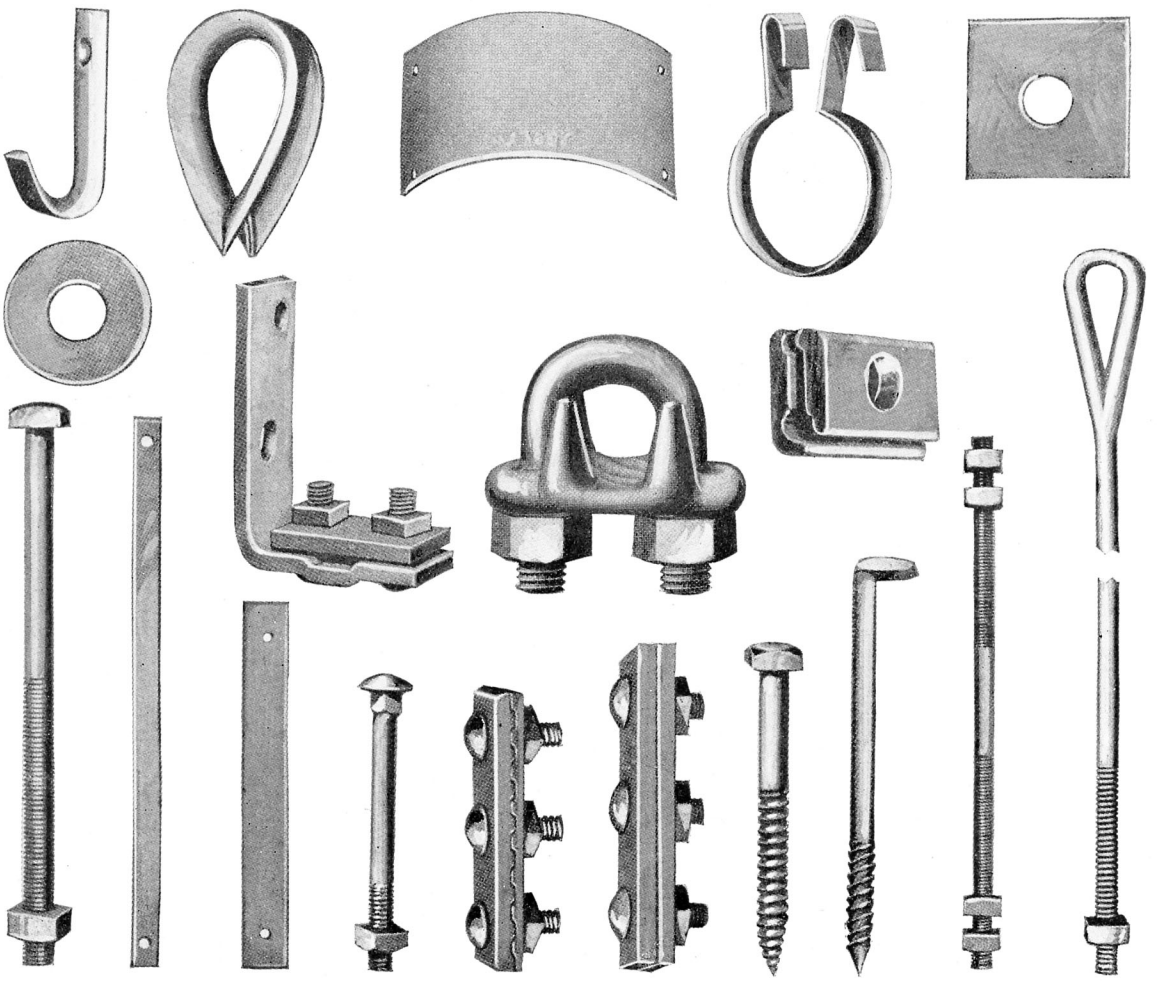
have to dead end and make square corners with such frequency that No. 12 wire pulls ten pin cross arms out of shape and greatly increases the danger of damage by sleet. There are no overloaded ringing conditions to contend with in exchange work and the difference in the talking qualities of half a mile or so of No. 12 and No. 14 wire could not be detected.

Tie Wires and Insulators

Tie wires for iron lines should always be cut from the same size and grade of wire as the line itself. Insulators on country lines and in open wire exchange leads may be of either glass or porcelain, but it is recommended that double groove insulators be used in all cases so that on corners and dead ends the lower groove can be used to reduce the strain on the wood pin. The second groove is also needed in dropping service wires off to houses both in the country and on city party lines as well. Double groove insulators cost no more and are equally as serviceable as single groove insulators for regular straightaway work.

Special materials for use at the subscribers' premises are fully described under the chapter covering the overhauling of existing rural lines.

Special materials used in exchange work will likewise be found described in the chapter covering the overhauling of existing exchanges.



General types of pole line hardware recommended herein.

Practical Suggestions on Building New Rural Lines

AS old lines are rarely rebuilt without stringing additional wire on the same poles and without completely rebuilding certain parts of the line found to be incorrectly routed, it may not be amiss to give a few suggestions relative to the best methods of doing this work.

Surveying New Lines

Laying out a new line is a piece of work that should never be hurried. Don't take "hearsay" or "traditional" information concerning the legal width of any particular piece of road but consult the county surveyor and have him dig clear back to the Government field notes, if necessary, to determine the established width of any highway along which it is proposed to run an important new lead.

Two men should go over the route and stake out the entire line before any work is done for nothing is quite so detrimental to good surveying as to have a digging gang on the ground before the laying out of the line begins.

Ordinarily it is impossible to maintain straight sections of more than a mile of line because the Government section corner stones line up for two mile stretches only once in a while and then mainly by accident. Select a certain distance from the center of the road and endeavor to maintain that distance for a full mile stretch changing it only when the presence of a hedge fence or other obstruction makes it necessary to "move in."

Perhaps the best method of laying out a country line is to set a flag pole at one end of a mile stretch at what appears to be the proper distance from the center of the road. Next distribute stakes the proper distance apart by counting turns of a rag tied to the front wheel of the vehicle used. At the distant end of the mile sight back to the first flag pole to see if it will be possible to carry the line parallel to the highway boundary at the distance already determined. If so, line upon the way back, respacing the stakes if necessary. By "respacing" is meant getting poles out of ravines and gullies and still preserving the spacing fairly uniform. If a pole's regular spacing brings it in the bottom of a narrow gully move it ahead or back whichever will get it out of the hole at the least distance from its proper location.

Suppose it is found necessary to move a pole ten steps ahead to get it out of a gully. Instead of leaving a single span 10 steps over length the next pole back should be brought up 8 steps, the next one 6 steps, then 4 and 2 steps respectively, while the 5th pole's location is not disturbed. The 10 extra steps being divided between 5 spans becomes unnoticeable and the strength of the line is not impaired.

After moving ahead to avoid a ravine or obstruction and spacing out behind the pole so advanced, it is common practice to resume the regular spacing but it is more accurate to space closer ahead of the moved-up pole, until poles are again in their proper location, so that while 5 spaces behind the moved-up pole are being stretched 2 steps each, the 5 spaces ahead of the advanced pole should be shortened 2 steps each. This will leave the line with exactly the predetermined number of poles per mile and greatly facilitate the proper location of transpositions and line trouble. The proper number of poles per mile varies from 25 to 40, according to local conditions and cannot be stated definitely.

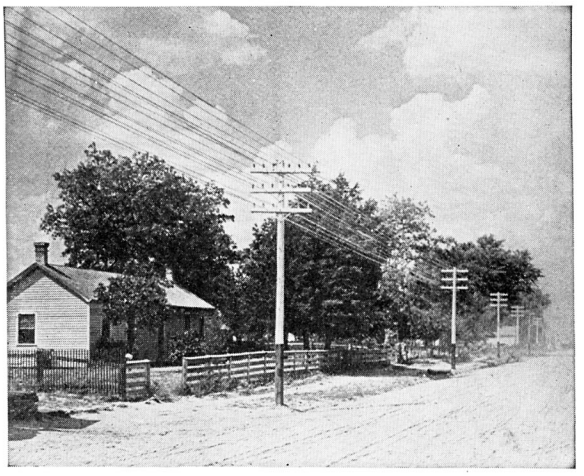
Best Methods of Lining Up

The best method of lining up a one or two mile straight section is for the "sighter" to keep one span behind the "locater." The "sighter" should sight **over** some low pointed object which can be carried along and "jabbed" down in line with the newly set stake. The "liner" should use some slim object, such as a ground or guy rod, which will automatically mark the proper point to be staked as soon as it has been lined up.

Under some conditions a pair of field glasses are a great help, making it possible to see a distant flag pole more readily but ordinarily no tools whatever are required to get poles in perfect alignment in less time than they could be lined up with a transit.

Where obstructions prevent lining up at the side of the road, the flag pole may be set in the middle of the road and the location of every hole determined by laying off the proper distance from the center.

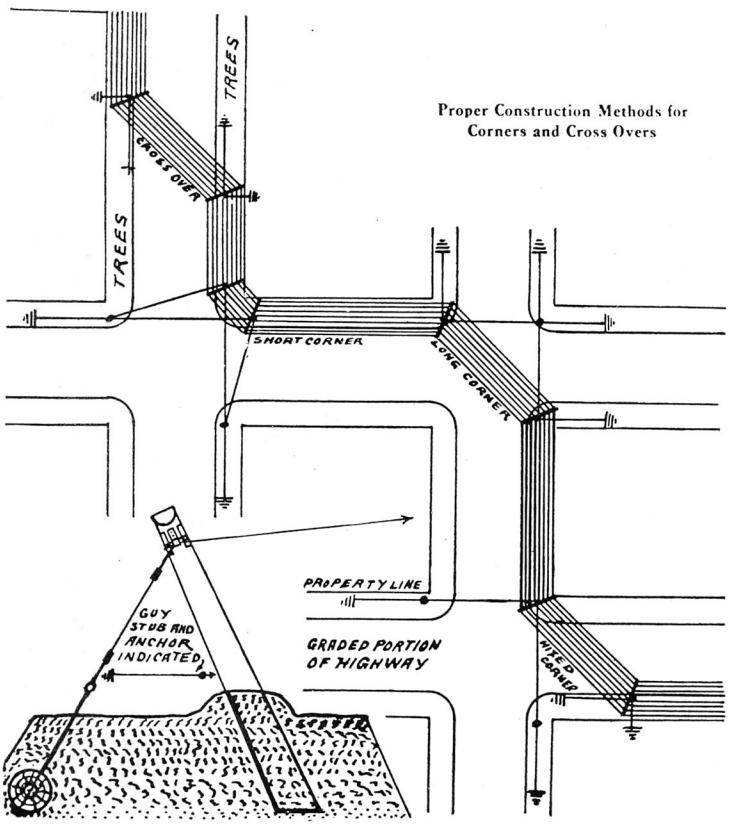
When a hill is encountered between two section corners, it is necessary for two men to go to the top of same and "cross line" each other until they have established two points in line with the ends of the mile section after which the two half mile sections may be readily lined up.



This line was in deplorable condition until the right man got on the job, when it was put into the condition shown at a trivial cost compared with the benefits derived.

Laying Out Corners

In laying out two pole corners first locate the point in line with both leads. Next drop back from this "true corner" suitable equal distances to secure satisfactory locations for both poles. Next join these two points with an imaginary line which will meet each lead at a blunt angle of 135 degrees. Now instead of staking corner pole holes in line with the main leads, lay out into this 135 degree angle from 18 inches to two feet, and dig a slanting hole so the corner poles will not be set perpendicular but will be "raked" sharply against the strain of the wires, or in other words have their tops in line with the main leads even though the butts may be two feet out into the angle.



Proper Construction Methods for Corners and Cross Overs

In country and toll line work one encounters three distinct types of corners which are clearly shown in the accompanying illustration and which have come to be designated as "short"—"long" and "mixed" corners respectively. We also encounter the "cross over," which is nothing more than a special variety of two pole corner. "Mixed" corners and "cross overs" in the middle of a section should be avoided whenever possible, owing to the difficulty of side guying. A "mixed" corner is really a combined corner and "cross over," and is therefore, frequently permissible to avoid a "cross over" a little further along the line. In such cases the slug hole has to be dug on private property—but by using a deep hole and a nine foot anchor rod, the eye of the rod can be brought up outside the fence and payment of any damages made unnecessary.

Guy stubs should be sufficiently high to give guy wires ample clearance. They should be of large size and "raked" sharply toward the anchor log as indicated herein.

Digging

Poles and anchor logs should be distributed before the digging is done as holes should never be left open over night and some poles possess excessive stumpage and require extra large holes.

Good holes can be dug only with long straight handle shovels and in holes deeper than four feet, most soils require the use of a flat toed spoon for removing the dirt. A good hole is one shaped like an old fashioned churn, large at the bottom and small at the top. The holes for white cedar should be started only large enough to admit the pole butt and must be flared all the way down so as to afford room at the bottom for shifting the poles into exact alignment and to permit of tamping. With small topped holes, the labor of tamping is reduced one-half and a much firmer line is secured.

Anchor or "slug" holes should be marked out when the rest of the line is surveyed by driving a stake at each end of the hole desired. These holes should be dug to the exact size of the anchor log and care must be taken to "sight" the anchor rod to the pole shims while starting to tamp. Anchors should, therefore, be placed by the pole setting "gang," and at each corner the poles and stubs must be set first and the anchor rods pointed to them.

Pole Setting

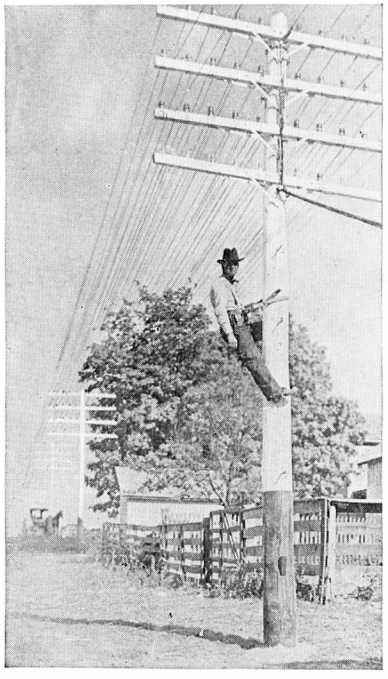
In setting poles one man must remain a span ahead, and give the signals to first get the pole butt set in line, and then to keep the pole in line and perpendicular while it is being tamped. The party holding the pole can usually tell by its balance how it should stand in the line but it is a good idea for the dirt shoveler to take an occasional look at the pole while the tamping progresses, so that it will be set right both ways. Cross arm facing should be in on corners and cross-overs and should alternate on straight stretches.

The next step after pole and anchor setting for a new country line is guying and tree trimming, for unless the "cart has been put before the horse" the poles were fitted with cross arms before being erected.

Guying

Siemens Martin strand is tough and pliable and can be "made up" in the old fashioned way when it is not desirable to use clamps. Always twist the makeup in the direction which **increases** the twist in the body of the strand, as the strand in the "makeup" itself will otherwise be "burned" and weakened.

Strain guys of No. 6 or No. 9 wire should always be placed around corner poles, back to the butt of next pole on each side and left until after the line wire has been strung so that all slack will be out of the regular guys before stringing begins.



This exchange learned the meaning of good service after their old pole house and water soaked paper insulated cable had been replaced with the hand made cable of rubber covered wires which is carried direct from line wires to the switchboard arrester.

Stringing Line Wire

This is the most important part of new line work with respect to future trouble. The method to be followed varies with the number of wires to be strung at a time, but the general principle is that line wire once pulled must never be "eased off," and tie wires must never be allowed to hold the strain even for a moment. Line wire should be pulled with smooth jaw grips to prevent any possible injury to the wire.

In the early days when telephone work was being done largely by telegraph methods, three or four climbers were needed to string even a single wire, grounded bracket line. Each lineman carried the wire up slack and when all were up, it was customary to grab the wire with a pair of blocks trailing behind the wagon and pull it with the team until the head lineman waved the driver down and yelled, "Tie." As soon as the four tie wires were in place, the wire was turned loose and the process repeated. After a mile or so had been strung in this improper fashion, the "back lash" when the wire was loosened became so great the tardy lineman was almost thrown from the pole and the pole itself bent almost to the breaking point.

In cold weather, lines strung in this manner break faster than they can be repaired and the breaks always occur at the poles where the head man tied in. Releasing the wire put a vicious kink in it at the tie and after the next pull had yanked the wire ahead again, the head man's tie was loose and had no mission except to "fiddle" the line wire in two, or weaken it until cold weather could easily finish the job.

The Right Way

The proper method of stringing a one wire bracket line is to use one good lineman. Dead end the wire at the starting point, not on a bracket nailed on the side of the pole but by passing a wire around the entire pole, using a circuit breaker or not less than four brackets nailed on backwards in a circle clear around the pole. Leave the lineman at the foot of the second pole where he is to remain until at least a half mile straight stretch has been strung along the ground at the foot of the poles. Pull at the furthest pole the wire will reach, dead end and throw the fractional span which is left into the wagon to be cut into tie wires. Take end of new coil and make a "half connection" to the tight wire and reel off another half mile coil and proceed as before.

Meanwhile, the lineman will have started carrying up and tying in the tight wire. If the spans are reasonably short he will not attempt to tie in at the last pole, but will come ahead to the dead end and wait until the wire is pulled ahead. He then cuts the dead end loose from the pole, finishes the half connection and resumes tying in where he left off.

In this manner two men and a boy to drive can put up as much wire as could the old time "gang" and do it easier because there is no wearisome waiting up the poles, and it is only necessary to stay up long enough to tie in the tight wire.

In stringing two wire bracket lines, follow the same method except it is advisable to have two men tying in, particularly if the country is hilly. In pulling across a deep ravine it is of course necessary for one man to hold the wire from going higher than the pole tops, and tie it in as soon as pulled. In going over a high hill stop and pull to the butt of the pole on the hill. The lineman will be on the job to cut loose as soon as you start to pull, and to carry the wire up before it gets too tight. Being up a pole on a hill he is of course able to signal for more slack if he needs it. In pulling around two pole corners always pull and dead end one pole before you reach the corner. Then string the wire over the corner poles. The lineman will again be on the job to cut loose as soon as you pull ahead and get the wire into the lower grooves of the glass on the corner pole before it is pulled too tight.

When a second set of blocks together with a "cheap boy" is available it is not necessary to bother with dead ending and in making half connections. A complete splice can be made and the boy left to bring the blocks ahead to the wagon as soon as the lineman takes them off.

In stringing on cross arm lines much labor is saved if the slack wire be "forked" up to position with a pike pole as it is paid out. For stringing five or six wires at a time most foremen prefer to use a "running board" and pull the wire over the cross arms while the wagon carrying the pay out reels remains stationary. The wires are all pulled at once and a single set of large blocks and set of equalizing pulleys is often used where all wires are of the same size. In all cases the wires should be held tight by one set of blocks until the other set of blocks pulls up the slack on ahead.

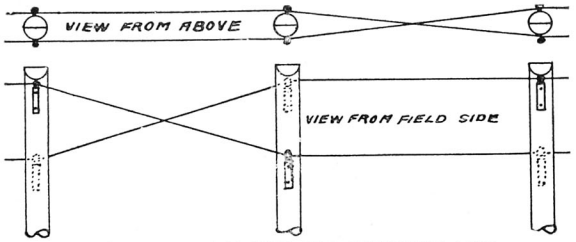
Tie wires should be cut at odd times and formed ready for use on a bracket and insulator. In applying the ties to iron wire give a turn and a half with the hands, cinch the next half turn with the pliers and bend the ends into the groove of the glass insulator.

Wire of good quality put up in this painstaking manner will stay up indefinitely without further attention, and with practically no trouble from cold weather breaks.

Transpositions

When transposition poles are encountered while stringing two wires, simply reverse positions of the reels on the wagon, or if near the end of a coil make the reverse in the splices when the new coils are connected. When stringing with a running board, the necessary number of twists to each circuit in each run can be kept track of and given before the wire is pulled up, thus making it unnecessary to "cut" in transpositions as they will be in without cutting when the wires have been tied in.

Transpositions even on short metallic farm circuits are necessary to secure complete freedom from cross talk, but it is not necessary to make them at as frequent intervals as is common prac-

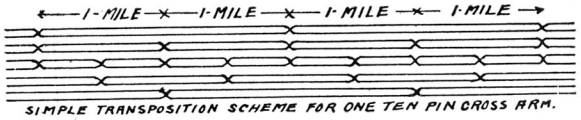


TRANSPOSITION SCHEME FOR BRACKET LINE

tice. The more complex systems as used on long distance toll lines should be kept away from, and the following system used as it is one which anybody can understand and check up for correctness.

Any metallic circuit is balanced against outside disturbances by transposition at regular intervals. Two circuits on the same pole line can be kept from cross talking with each other either by transposing one circuit twice as frequently as the other or by spacing the transpositions the same distance apart in both circuits, but "staggering" them. Both methods are to be used as indicated in the accompanying diagram showing a five circuit lead. On single bracket circuits transposing is accomplished by setting one pole at regular intervals with the bracket reversed as to position. The wires are crossed when stringing and the cross takes care of itself when the transposition pole is reached.

On four pin arms transpose each circuit every mile, but stagger the transpositions. On six pin arms the two outside circuits transpose the same as directed on a four pin arm. The pole



SIMPLE TRANSPOSITION SCHEME FOR ONE TEN PIN CROSS ARM.

pin circuit then transposes every two miles unless the lead is likely to require a ten pin arm at some future time when the middle circuit should be transposed every half mile or every four miles when the latter distance is found sufficient to make the circuit quiet.

On ten pin arms the middle circuit should transpose every half mile when paralleled by high tension power lines and every four miles where outside disturbing current is not present. The circuit on each side of the pole pin circuit should be transposed every mile, and the transpositions staggered as already described. The circuit at each end of the arm should be transposed every two miles, and the transpositions staggered as indicated in the accompanying diagram.

Importance of Phantom Circuits

As the proper use of phantom coils makes it possible to secure six and even seven full metallic circuits from an eight wire lead, one ten pin cross arm will be found sufficient for the ordinary country lead where phantom coils are employed and no attempt should be made to change an existing rural system from grounded to metallic without the use of phantom circuits. This is too large and important a subject to attempt to describe here, but it will be well for the reader to make an immediate investigation of this subject for with the proper use of phantom coils it has been found possible to free every grounded rural lead from cross talk and induction practically without the use of any additional wire. This is one of the most important questions which a telephone operator now faces in view of the rapid development of high tension transmission lines from city power plants to the smaller towns in the country.

Rebuilding Small Town Exchanges

THE average run-down exchange is considerably more difficult to put in condition to give good service than is the run-down rural line, but practically all of the suggestions for repairing old rural lines apply with equal force to fixing up run-down and dilapidated small exchanges.

Cable

The first thing to determine is whether to put up any new cable and if so, how much, or, in the case of extremely small exchanges, whether it is not wise to dispense with the use of cable altogether.

In small grounded line exchanges, it is the rule rather than the exception to find a twenty or thirty foot length of defective paper insulated cable between the office pole and the switchboard protection. In remedying such conditions, the old cable should be dispensed with and where all lines can be brought in open wire to a "King Pole" just outside the central office, it is recommended that a lead covered cable of No. 18 copper wires, with weather proof braid over the rubber insulation of each wire be used in place of the paper insulated cable and that the cable box be dispensed with altogether.

The No. 18 copper wires will readily carry to the office lightning arrester all the current which the iron line wires are likely to bring to the office pole. The operator can clean smutty carbons after a storm and it becomes unnecessary to climb the office pole except at rare intervals.

In exchanges of larger size where it is not convenient to bring the lines clear to the central office in open wire, paper insulated lead encased cable must be used and where it is found advisable to use such cable at all, enough of it should be used to completely dispense with heavy leads of open wire in the center of the exchange.

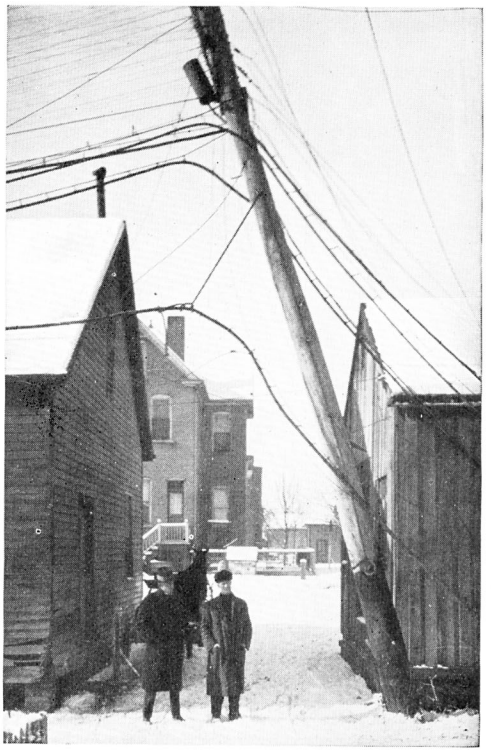
The residence city lines should be brought to various junction poles throughout the exchange and there dead ended and connected with rubber covered spider wire into approved galvanized cable terminals with carbon and fuse protection, self-soldering nozzles and sealed fanning chambers.

Protecting Paper Insulated Cables

The two things most likely to damage paper insulated cables are lightning and moisture. Lightning can be kept out only by the use of carbon arresters (in addition to fuses) at both ends of the cable, as lightning has been known to back up into good cables at the central office end and cause damage where carbon protection has been omitted and switchboard drops have not been insulated from the mounting strip.

Moisture can be kept out of cables at the outer end by the use of approved terminals with self-soldering nozzles and a fanning chamber designed to be sealed with a face plate and rubber gasket, after filling with paraffine wax or cable compound. Moisture can be best kept out of the office end of paper cables by splicing on a ten-foot length of wool insulated lead encased cable which prevents moisture reaching the dry paper core and still permits the cable to "breathe" in case of sudden changes of temperature.

This "breathing" explains why in cables tightly sealed at both ends, one frequently finds that more than a pint of water has soaked in through a mere pin hole in the sheath almost invisible to the eye.



The result of attempting to hold a city cable lead with a small "patent" anchor where a ¾"x9' rod and Carbolineum treated anchor log was needed. Patent anchors are all right in their place but should not be used on such heavy work.

Hot sunshine on the sheath frequently sends the imprisoned air inside cables up to a temperature of 140 degrees. This produces a great pressure inside the cable and causes the surplus air to "blow off" through any available opening or weak point in the sheath. Then a dash of ice cold rain produces several pounds of negative pressure or vacuum inside the sheath and causes the cable to actually suck in water from the rain-coated sheath. Leaving the office end unsealed allows equalization of pressure and prevents the complete waterlogging of punctured cables at the time of the first rain.

In exchanges, as on country lines, the corners demand first consideration. A row of old poles in the straightaway portion of a lead, after holding up several cross arms of open wire, can be depended upon to hold up a small cable for many years longer but considering the relatively great labor expense to cost of the cable itself, no one can afford to string new cable on old leads until all cable terminals and other points where the "messenger" strand must dead end, have been provided with seven or eight inch top poles with Carbolineum treated butts shaved above the ground line and stepped.

With all corner, junction and terminal poles set new, it is no trick to replace the old supporting poles in the straight sections of the lead when their usefulness has been exhausted.

Stringing Cable

Aerial cable in small plants should always be hung with galvanized cable rings from Siemens Martin guy strand. A wire for drawing in the cable should be strung parallel to the messenger and clipped in when the rings are crimped to the strand. If a gem wire grip is not available for pulling in the cable, a pipe cone, or piece of bored-out pitchfork handle can be used over the end of the cable to keep it from fouling with the rings. Use plenty of old fashioned soft soap on the cable sheath and it will slip through the rings with surprising ease and the cable will be most bright and attractive after the first heavy rain has washed off the soap. Heavy black oil is frequently used for this work but it leaves the cable discolored, greasy and unsightly, and should not be used when the soft soap can be had.

Splicing Cable

Anyone capable of doing proper pole setting and guying can string cable successfully, but for the important work of splicing, branching and terminating the cables, a man of known experience and ability should be secured as this part of the work is such a trade in itself that no attempt can be made here to describe the detailed methods.

Aerial Cable Specifications

Aerial cable for small exchanges should always be No. 22 B. & S. gauge. Two wrappings of paper in reverse directions on each wire is preferable to a single wrapping, no matter how heavy, or to two lighter paper wrappings applied in the same direction. Each cable conductor should not have an electrostatic capacity or "leakage" to alternating currents greater than .12 microfarads per mile when tested against all the other conductors and the sheath itself.

Considerable argument prevails as to whether pure lead or an alloy of lead with a small percentage of tin or antimony makes the best and most durable cable sheath. The impure lead or alloy possesses much greater tensile strength and there is consequently less danger of straining the cable while pulling it into the rings. After the cable is once installed, however, there is little doubt but that the pure lead sheath is more durable and reliable so that for short lengths of aerial cable in small plants, the use of pure lead sheath cable and plenty of soft soap and care in putting it up, is recommended. Cable must never be allowed to come in contact with anything except its supporting rings and must be protected from contact with other poles, trees, etc., by the use of cable "splints."

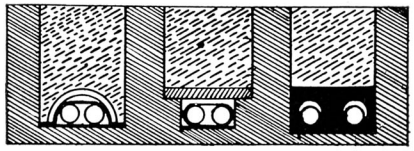
Underground Cable in Small Plants

Underground cable was once supposed to be something beyond the reach and knowledge of the ordinary telephone man, and something that could not be undertaken without an abundance of capital, engineering talent, concrete machinery and vitrified conduit.

Of late years, however, the development and perfection of fibre conduit has robbed underground work of much of its "pomp and ceremony," while scores of underground installations which have been working for years with cables buried directly in the earth, indicate there is no longer any excuse for stringing small exchange cables on poles over old frame fire traps when there is no paving in the way of putting the cables underground.

Great care must be taken before burying cables directly in the earth to make sure there is no prospect of an electric railway or the electrifying of an old steam railway. If there is any such prospect, even remote, it will pay to use the fibre conduit even if the latter is buried directly in the earth. For best results, however, it is recommended that enough concrete be used with fibre conduit to hold it in good alignment and to prevent mechanical injury from above.

Where there is no probability of an electric railway, cables may be laid in the bottom of dirt trenches and covered with half tile or may be buried in small sub trenches and covered with 2" x 12" planks treated with hot Carbolineum and laid on the bottom of the main trench. In either case the cable should be laid on and covered by tarred building paper. These latter methods



UNDERGROUND CABLE METHODS
TAR PAPER AND HALF TILE | TAR PAPER AND PLANK | FIBRE CONDUIT IN CONCRETE

offer a very great advantage over conduit in that every foot of cable is accessible with a little digging to take up one section of tile or plank. In case of damage to any portion of the cable, the location of the fault can be determined approximately by voltmeter tests and that section of the cable opened up by an ordinary laborer. The exact location can then be made with an exploring coil and the trouble repaired without cutting the cable in two.

Pure lead sheath is recommended in all cases where cables are to be laid in the earth, as earth salts are likely to attack alloy sheaths while pure lead coffins which have remained buried for centuries have been so little effected that only a scratch of the finger nail was needed to reveal bright new lead.

Where underground cables are to be brought up poles, an iron pipe with a 90 degree bend below the ground should be used part way up the pole as mechanical protection for the cable. In case of damage to the cable inside this pipe, it can be slipped up the pole and the bad spot in the cable repaired without cutting it in two.

Earth Buried Cable "Works"

The prospect for trouble in cable properly installed and properly protected from lightning and moisture is so remote as to be almost negligible and cable should be replacing old leads of rusted-out open wire in small plants much more rapidly than it is. The burying of cables directly in the earth is recommended for small exchanges because "it works" and in the belief that a greater knowledge of this method will stimulate the use of cable and result in much general improvement in the work.

Lines Should Be Metallic Through Cables

Cables should always be run full metallic from the central office to the cable terminal so as to afford the foundation for an ultimate complete metallic exchange. The use of repeating coils in all local cord circuits on the magneto board overcomes electro-magnetic induction within the cable, even though the lines are grounded from the terminal on, and while this does not relieve static induction within the cable, the service is greatly improved and it becomes possible to give heavy toll talkers the benefit of metallic circuits at once by providing the second wire from the cable terminal to their telephones.

Metallic Party Lines Better Than Individual Grounded Lines

Metallic circuits through all new cables are recommended for the further reason that the development of simple low voltage harmonic ringing systems has made it possible for all exchanges, no matter how small, to place as many as four outlying residence telephones on the same line and call any one telephone with a single ring absolutely without tapping or disturbing the bells of any of the other parties. The four parties do not disturb each other's bells when calling for central but each one rings in and throws the central office drop just as if his were the only telephone on the line.

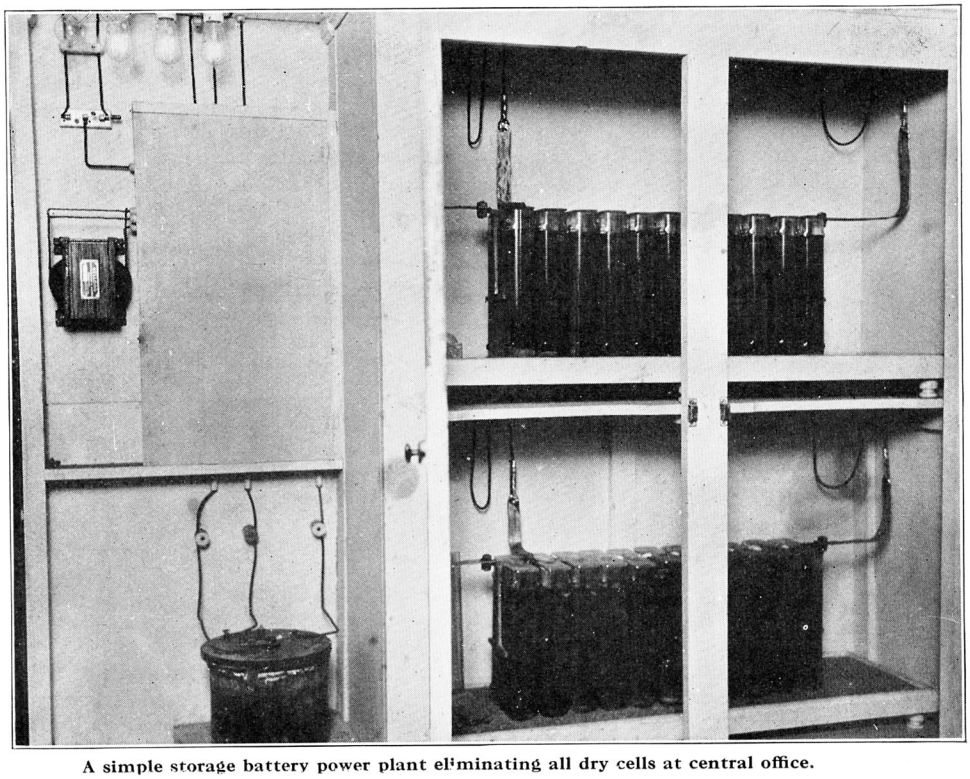
As this system becomes better understood, the demand for METALLIC CIRCUIT PARTY LINE SERVICE will rapidly increase as such service is far superior and more valuable to the subscriber than single grounded service, and requires only half as much wire to furnish if the lines are loaded to four parties and the same amount of wire where only two parties are placed on the same metallic circuit.

This system, furthermore, does away with all grounds at the telephones which in itself means a greatly improved service with less chances for operating trouble.

Overhauling Open Exchange Leads

After the cable question has been settled, the open wire leads can be overhauled one at a time according to the general methods already given for the overhauling of old rural lines. New poles should be provided for important corners and these reconstructed and guyed in accordance with standard construction methods. Particular attention must be paid to all joints between copper spider wire and rusted iron line wire and both wires must be sandpapered bright and soldered. Drop wires to subscribers' telephones, also interior wiring and ground rods should receive attention already recommended in the case of telephones on country lines.

When approximate bell resistances are known, the condition of lines in a magneto exchange can be determined in an hour's time with a low resistance voltmeter and a couple of cells of dry battery connected to a plug and cord. The high resistance lines revealed by this general test should then be gone over carefully and the high joints or poor ground connections made good until the line will show only normal resistance in addition to the resistance of the bells.



A simple storage battery power plant eliminating all dry cells at central office.

Overhauling Central Office Equipment

THE subject of Central Office Equipment like that of Phantom Coils and Cable Splicing is too involved to be fully covered in this work but a few suggestions along the lines of service betterment within the Central Office will be included.

Cords

In the average run-down office, first attention should be given to the switchboard cords as nothing can cause so much general trouble and service dissatisfaction as a scratchy, "choppy" cord or one subject to cut-outs. Tinsel cords in particular require almost constant attention, and it is recommended that the use of tinsel cords be discontinued and a cord with combination tinsel-steel conductors be adopted instead. Tinsel cords will partially break and become scratchy in spite of the greatest care. Steel cords are free from this trouble but they offer too great resistance to be considered, especially in long distance connections. The combination cord with steel over tinsel, as now offered by several manufacturers, is the proper construction and practice as the low resistance and good talking qualities of tinsel are thereby combined with the staying qualities of steel. It is very uncommon for a good tinsel-steel cord to develop any electrical trouble whatever and good service is assured at all times.

Testing Cords and Cord Circuits

It may be well to give a few suggestions as to how cords and all cord circuit apparatus should be tested. On single supervisory switchboards, cord circuits can be tested by connecting one cell of dry battery to some idle jack and an operator's head receiver to another idle jack and connecting the two jacks by means of the various cord pairs to be tested. Cords should remain quiet when "wiggled" and the key levers should be lightly pressed in all directions to make sure that talking subscribers are not subject to cut-offs when the operator's sleeve brushes the cam levers.

On double supervisory switchboards, direct current as furnished by a dry cell cannot be used for testing cord circuits on account of the condensers which such cord circuits contain. For these boards it is necessary (and for single supervisory boards it is better) to manufacture low voltage artificial voice current which will pass through condensers and repeating coils and in fact go anywhere that a voice current will. Such current can always be produced by placing a high frequency buzzer in series with a dry cell and the primary of an induction coil. The secondary of the induction coil should then be shunted with a foot or two of fine German silver wire to give tone of proper loudness which should be from an alternating current of about 1 volt pressure and of the highest frequency obtainable. Such testing current will balk completely and refuse to go through any place where ordinary voice current would not pass and any faults in the cord circuit equipment are easily detected when the shunted induction coil secondary is connected to one switchboard jack, the observer's telephone receiver to another jack and the two jacks connected with the different cord circuits to be tested.

If the observer wears the operator's receiver on one ear and the regular observing receiver on the other ear, the listening functions of the cord circuits can be tested at the same time the talk-through tests are made and all scratchy cords and insecure normal contacts in keys can be located by twisting and wiggling cords and by gently pressing key handles in all directions as suggested for the dry battery test on the single supervisory circuits.

The Importance of Soldering

When all cord and key troubles have been corrected the next move in a run-down Central Office should be a general soldering campaign to get rid of all possibilities for loose connections and "cut outs."

Why so many men in charge of small offices hate solder and soldering worse than the proverbial cat does hot soap, can only be explained by their having had no opportunity to learn how soldering can be made easy and how it should be done.

No Acid, Paste, Soldering Salts, Sticks or Fluxes of Any Kind Should Ever Be Permitted in Switchboard or Telephone Instrument Work and Nothing but Rosin Core Solder Should Ever Be Used

The secret of soldering with rosin core solder is simply to have a clean, hot, soldering copper. Take the dirty one found in the average exchange, clamp it in a vice and file the four sides of the point bright and smooth. Turn the blow torch, not on the filed surface, but on the butt of the copper and let the heat work out to the point. As the copper grows hot, keep trying the filed surface with rosin core solder and as soon as the rosin will melt take the copper away from the fire and rapidly "smother" the point with a plastic mixture of molten solder and rosin. As soon as the air has been excluded from all the newly filed surface put the butt of the copper back in the blow torch flame and let the solder and rosin "sweat." If the point of the copper is now kept out of the flame there is little danger of getting the copper too hot and the hotter it is the better the solder will work.

Don't use too much air pressure on the blow torch. A gentle pressure and a quiet flame of large volume is preferable to a "blast" and heats the copper better and more uniformly.

Rosin core solder can be used on any wires or terminals that are bright and clean, as well as on those that are tinned, and when wires or terminals are slightly corroded, a bit of fine sandpaper will soon put the joints into condition so that the rosin core solder can be used.

Unsoldered connections are most frequently found on arrester and cross connecting equipments and where additional drops have been installed and the switchboard cable wires merely wrapped around the terminals. In soldering, best results will usually be had by touching the end of the rosin core solder on top of the joint and applying the copper in such manner as to melt off a sixteenth of an inch or so of the solder and sweat it into the joint. With a large soldering copper heated nearly red hot, perfect joints can be made almost as rapidly as they can be touched.

When soldering on vertical racks, always work from the top down to avoid the danger of overlooking short circuits from possible solder drippings, though when solder is properly applied it should all be used and there should be no drippings. When soldering in additional drops, a piece of cardboard slipped in immediately below the row being soldered will prevent possible trouble from solder drippings.

Operator's Equipment

An exchange is judged for efficiency by its neighboring plants according to how well they hear the operator and to keep the operator's transmitter and transmitter battery up in good condition goes a long way toward securing high regard for the service by local subscribers.

An operator's transmitter being in service almost constantly should not be expected to last for a long period of years without attention, as the same transmitter probably will on an ordinary telephone. An extra operator's transmitter should be kept on hand at all times so as to give opportunity for cleaning and overhauling the regular transmitter without interruption to service.

The question of switchboard transmitter battery for small exchanges has never been definitely settled. But few existing boards are provided with an extra contact on the operator's listening keys to close the battery circuit automatically when the listening key is thrown to talking position. This means that the batteries are in service all the time the operator's plug is inserted, but a great deal of battery needlessly wasted could be saved by pulling the operator's plug at night and during times of dull traffic in the day time and where the operator will do this, the use of three dry cells and a high resistance common battery transmitter is recommended in preference to Blue Vitriol gravity batteries with their attendant muss and dirt.

In using high resistance hanging transmitters, care must be taken not to turn the transmitter over on its back as the carbon in these transmitters being very fine will often become so loose and "feathery" that the transmitter will not talk well until one or two words have been spoken into it loudly to make the carbon settle back to its working condition.

It is also recommended that two sets of dry cells be provided and connected to the two ends of a double pole double throw switch and the blades of the switch connected to the switchboard battery leads. The two ends of the switch should be marked "EVEN" and "ODD" and the switch handle should be thrown correspondingly on the even and odd days of the month. This means that the battery in service today will have two nights and a day in which to recuperate

before it goes on duty again and when so used, immensely longer life will be secured. Those who have tried out dry cells on operator's transmitters and given it up as a failure after leaving the cells on permanently night and day with no chance to recuperate, should try out the system above recommended.

For boards having extra contacts to keep the battery circuit open, except when listening keys are thrown, 4 cells of Potash battery of the Edison or Gladstone type with transmitters of not more than 20 ohms resistance will give the best and most uniform transmission known, except that obtained from storage batteries, which we will not attempt to discuss here. Not less than 4 cells of 300 ampere hours capacity should be used and 400 ampere hours capacity is recommended. The initial cost of such a battery is in the neighborhood of $12.00 but the expenditure is well justified, particularly on toll operators' positions, by the loud, clear and uniform transmission which results.

Operators' receivers should be watched and rusted-out diaphragms replaced with new. Diaphragms should be kept as close above the magnets as is possible without "freezing" and where a large air gap is found, the ear cap and diaphragm should be removed and the receiver given a few strokes on a flat sandpaper surface to reduce the air gap to proper dimensions.

Ring-Off Troubles

In single supervisory switchboards in exchanges having telephones with 80-ohm ringers, ring-off troubles can not be wholly overcome except by changing the cord circuits to the double supervisory type with two ring-off drops and two condensers, but where this expense is not justified in connection with old boards, the ring-off trouble can be greatly relieved by placing all ring-off drops in good adjustment, giving particular attention to shutter rods that have become battered down until they will not allow the drop shutter to operate.

Even on double supervisory boards, proper attention must be given to maintaining ring-off drops in good adjustment for no matter how perfect such circuits may be electrically, the service will be bad if any ring-off drops are battered until the shutters will not release.

Ringing Equipment

In small offices ringing equipment has perhaps a more important bearing on the quality of service rendered than any other single item. The average small office being dependent on dry batteries as the source of ringing power, is forced to use some form of "pole changer." It is entirely possible to get good results from dry battery pole changers provided they are maintained in proper adjustment and the ringing and vibrator batteries are kept up and provided further all buzzers and similar high impedance objects are removed from the ringing circuit as it is impossible to get a good ring out on a heavily loaded line through the "choke" of an 80-ohm buzzer.

A good, vigorous vibration is the first essential to good ringing and the vibrator battery must be kept up and the adjustment of the machine so looked after that a strong vibration, without pounding, will be maintained at all times. The vibrator must not run too fast or old worn bells with long strokes cannot keep up with the ringing current impulses and a "fluttery" ring will result. Twenty cycles or "round trips" per second is the greatest rate at which any "pole changer" should be allowed to vibrate and 16 or 18 cycles per second will ordinarily be found to give a much surer ring.

Good ringing for country lines requires from 80 to 100 volts of alternating current and as it is an exceptional pole changer that will deliver more than one alternating volt per dry cell of ringing battery, it is suggested that 80 dry cells be made the minimum where country lines are to be rung.

It is indeed rare to find pole changer dry batteries properly connected as a careful inspection will almost invariably show wires accidentally hooked **in the groove** of screw terminals after which the nut has been firmly set down with pliers. These loose connections are a very frequent cause of "fluttery" rings.

Another common occurence is to find a carbon to carbon or zinc to zinc connections thereby causing a section of cells to oppose or "buck" the others, so that if ten cells are reversed the effect is the same as taking off twenty altogether. Of course, when only one reverse is made in connect-

ing up a number of dry cells the error is detected because they "don't come out right," but when two reverses are made everything apparently comes out right and the reversed section of dry cells frequently remains undiscovered.

The third and most common error of all is to so place batteries that local short circuits can occur and kill a few cells in the interior of a bunch of ringing batteries. The only sure way to avoid this is to place ringing batteries on shelving where they can be inspected and any inherently defective cells located and weeded out. To avoid the possibility of short circuits, it is necessary to place the first row with zincs turned in toward the wall and the second row with zincs turned out away from the wall. A one-inch board must then be set on edge between the second and third rows and the third row set with zincs turned in toward the wall and the fourth row with zincs turned out away from the wall.

It is also advisable to place batteries where they will not be subjected to extreme cold or extreme heat either winter or summer.

Pole Changer Adjustments

Of equal importance to good ringing battery is the proper adjustment of the pole changing contacts which may be stated as follows: The two contacts on each side must make at exactly the same time and break at exactly the same time. The duration of contact in each direction must be exactly the same or, in other words, the springs must be bent exactly the same distance in each direction. The dead interval, when the vibrator is free from all contact, must not be so great as to cut down the duration of contacts.

All springs must come to firm rest on their stops, when stops are provided, and in the case of pole changers having screw adjustment for stops, care must be taken to see that the springs are free to move and that they do not snag on the threads of the adjusting screws.

Safety Resistances

It is, of course, necessary to use some form of resistance in ringing leads to prevent damage to pole changers in case of short circuit and also, to prevent blowing of fuses or operation of heat coils when ringing on short lines having 80-ohm telephones. Formerly it was customary to employ carbon lamps in the line side of each operator's ringing lead for this purpose but it was found that carbon lamps, which possess very high resistance while cold, showed a tendency to choke out the first short ring of code signals starting with one short. The use of modern metallic filament "Mazda" lamps puts the first short signal over in good shape but shows a tendency to "lay down" at the end of long rings on heavily loaded lines so the ideal ringing resistance unit for each operator's position is a carbon and Mazda lamp in multiple as the Mazda lamp causes all signals to start strong while the sluggish carbon lamp gets into action in time to keep them strong.

In small exchanges, the ringing resistance can be cut in series with the ringing battery which makes it impossible to short circuit or damage the pole changer, but in all exchanges where two or more operators are constantly on duty in the day time separate ringing resistances should be provided for each operator's position and all other resistances should be eliminated.

Storage Battery Ringing

In large magneto exchanges where electric lighting current is available, either constantly or for a few hours each day the installation of a small set of storage batteries for ringing purposes so as to get away from dry battery expense and secure uniform ringing at all times should be investigated and carefully considered, for, as already suggested, there is nothing, except it be transmission itself, which has a greater influence on the rural patrons' opinion as to the efficiency of the service than the reliability of the ringing.

The Commonwealth Press Chicago

Examples—Method of Measuring Sweep

FIGURE 1—7-ft. Posts. Excessive Sweep.

NOTE: If the distance between the tape and post does not exceed 4 inches, the post conforms to grade, as outlined by specifications.

FIGURE 2—25-ft. Poles. Excessive Sweep.

NOTE: If the distance between the tape and pole does not exceed 5 inches, the pole conforms to grade as outlined by these specifications.

FIGURE 3—Excess twist in grain of sawed post.

FIGURE 4—Maximum twist in grain permitted in sawed posts.

Figure 5 — Maximum sweep below ground line.

Figure 6 — Excessive Sweep below ground line.

Figure 7 — Short kinks not permitted.

Figure 8 — Short kinks not permitted.