

Chicago, Ottawa & Peoria
Railway Company

RULES AND REGULATIONS
FOR THE GUIDANCE OF THE
MAINTENANCE OF WAY DE-
PARTMENT



EFFECTIVE APRIL 1st. 1914

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Chicago, Ottawa & Peoria Railway Company

The rules herein set forth are for the government of employees of the Chicago, Ottawa & Peoria Railway Company's lines, and become effective April 1, 1914, superseding all previous rules and instructions inconsistent therewith. Special instructions may be issued by proper authority.

H. E. CHUBBUCK,
Vice President Executive.

F. E. FISHER,
General Superintendent.

W. F. CARR,
Engineer of Maintenance of Way.

General Rules

GENERAL RULES.

Employees whose duties are prescribed by these rules must provide themselves with a copy.

Employees must be conversant with and obey the rules and special instructions. If in doubt as to their meaning they must apply to proper authority for an explanation.

Employees must pass the required examinations.

All employees above the class of laborer must be familiar with Rules of the Transportation Department.

Employees must render every assistance in their power in carrying out the rules and special instructions.

Any violation of the rules or special instructions must be reported.

The use of intoxicants by employes while on duty is prohibited. Their habitual use or the frequenting of places where they are sold is sufficient cause for dismissal.

In case of danger to the Company's property employes must unite to protect it.

For positions above that of laborer any person who cannot read and write English or who does not possess a knowledge of the rudiments of arithmetic shall not be employed.

Minors shall not be employed in maintenance department.

A person dismissed from any ^{any other} department of the service shall not be employed in ~~the~~ department without the consent of the head of the department from which he was dismissed.

Civil, gentlemanly deportment is required of employes in their intercourse with the public, their subordinates and each other. Boisterous, profane or vulgar language is forbidden. Courtesy and attention to patrons is demanded. Employes must not enter into altercation with any persons, no matter what provocation may be given, but will make note of facts and report to their immediate superiors.

Employes who are dishonest, immoral, quarrelsome or otherwise vicious will not be retained in the service.

All employes must devote themselves exclusively to the Company's service, attending to their duties, during prescribed hours, residing wherever required and obeying promptly instructions of executive and general officers, and those of heads of departments, in matters pertaining to their respective branches of service.

Chicago, Ottawa & Peoria
Railway

General Notice

To enter or remain in the service is an assurance of willingness to obey rules.

Obedience to the rules is essential to the safety of passengers and employes and to the protection of property.

The service demands the faithful, intelligent and courteous discharge of duty.

To obtain promotion, capacity must be shown for greater responsibility.

Employes, in accepting employment, assume its risks under Employer's Liability Act.

Employees who are careless of the safety of themselves or others will not be continued in the service.

Employees whose duties are prescribed by these rules, if discharged, will not be re-employed without the approval of the General Superintendent.

Employees are required to report any misconduct or negligence affecting the interest of the Company. Withholding such information will be considered proof of negligence or indifference and treated accordingly.

Employees will be regarded as in line of promotion, advancement depending upon the faithful discharge of duty and capacity for increased responsibility.

Employees whose duties require service on more than one division or subdivision are under the jurisdiction of the officers of the division or subdivision on which the service is being performed.

Employees must return property entrusted to their care, when leaving the Company's service, or upon demand by proper authority.

Employees are forbidden to offer testimonials to their superiors either directly or indirectly, and those in authority will not accept such presents or testimonials. The acceptance of gratuities or rewards from passengers or other patrons of the Company is forbidden.

Employees must not remain near the track when trains are passing as coal, stone, car doors or other articles are liable to fall from the train. On double track employees must stand outside and clear of both tracks while trains are passing. All employees are further warned that they must not rely on others to notify them of the approach of a train.

Foremen and others in charge of work must always bear in mind that SAFETY is the first and most important consideration.

Every person accepting employment does so with a full knowledge of the DANGERS INCIDENT TO THE OPERATION OF RAILROADS and agrees to exercise due care in the performance of his duties to prevent accident to himself or others and, before using them, see that machinery or tools are in a safe condition to perform the services required.

Foremen must forbid their men from placing themselves in dangerous positions. The men must not be permitted to get on or off cars while in motion.

When persons, who are evidently intoxicated, idiotic or insane, are seen in the vicinity of stations or tracks, they should be carefully guarded from approaching trains and, as soon as possible placed in the custody of police or proper authority.

Trainmen are required to handle their own switches.

Except to prevent an accident, employees unauthorized to do so will not handle switches for trainmen. Ordinarily switches must not be thrown for velocipede or handcars; such cars must be lifted over. When necessary to throw switches for loaded push cars, it must be done only under the personal supervision of the foreman and switch must be immediately returned to its proper position.

In doing work in cities all ordinances must be obeyed.

If any street is to be closed, first obtain permission and then notify the Fire Department.

Do not interfere with the property of other companies unless permission has been obtained from them.

If any damage has been done to another Company's property make temporary repairs immediately and then report the damage to your superior officer.

Do not make permanent repairs unless the consent of the owners have been obtained.

Protect all openings, construction or excavated material as follows:

(a) By suitable fences, barricades or red flags when required.

(b) By watchmen at night and by day when necessary.

(c) By red lights at night.

(d) Indicate temporary crossings and bridges by white or green lights.

Hospital asso.

Track and Roadway

DEFINITIONS.

Alignment—The horizontal location of a railway with reference to curves and tangents.

Auxiliary Fastenings—Nutlocks, tie-plates, rail braces and anti-creeping devices.

Curve—A change in direction by means of one or more radii.

Curve, Compound—A change consisting of two or more simple curves of different radii, all in the same direction, joining one another at points with common tangent.

Curve, Degree of—The angle subtended by a 100-ft. chord.

Curve, Easement—A curve of regular varying radii connecting a tangent to a simple curve, or connecting two simple curves.

Curve, Reverse—Two curves in opposite directions in a continuous line joining at a common tangent point.

Curve, Simple—A change in direction by means of a single radius.

Curve, Vertical—A curve used to connect intersecting grade lines.

Elevation (as applied to curves)—The amount which the outer rail is raised above the inner rail.

Fastenings—Splices, bolts and spikes.

Frog Number—One-half the co-tangent of one-half the frog angle.

Gage (of track)—The distance between the heads of the rails measured at right angles thereto at a point 5-8 in. below the top of the rail.

Gage, Standard—The gage of four feet eight and one-half inches.

Level—The condition of the track in which the elevation of the rails transversely is equal.

Line—The condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves.

Surface—The condition of the track as to vertical evenness or smoothness over short distances.

Tangent—Straight track.

Track—Ties, rails and fastenings; with all part in their proper relative position.

ORGANIZATION.

The Engineer of Maintenance of Way reports to and receives instructions from the General Superintendent.

He has full charge of all matters pertaining to engineering, track, roadway, bridges and buildings, rights of way, fences, overhead lines and signals.

GENERAL RULES GOVERNING ROADMASTERS.

Roadmasters shall report to and receive instructions from the Engineer Maintenance of Way.

Roadmasters shall be responsible for the safe condition and proper maintenance of tracks, roadway, fences, right of way, station grounds and driveways, and must inform themselves of the conditions of structures. They must make temporary repairs of such defects as may endanger or delay the movement of trains and promptly report defective conditions to the Engineer Maintenance of Way.

Roadmasters are forbidden to pass employes on this Company's trains, except on Company business.

Roadmasters must make frequent inspections of track, roadway, right of way, station grounds and driveways, and have necessary repairs made as promptly as conditions require.

Roadmasters shall, as necessary, employ men for carrying out the duties for which they are responsible.

Roadmasters must know that foremen are familiar with the operating rules in regard to train signals and flagging, and that they fully understand and comply with them.

Roadmasters will have immediate charge of all track foremen and road watchmen, and are authorized to discharge such employes for neglect of duty. They will, however, in case of accident resulting from the neglect of an employe, report the case before discharging him to the Engineer Maintenance of Way.

In reporting the discharge of a track foreman, they will give the cause of same so that a record of the man's standing may be kept for future reference. A discharged foreman is not to be re-employed on another division of the road without permission from the Engineer Maintenance of Way. Should a discharged foreman desire an investigation, he can present his case to the Engineer Maintenance of Way through the Roadmaster and it will be considered.

Roadmasters will carefully see that the time of the men and the rate of pay are correctly reported and properly classified on the check rolls. They will note the time each track foreman is absent from work, and make proper deductions on check rolls.

Roadmasters must in case of obstructions or damage to track or roadbed proceed to the place with the forces at their command and do all in their power to promptly clear and repair the track.

Roadmasters shall investigate and report on prescribed form accidents which may be attributable to defects in or result in damage to track, roadbed or structures.

Roadmasters shall conform to the prescribed standards and plans in the execution of work under their charge.

Roadmasters must know that foremen are supplied with tools and materials necessary for the efficient performance of their duties and see that these are properly used and cared for.

Roadmasters must spend a portion of each day with track foremen and instruct them in the proper and efficient methods of doing whatever work they find the track foreman and his men engaged in, and they shall personally handle the gang in an explanation to the track foreman of any efficient manner of doing work which he does not understand.

Roadmasters must not, except by proper authority, permit experimental trials of appliances or devices nor give out information of the result of any trial.

Roadmasters shall keep themselves informed in regard to all work performed in their districts by contractors or

others who do not come under their charge, and see that nothing is done by them that will interfere with the safety of track or the movement of trains.

Roadmasters shall have immediate supervision of work train service only when authorized by the Engineer Maintenance of Way.

Roadmasters must know that the foreman are provided with the rules, circulars, forms and special instructions, pertaining to their duties and that they fully understand and comply with them.

Roadmasters shall see that the vicinity of bridges and trestles are clear of all combustible matter and that bridge seats, tops of piers and other readily accessible portions of bridges and trestles are clear of cinders and dirt and that water barrels are full of water.

Roadmasters shall see that waterways and the approaches and outlet thereto are free from obstructions.

Roadmasters should be thoroughly posted in regard to the right of way and other land boundaries on their respective territories and they shall see that no encroachment upon or occupancy of any portion of the Company's buildings, right of way or station grounds is permitted, except by proper authority.

Roadmasters must see that proper judgment and caution is exercised by all employes under their supervision to prevent the extravagant use of material entrusted to their care and economy must be practiced at all times.

Roadmasters must pay strict attention to the proper adjustment of switches and alignment of the track.

Roadmasters must personally observe alignment and elevation on curves and must instruct track foreman about the proper elevation for every curve on their sections.

Roadmasters must also frequently examine the track gauges and compare them with the standard furnished by the Engineer Maintenance of Way.

Roadmasters should keep a memorandum of the number of men at work on each section and compare with the reports returned by the track foreman.

All requisitions for material, such as cross ties, spikes, angle bars, bolts, nuts, nut locks, tools, fence material, etc., must be made in writing to the Engineer Maintenance of Way.

Roadmasters will personally examine their track in the month of October each year and ascertain the number of cross ties required on each mile, and the number of cross ties and switch ties required in each siding for the coming year, and make report of same before the fifteenth of November to the Engineer Maintenance of Way.

Each year during the month of November Roadmas-

ters will personally examine all rails in main track and make a report to the Engineer Maintenance of Way, giving the number of perfect rails, number of rails fit for cutting and drilling for future use in main track, and number of rails worn out and fit only for mill on each mile.

Roadmasters will see that each track foreman is supplied with one switch key and gives a written receipt for same. In case the switch key is lost or not returned when the track foreman leaves the service of the company, \$1.00 will be deducted from the amount then due the track foreman. They will make the proper endorsement regarding the switch key on the discharge ticket.

When a track foreman is discharged or leaves the service of the Company the Roadmaster must make out a correct list of tools on hand. He will note all tools missing or not accounted for and send such report to the Engineer Maintenance of Way, so that the proper settlement can be made. In such case, he will write on the discharge ticket, "Tools not accounted for as per report."

Roadmasters must keep the Engineer Maintenance of Way advised of their whereabouts and probable movements.

Roadmasters will instruct their foreman to avoid all unnecessary use of Company's telephone, especially for material. The telephone is only to be used in cases of emergency or when delay would involve a loss to the Company. Telephoning for material can usually be avoided if the foreman will inform themselves ahead as to what material they will need, asking for same by a monthly requisition.

Roadmasters shall work in connection with and furnish assistance to all other heads of any divisions of the maintenance of way department.

GENERAL RULES GOVERNING TRACK FOREMEN.

Track foremen shall report to and receive instructions from the Roadmaster.

Unless otherwise directed, they shall be responsible for the proper inspection and safe condition of the track, bridges and roadway under their charge, and shall do no work thereon that will interfere with the safe passage of trains unless under proper protection.

Track foremen must go over their sections or send some reliable man, with suitable tools, at least once a day to make a thorough inspection, to see that the track, highway crossings, signals, culverts, bridges, fences, overhead lines, etc., are in safe condition.

Track foremen must personally pass over the whole extent of their section at least twice a week.

Track foremen must engage in the work personally

and they shall employ men as the Roadmaster directs. They must treat employes with consideration and see that they properly perform their duties. They must discharge men who are incompetent or neglect their duties, but in no case shall they discharge men without cause. They must keep the required records of the time of their men and of the materials used.

Track foremen must each have a copy of the current time table, and be thoroughly familiar with the rules and regulations therein, and with the time of trains over their sections. They must carefully observe signals displayed by all trains and assure themselves before obstructing track that all trains and sections due have passed.

No notice will be given of extra trains, and employes must protect themselves as prescribed by the rules.

Track foremen must provide themselves with reliable watches, and, when possible, verify time daily with the standard clock or with the watch of the Roadmaster or of other employes, who are required to have the standard time.

Track foremen must get their men out of the way of a moving train before the train is dangerously near.

Track foremen are forbidden to pass their men on this Company's trains, except on Company business.

If, in the judgment of the track foreman, the track or any bridge or culvert is not in condition for the passage of trains at the usual rate of speed and this condition will continue over night or for the greater portion of the day, notice must be given immediately to the Roadmaster and the Train Dispatcher. In such notices, the place of danger, its nature and the speed at which trains may pass must be stated.

In addition to sending this notice yellow slow signals must be displayed. When repairs have been made the person making them must at once notify the Roadmaster that the slow order may be recalled.

Except in cases of emergency, no work that will obstruct the track shall be done during fogs or storms.

Track foremen shall conform to the prescribed standards and plans in the execution of work under their charge.

Track foremen must not, except by proper authority, permit experimental trials of appliances or devices, nor give out information of the results of any trial.

Track foremen shall keep themselves informed in regard to all work performed on their sections by contractors, or others who do not come under their charge, and see that nothing is done by them that will interfere with the safety of the track or the movement of trains.

Track foremen must keep bridge seats, tops of piers and all other readily accessible portions of bridges and

trestles, cleaned of cinders and dirt. Where water barrels are furnished, they must keep them filled with water.

Track foremen must use constant care to see that waterways and the approaches and outlets thereto are kept free from brush, drift-wood and other obstructions. After every rain storm or extraordinary flow of water, track foremen must examine all structures for the passage of water, for any undermining of foundations or the erosion of the embankments, which may effect the stability of the roadbed.

ROADBED.

Roadbed shall be divided into two classes: Class "A" and class "B." Single track class "A" roadbed shall be eighteen feet in width and class "B" shall be sixteen feet in width. Class "A" roadbed on double track shall be thirty-one feet in width and class "B" roadbed on double track shall be twenty-nine feet in width, all to conform to standard drawing showing roadbed sections.

No stumps, logs, brush or other perishable material shall be used in the construction of the roadbed without specific instructions from the Engineer in charge of the work in writing.

Roadbed shall be graded to the established grade and shall conform to the cross section shown on the standard plans. Any inequality developing in the roadbed shall be corrected before track laying is commenced.

Effective drainage is most essential and side ditches shall be made in accordance with the standard plans. The section may be enlarged where greater waterway or steeper grade in ditch is necessary, or where a standard ditch cannot be economically maintained. All embankments along waterways, subject to erosion by action of high water or ice, shall be protected with rip-rap.

Slopes of cuts subject to slides shall be protected with sod, rip-rap or paving. Growth of vegetation shall be encouraged on banks and slope gutters or intercepting ditches shall be constructed where necessary.

Where material has to be wasted, same shall be deposited, if possible, below grade line, and under no circumstances shall the waste bank have its nearest edge within ten feet of the slope stakes of the cutting. Waste material shall be used to widen the embankments uniformly on both sides or as may be directed by the Engineer in charge, and no material shall be wasted unless by written order of Engineer in charge.

Where the quantity of excavations from the cutting of standard cross sections is not sufficient to form the embankments, the deficiency shall be made up by widening the cuttings on one or both sides of the center line as may

be directed. No material shall be taken from borrow pits unless such borrow be made by written order from the Engineer in charge. The nearest edge of the borrow pit shall not be nearer than six feet from the right of way line and all borrow pits must be left, if at all possible, in such condition that they will drain.

DITCHES.

Ditches must be kept free from cinders or other material likely to wash into and choke the drains. The flow of water in ditches must not be obstructed by cross ties or other material of any kind. Berme or intercepting ditches shall be provided, when necessary, to protect the slopes of cuts, and shall be located at least five feet from top of cut; if necessary to prevent erosion, they shall be protected by stone, cribbing or in other suitable manner.

The direction of the ditches must in general be parallel and in uniform line with the rail. The ditches must be graded so as to pass all water freely during the heaviest of rains. Where old ditches are too small they must be enlarged to the necessary size. They must have a slope at the back of one and a half to one and must be graded from the top of slope of roadbed to the back of the ditch with a slope of one and one-half to one.

Earth taken from the ditches or elsewhere must be deposited upon the slopes of embankments, and properly spread so as to preserve the ties and the ballast and in no instance shall the earth taken from ditches be spread on the shoulder of roadbed up above the bottom of the ballast.

At the end of cuts it often happens that the ditch washes so deep as to interfere with the track or roadbed. Where such is the case a special effort must be made to stop such wash by filling with boulders or old ties taken from track, which are nearly always available.

All ditches, waterways, bridges and culverts must be frequently inspected and cleared of all drift wood and other rubbish. If it is at all possible to do so, the drift or rubbish should be removed to the down stream end of waterway, or piled up and burned. It should by no means be thrown out in a careless manner, or in such a place that it is liable to wash back with the first rain.

Cross drains, either a wood box or tiles must be put in wherever necessary, and all cuts of a wet or spongy nature must be tiled in order to get the best drainage.

It must be kept in mind that water is the track's greatest enemy and the farther it can be kept from the track or the sooner it can be diverted from it, the better

the track will be protected. The first and most important provision for good track is proper drainage.

It is expected that all new ditches be dug and all old ditches cleaned and in shape for the winter season before the first day of November of each year and cleaned out in the months of March and April in the spring of each year in order to care for spring water fall.

BRIDGES AND CULVERTS.

All bridges and culverts shall be constructed and maintained in accordance with standard plans.

General foremen of bridges and buildings, Roadmasters and track foremen must be thoroughly familiar with the condition of all bridges and culverts on their districts or division. They shall particularly examine bridge foundations that are under water and immediately report any defects.

The Roadmaster shall see that the bridges and bridge seats are kept clean and he shall not allow any soil, rubbish or other material to collect around the bases of any steel posts or towers, rods, lateral braces, etc., which collection will cause the rusting of steel work.

Care shall be taken that dry grass and other inflammable material is kept away from bridge structures.

The channel of streams on either side shall be examined frequently by the track foremen and cleaned of all brush and debris that may interfere with the free flow of water.

The waterways between abutments of culverts where excessive scouring occurs shall be paved.

It is the duty of the track foremen to know that bridge warnings are in proper condition at all times. Repairs that he can make with his own force should be attended to at once and if the repairs are such as to require the attention of carpenters he shall at once communicate the fact by wire to his Roadmaster.

BALLAST.

Stone Ballast—Stone ballast shall be sufficiently durable not to disintegrate in the climate where used, hard enough to prevent pulverizing unduly under the action of tools or traffic, and shall break with an angular fracture when crushed.

It shall be broken into pieces of such size that they will in any position pass through a 2½ in. ring and will not pass through a 2¾ in. ring.

It shall be free from dirt, dust or rubbish

Gravel Ballast—Gravel ballast taken from the bank or pit shall not contain more than 33 per cent of sand, and

washed or screened gravel shall not contain less than 25 per cent sand

Cinder Ballast—Cinder ballast shall be preferably of coarse cinders passing through a four-inch ring.

Slag Ballast—Slag ballast shall be broken or crushed so that it will pass through a 2½ in. ring.

All ballast used shall conform to standard specifications and the kind that shall be used will be designated in a written order from the Engineer Maintenance of Way.

Gravel ballast shall be leveled between all ties to a plane one-half inch below top of ties and border shall conform to standard plans.

The space between joint ties and ties against which anti-creeping devices abut must be kept filled with ballast at all times.

Ballast shall be distributed as uniformly as possible from the cars and good judgment should be used on the part of the track foreman so that after the distribution of gravel is made no trucking with push cars will be necessary to give his ballasted track the necessary uniformity in width.

No ballast shall be spread or distributed without first having the ties all evenly spaced.

The thickness of all ballast placed on the roadbed shall be of the depth shown on drawing of standard roadbed sections. The spikes shall be driven home in the ties and the joints tightened before ballasting is commenced.

No more raise shall be given to track when correcting surface than is necessary to bring the low portions up to the high spots or the standard grade. When there is already sufficient ballast under the track it is simply a waste of material and labor to give track a greater raise than is required to secure good surface. Besides, putting ballast under the track where not necessary induces a condition that will cause track to settle where a high raise has been made and in this way produce uneven surface when ballast has become compacted. Using only as much ballast as necessary and firmly compacting it by using a tamping bar insures the track remaining in better surface than otherwise and the firmness of the roadbed depends upon how well ballast is tamped under the ties and how little the old ballast in the track has been disturbed.

Another reason why track should not be raised more than one or two inches is that the track is deprived of the full effect which the ballast at the ends of the ties exerts in holding the track in line. Jacks, when set in a lightly inclined position, will cause the track to bulge out of line, and they should be set in a vertical position; and as gen-

eral surfacing is carried on during the hot summer months, while the steel is expanding to the fullest extent, the jacks, even though set in a vertical position, will have the strain of the expanding steel brought to bear on them, thus causing them to lean slightly, permitting the track to "kick" out of line. The frequency of this trouble depends somewhat upon how much of a raise is being made and how much the track is deprived of the resistance afforded by the ballast in the track and at the ends of the ties.

The track foreman shall watch the tamping of ballast under the ties very closely and know that all ties are evenly tamped in order to obtain a true and uniform bearing. Where track is only shovel tamped the joint and shoulder ties shall be given the advantage by tamping with either the tamping bars or tamping picks. Shovel tamping should only be done in case of a general lift of three inches or over with any kind of material, lighter lifts shall be tamped with tamping bars or tamping picks. Each tie shall be tamped solid from a point eighteen inches inside of the rail to the end of the tie with a tamping bar or tamping pick; if possible, tamping the end of the tie outside of the rail first and allowing a train to pass over before tamping inside of rail; care should be taken not to disturb the old bed. After train has passed the center of the tie should be loosely tamped with the blade of a shovel. Shovels must not be used for tamping when picking up low joints or smoothing track in any kind of ballast.

A piece of newly surfaced or ballasted track is never finished until it is dressed up and nothing looks neater or shows up better for the foreman in charge than to have a track filled in and dressed up in the proper manner.

Where rails are out of level but where the difference in elevation is not excessive and is uniform over long stretches of track, a difference in elevation between the two rails of three-eighths of an inch may be permitted to continue until such time as the track would ordinarily be surfaced.

When a good bearing is obtained on gravel or finely broken rock the general surface must not be raised until a new bed of gravel or rock is needed; and where ties are renewed the ballast should be carefully taken out and put back instead of raising on it.

Foremen must never raise the general surface of the track in tunnels or subways when surfacing.

The use of track jacks on the inside of rail is absolutely prohibited and no excuse will be accepted for a violation of this rule.

In every possible instance a tamping bar shall be

used in preference to a tamping pick and the foreman shall issue instructions and see that each tamping bar is held at an angle of about forty-five degrees while in use and the men using them shall stand opposite to each other and strike the ballast at the same time. This is to enable the man using the bar to thoroughly tamp under the tie instead of at the side of the tie.

Track foremen shall use a leveling board in surfacing track in order to obtain a true surface and while there are some few foremen who can carry a surface without it, it is necessary that a leveling board shall be used by every track foreman in the employ of this Company.

CROSS TIES

The following woods may be used for tie timber without preservative treatment: White oak, burr oak, walnut, black cherry, chestnut and white cedar. The following woods may be used for tie timber with preservative treatment, preferably plain creosote: Red oak, black oak, water oak, beech, elm, maple and gum

All cross ties shall be six inches in depth, eight inches in width and eight feet long and shall conform to the specifications herein stated:

1. Cross ties shall be well and smoothly hewed or sawed out of straight, growing timber of specified dimensions and out of wind, sawed ends, with straight and parallel faces, the minimum width of either face to be not less than that given hereinbefore. Ties shall have bark entirely removed before being delivered on the Company's ground. They shall be free from splits, shakes, loose or decayed knots or any other imperfections which may impair their strength or durability.

2. Except in pole ties with rounded sides, none shall be less than eight inches wide of face, and in no ties shall the thickness be less than six inches. A variation in size will be permitted of one-half inch over in thickness, two inches over in width and one inch over in length.

3. In pole ties with rounded sides the width of face may be less than that hereinbefore mentioned, but in no case shall the width of face be less than six inches.

4. Ties which are delivered along the right of way of the railway shall be piled at station yards or at points between stations designated in the contract, not less than ten feet from the nearest rail; each pile to be of either twenty-five or fifty ties, built two ties on the ground and above in alternate courses of seven and two, except the top, which shall be placed to form a watershed. Each pile shall be plainly marked with the owner's name and the date when piled. Three feet of space shall be left

between piles to permit inspection. Sawed ties shall be piled separately from hewed ties.

5. All rejected ties shall be removed from the Company's right of way within ten days after notice is given.

6. Ties treated with a water solution, like zinc-chloride, particularly red oak and beech ties, shall be piled in close piles on well drained ground to prevent checking.

7. All grass and vegetation shall be cleared from ground in the vicinity of piles of ties, this for fire protection.

8. Ties shall be cut, as far as possible, in the winter period; that is, from October to March.

Track foremen shall not under any circumstances use ties from piles which have not been inspected and marked, except where absolutely necessary in the case of a wreck. In this event they will report promptly to their Roadmaster the location of the pile and the number of uninspected ties used.

No track foreman shall ever use any ties unless instructed to do so by the Roadmaster.

All cross ties shall be laid at right angles to the track. The largest and best ties should be used as joint ties and the shoulder ties should be as near as possible of the same size. Where suspended joints are used ties must be placed eight inches apart and the remaining ties should be spaced evenly between the joint ties.

Cross ties shall be spaced as follows:—Eighteen ties to each thirty-three-foot rail, or seventeen to each thirty-foot rail in the main track and fourteen ties to each thirty-three-foot rail or thirteen ties to each thirty-foot rail in side tracks. This number may be increased on curves of six degrees and over, if deemed necessary. Special instructions modifying this rule may be given.

The ends of all cross ties must be lined true on the south and east side of track, except on curves, where the lined side will be on the inside of the curve, except also on double track, where the ties shall be lined true on the outside of tracks. The ties shall be so placed in the track that the distance from the lined end of the tie to the base or outer flange of the rail will be sixteen and one-fourth inches. The bow or best side of treated or soft wood ties shall be laid up and the sap of all white oak or untreated ties shall be laid up, in other words the heart sides of all untreated ties shall be turned down.

In putting in ties the pick shall always be stuck in the side of the tie and foreman shall never allow their men to stick the pick in the top of any tie.

When necessary cross ties shall be adzed in order to give the rail and tie plate a true and uniform bearing.

Every foreman shall keep a supply of wooden spikes

or tie plugs in his tool house and with his gang. The invariable rule must be to plug every hole wherever a spike is drawn.

Care must be exercised by the track foreman in distributing cross ties for renewals. They should never be unloaded haphazard or at random, which will necessitate the shifting or trucking of them back and forth to get them where they are needed.

Ties distributed in advance of the time of use must be neatly piled, care being taken not to place them on sodded banks.

Ties should be piled in accordance with specifications, and, if possible, should not have less than six month's summer seasoning before being used. In every case the oldest ties should be used first.

In renewing cross ties foreman shall exercise judgment in securing a tie of similar dimensions to the tie to be removed so that the old bed will not have to be disturbed to any extent in placing the new tie.

It is the duty of the Roadmaster to be fully informed as to the tie requirement on each district or division under his care. Ties in track must not be broken or disfigured when inspecting their condition. Old ties shall not be disposed of for several days in order that the Roadmaster and others may have an opportunity to examine them.

All spikes and plates must be removed from old ties before they are disposed of. Old ties shall be disposed of by burning; the practice of giving them to farmers and others for fuel is condemned, because the party taking the ties is apt to either break down the right of way fences or to drive in and cut up the road bed and right of way lands in hauling the ties out.

Track foremen shall have an order from the Roadmaster before disposing of ties in any manner.

Old ties must not be burned on sodded banks, close to fences, nor where injury will be done to pole lines, to masonry or passing trains.

Cross ties that will give service for six months must not be removed from the track except in public or private road crossings.

In renewing cross ties in public or private road crossings, where it is necessary to move considerable material, it should be the practice of every foreman to renew all ties under the plank in the road crossing in full, in order to save taking up such crossings any more than possible. It should also be the practice of the foreman to get good clean ballast under these road crossing by taking some from the open track on each side of the road crossing. Any good, sound ties removed from such crossing shall

again be used at some convenient place in the open track, and any dirty ballast removed from such crossings shall be cleaned by forking and used to fill the open track that has been robbed for the clean ballast.

All shims shall be eight inches long and six inches wide, of white oak or walnut and of the same thickness throughout, not wedge-shaped, with the spike holes bored.

TIE PLATES.

Shoulder type tie plates should be used on all soft wood ties and on all ties that have been treated and on all curves over six degrees.

Tie plates shall be applied according to standard plans and care taken that the shoulder will have full bearing against base of rail.

Tie plates should be applied with a machine or some approved device.

To apply tie plates on track in service, if the tie is cut by the rail, adze it perfectly smooth a little deeper on the inside than on the outside, over a space about three inches beyond the ends of the plate. Never leave the adzed surface dished or hollowed. Place plate under rail exactly square with it.

Track foremen shall keep all tie plates neatly stacked one upon the other, the flanges of the tie plates being placed downward.

RAILS.

Steel rail must be in accordance with standard specifications.

Rails must never be thrown from cars nor unloaded while cars are in motion, except when an approved unloading device is used.

Rails distributed for use must be placed base down, parallel with track, with uniform bearing surface on road-bed.

Before being laid crooked rails must be carefully straightened.

All steel rail shall be laid with the dates and maker's mark on the outside of track.

Rails must be so laid that each joint will be opposite the middle of the opposite rail of same track on tangent; on curves a maximum variation of eighteen inches will be allowed. This rule may be varied in laying rail through switch connections, where joints must be staggered not less than three feet. If avoidable, joints should not be placed through switches, guard rails or road crossings.

Rails must be laid one at a time, and, to insure per-

fect adjustment, the rail ends should be brought squarely together against proper shims and carefully bolted and spiked.

In laying rail, iron shims, to separate the rails at the joints, must always be used. Wooden chips will not answer and must not be used. Standard iron shims will be furnished upon requisition.

Expansion must be fully considered. This rule must be carefully observed, as many serious accidents have occurred by neglecting this simple method of making a proper allowance for expansion.

In laying rail around special work in pavements there should be no expansion allowed, but the rails shall be butted firmly and squarely against the ends of the special work.

In laying rail through pavement, which is usually done during the summer months, very little or no expansion should be allowed, as rails thus laid are not subject to the extreme temperatures, and the expansion or contraction is much less than where track is laid in the open, as in the country.

Rails of the same section shall be used in road crossings, switch connections, railroad crossings, station platforms, open floor bridges, trestles and viaducts in order to avoid compromise joints.

Short pieces of rail must never be used on the outside of curves and at no place must anything shorter than fifteen-foot lengths be used in main track.

Before rail renewals are made the track shall be placed in good surface and line.

The most fruitful source of laminations, breakage and damage to rails is low joints, and they must not be permitted to remain any longer than the time necessary to put them up.

No more rail shall be laid at one time than will have ties resurfaced and track properly lined, surfaced, gauged and back-filled with ballast within the following six days. Rails must be fully spiked, with four spikes to each tie, and bolted and the joint ties spaced the same day as laid. In relaying rail, the ties must be adzed to give the rail the proper bearing.

The use of switch points in laying rail is prohibited.

It is essential that the creeping of rails be prevented. Where this occurs each individual rail should be thoroughly anchored and a sufficient number of anti-creeping rail devices of an approved design used for this purpose. They shall be attached to the rail opposite the joints and if more are required they shall be applied to both rails at the same intermediate ties.

A steel rail must not be punched or slotted, but when

necessary to make holes for bolts, they must be drilled with the proper tools furnished for that purpose.

All rails which have to be fitted to special work shall be sawed; chisel cutting rails for any main track work will not be allowed.

In sawing a rail, saw blade shall be constantly cooled by frequent application of water poured on the blade while the sawing is being done.

Whenever rails are to be bent a rail bender shall be used.

In cold weather it must be borne in mind that if a rail be bent too abruptly it is liable to break and rail should be heated to normal temperature before the bending is done.

Track foremen and watchmen must examine rail frequently and carefully for signs of damage or defects such as splitting of head (which is indicated by a black streak along top surface), splitting of base (which is evidenced by rust streaks at junction of web and upper side of base, and results in what is known as "half-moon breaks"), nicked or dented base from broken wheel or other damage from derailed equipment, burned spots on head from slipping of driving wheels, etc.; and such rails (damaged or with signs of defects) if, in the judgment of the foreman, they are unsafe for traffic, must be removed as soon as discovered, or, if not in immediate danger, they must be reported promptly to the Roadmaster and removed from track whenever in his judgment the injury or defect is of such nature or extent as to impair the strength of the rail.

Old steel rail, which has been replaced by new rail, will, if it is sufficiently good, be used again in the main track, but as far as practicable with other rail of the same section. If it be not needed for immediate use it shall be neatly stored at points designated by Roadmaster and not left lying in the ditches.

JOINTS.

Splices must be applied with their full quota of bolts, nuts and nut locks and the bolts on each joint or splice must be staggered, that is, put one-half of the nuts on the inside of the track and half on the outside of the track.

Rail joints or splices must be carefully distributed over sections and must be properly piled and taken care of. The base fitting channel of continuous joints shall be laid downward.

The openings between the ends of thirty-three foot

rails shall vary with the temperature as follows:

Temperature Fahrenheit.

Openings between rails for 33-ft. rail.

From 10° below to 14° above zero.....	3-16 inch
From 14° above to 38° above zero.....	1-4 inch
From 38° above to 62° above zero.....	3-16 inch
From 62° above to 86° above zero.....	1-8 inch
From 86° above to 100° above zero.....	1-16 inch

Above 100 degrees, rail to be laid close without bumping.

Standard steel shims must be used for spacing rails. During hot weather spacing between rail ends must be carefully watched, and when necessary rails driven back or a piece or pieces of rail cut out to avoid buckling of track.

Where rails are being laid over very steep grades or inclines the above rule may be varied from to suit the conditions, for instance, at the foot of heavy grades or inclines the expansion may be more, and at the top of heavy grades, less, as the tendency of rail is always to creep down hill. By close observance along this line much may be done to eliminate buckling of track.

In tunnels, where temperature is above seventy degrees, lay rails with close joints without bumping them together; and, when temperature is below seventy degrees make an opening of one-sixteenth of an inch for each twenty-four degrees variation for thirty-three-foot rails.

All rails joining others of different sections must have a comprise joint or a step chair to bring the rail to proper surface and guage and the compromise joints shall be made to fit the different sections and drilled accurately.

Where continuous joints are used, before being applied, all rust or scales must be removed from the base fitting channel, and the channel oiled well in order to allow the joints to fit up snugly.

Particular attention must be given to proper maintenance of insulating and compromise joints.

The space between rails at insulated joints should be one-half inch, using end posts as shown on standard plan.

Slot holes of splices, both inside and outside, should be fully spiked except on bridges, trestles and viaducts; and where plain bars or fish plates are not used on bridges, trestles and viaducts, spiking in the slot hole of the splice or against the end of the splice or joint must be carefully avoided.

Care shall be taken in applying bolts that the threads are not injured and bolts shall always be screwed up tight

with a long-handled wrench, with the flat side of the nut turned in and resting on the nut lock.

Loose joints are not only inconsistent with good track but by their rattling they advertise the bad condition of the track, an advertisement which injures the character of the road; joints must be kept tight.

SPIKES.

The rails must be fully spiked with four 5½ in.x9-16 in. spikes to each tie. The spikes must be driven vertically, as the under side of the head of the spike is formed with a view to driving it straight and not slanted under the rail or bent against the rail when driving. Neither must the attempt be made to draw rails to guage with a spike. Where tie plates are not used the inside spikes must be driven near the east or south side of the tie and the outside ones near the west or north edge, but not closer to the edge of the tie than two inches. Care must be taken in spiking to avoid striking the rail.

The number of spikes used per tie shall be as follows:

1. On tangents without tie plates, one spike inside and one outside at each rail.
2. On curves over three degrees, one spike inside and two outside at each rail.

Care must be taken to keep spikes driven home.

All spike holes shall be plugged.

Track foremen shall straighten all old spikes that are possible and use same in track again.

INSTALLATION OF SPECIAL WORK.

The unloading from cars or the handling of special work before being put into the track should be done with the greatest care and track foremen must not allow special work to drop from cars or wagons on the ground or pavement.

In laying special work at any time of the season there should be no expansion left between the rails at the frogs, mates or tongue switches.

All special work must be fully bolted and every joint must be bonded. The installation of special work requires the utmost care and nothing must be left undone which can be made to lengthen the life of the material.

Cross bonds and lace bonds should be applied and observation should be made around all special work for any signs of arcing of the ground return circuit and if any is noted, repairs should be made immediately of the bonds connecting the special work.

Where rails of a different height or pattern are used, the largest and best ties should be used immediately under the joint, together with a step iron tie plate, which will be

furnished with the material, and a compromise joint shall be used to connect the two different sections of rail.

All special work after being installed must be kept cleaned and oiled and all spring boxes must be kept free from dirt and sand in order to prolong the life of the material and prevent any failure in the operation of the special work.

The greatest of care should be exercised in placing ties under the special work. They shall be placed not more than eight inches apart under the tongue switch and mate and not more than twelve inches apart under any other portion of the special work.

The following table of middle ordinates shall be used in the curving of all rail for the radii below given:

Radius.	Middle Ordinates	Radius.	Middle Ordinates
40 ft.	10 ft.	40 ft.	30 ft.
45 ft.	3 3/4 inches	45 ft.	2 ft. 9 3/8 inches
50 ft.	3 11-32 inches	50 ft.	2 ft. 5 3/4 inches
60 ft.	3 inches	60 ft.	2 ft. 2 3/4 inches
60 ft.	2 1/2 inches	60 ft.	1 ft. 10 3/8 inches
70 ft.	2 5-32 inches	70 ft.	1 ft. 7 1/4 inches.
80 ft.	1 7/8 inches	80 ft.	1 ft. 4 13-16 inches
90 ft.	1 21-32 inches	90 ft.	1 ft. 3 inches
100 ft.	1 1/2 inches	100 ft.	1 ft. 1 1/2 inches
110 ft.	1 3/8 inches	110 ft.	1 ft. 1 1/4 inches
120 ft.	1 1/4 inches	120 ft.	11 1/4 inches
130 ft.	1 1/8 inches	130 ft.	10 3/8 inches
140 ft.	1 1-16 inches	140 ft.	9 5/8 inches
150 ft.	1 inch	150 ft.	9 inches

All curves having a radii of less than four hundred feet must be guard railed on the inner rail of the curve.

Guard rails on curves of one hundred feet radii and over must be bolted to the traffic rail with a 7/8 inch bolt at least every thirty-six inches and on curves of more than one hundred feet radii they must be connected to the traffic rail with one 7/8 inch bolt at least every forty-two inches.

All guard rails shall have cast iron fillers or spacing blacks at each bolt connection to the traffic rail and a pressed steel raising plate shall be placed on each tie under the guard rail and traffic rail. The raising plates shall have a three-eighths inch raise so that the top of the ball of the guard rail will extend three-eighths of an inch above the top of the traffic rail.

The flange way or throating between the guard rail and the traffic rail on curves of 75 feet radius and over shall be two and one-fourth inches and the gauge shall be widened to four feet nine inches; and on curves of seventy-five feet radius and up to three hundred feet

radius, the throating or flange way shall be two inches and the gauge shall be widened to four feet eight and three-fourths inches.

Joints or angle bars shall be omitted on the inside of curves and their place supplied by filler blocks applied in the manner hereinbefore directed

Extreme care shall be taken that there are no elbows or sharp kinks in the curve at the joints.

Care should be taken to avoid having a joint at the beginning or end of a curve. The joint should be a few feet either ahead or behind the beginning or end of a curve.

LINE, SURFACE AND GAUGE.

The track shall be lined and surfaced prior to back filling with ballast so that newly laid rails will not be bent by the passage of trains.

Track foremen must keep their track in the best possible line.

When lining the track the track foreman or man sighting the rail should stand, if possible, with his back toward the sun, because in this way a better view of the rails can be secured. He should stand as far from the place where his men are throwing the track in line as his ability to see clearly will permit. If he stands too close to his men a swing is quite likely to be thrown into the track. If track has swings in it these should be taken out first. When these have been attended to, the track foreman should move to a position about five or seven rail lengths from his lining gang, so that he can clearly see all short kinks in the line and can direct his men in their work, to prevent disturbing the general line. Care should be taken when lining that part of a tangent near the beginning of a curve, not to throw the last four or five rail lengths too far out. Where alignment is bad, it is necessary to go over track twice.

On tangents and on curves up to and including eight degrees the track shall be laid to standard gauge (four feet eight and one-half inches.) Gauge shall be widened one-eighth of an inch for every two degrees or fraction thereof over eight degrees to a maximum of four feet nine inches for tracks of standard gauge. Gauge, including widening due to wear, should never exceed four feet nine and one-half inches.

The installation of frogs upon the inside of curves is to be avoided wherever practicable, but where same is unavoidable, the above rule should be modified in order to make the gauge of the track at the frog standard.

Track gauges and levels in possession of track fore-

men shall be tested and verified at frequent intervals by the Roadmaster.

The track level shall be tested every morning before use. The test of the level is to be made by placing the board on the rails square to the line of the track and bringing the center of the bubble to the center marked on the glass, by a shim if necessary. When, in this first position of the board, the bubble has been found to be or has been brought to be in the center of the glass, the board is to be turned end for end and put on the same supports as before. If in this last position of the board the center of the bubble stands at the center marked on the glass the level is correct, but if the bubble fails to do so the level is out of order and must be sent to the Roadmaster for repairs.

Shoulder tie plates shall be used on all ties on curves over six degrees.

The outside of rails on curves over three degrees shall be double spiked.

Where tracks are intended to be spiked to standard gauge the rail should be held against the gauge with a bar while the spike is being driven.

In surfacing track the low rail on curves and the line rail on tangents should first be brought to proper surface and the other rail brought up with track level. Care must be taken to maintain proper elevation on curves.

The Roadmaster shall instruct the track foremen as to the proper elevation of every curve, and if for any reason the Roadmaster is unable to do that the proper elevation can be found by the string method. To determine the elevation proper by the string method; decide upon the average speed which trains are operated over the particular curve and take a string as long as the number of feet a train covers in a second's time. Put a knot in the exact center of this string and stretch it along the gauge face of the rail, measuring the middle ordinate, that is, the distance from the center of the string to the gauge line of the rail and use this distance or middle ordinate for the elevation of the rail. Stretch the string of whatever length calculations show it to be from point to point around the curve so that one stretching of it overlaps the one previously taken by half its length. This method not only gives you the correct elevation but when run out at the ends of the curve to the point where there is not longer a middle ordinate, it gives the proper run-off for the elevation.

As an example, assume the speed of the train at fifty miles per hour. It is found to travel seventy-three feet four inches per second. It would require a string for

a speed of fifty miles per hour of seventy-three feet four inches in length.

For elevating the outer rail on curves, the following table shall be consulted, but in no instance shall the elevation exceed seven and one-half inches:

Degree of curve.	Miles Per Hour.							
	20	25	30	35	40	45	50	
1°	¼ in.	½ in.	¾ in.	1 in.	1¼ in.	1½ in.	1¾ in.	
2°	½ in.	¾ in.	1¼ in.	1¾ in.	2½ in.	3 in.	3½ in.	
3°	1 in.	1½ in.	2 in.	2½ in.	3½ in.	4½ in.	5½ in.	
4°	1½ in.	2 in.	2½ in.	3½ in.	4½ in.	5½ in.	6½ in.	
5°	1¾ in.	2½ in.	3½ in.	4½ in.	5½ in.	6½ in.	8½ in.	
6°	2 in.	2¾ in.	3¾ in.	5 in.	6½ in.	8 in.		
7°	2 in.	2¾ in.	4½ in.	5½ in.	7½ in.			
8°	2½ in.	3½ in.	4¾ in.	6½ in.	8½ in.			
9°	2½ in.	3¾ in.	5½ in.	7½ in.				
10°	3 in.	4½ in.	6 in.	8½ in.				
12°	3½ in.	5 in.	7½ in.					
14°	4 in.	6 in.	8½ in.					
16°	4½ in.	6¾ in.						

Curves of the same degree should not always have the same elevation, for instance, a four degree curve at the top of a grade should not be given as much elevation as a four degree curve at the bottom of a hill, since the speed of the train is almost invariably faster over the latter than the former; however, in general, as a matter of safety, the preference should be given to fast passenger traffic.

The elevation at the beginning of a curve should be as great as at any other part of it, except at reverse points and where short tangents occur between curves of opposite directions. To insure smooth running, especially for trains at fast speed, the elevation should commence back on the straight line and continue gradually until the curve is reached.

The following table will show how far from the beginning of a curve the elevation should start:

- For 1 inch elevation, 40 feet back on straight line.
- For 2 inch elevation, 80 feet back on straight line.
- For 3 inch elevation, 120 feet back on straight line.
- For 4 inch elevation, 160 feet back on straight line.
- For 5 inch elevation, 200 feet back on straight line.
- For 6 inch elevation, 240 feet back on straight line.
- For 7 inch elevation, 280 feet back on straight line.
- For 7½ inch elevation, 300 feet back on straight line.

In reverse curves the rails must be level with each other at the reversing points; from the reversing point the elevation must be carried in either direction at the rate of one inch in forty feet. Where short tangents of insufficient length to apply the foregoing table intervene between curves of opposite direction, the middle of the

tangent shall be the neutral point at which the elevation in either direction shall begin.

To approximately determine the degree of a curve, stretch a sixty-two-foot line with a small knot at the center (which is thirty-one feet from either end), on the running side of a well-lined curve. Measure the distance from the knot to the running side or gauge face of the rail, and every inch of this distance indicated one degree of curvature. Thus, if the distance is two inches, the curve is a two degree curve; if it be four inches, the curve is a four degree curve, etc.

The inner rail of all curves should be maintained at grade.

Track cannot be maintained in good line unless the surface is reasonable good, and the finer points of lining must follow surfacing.

When surfacing track, the track level must be used to insure accurate work.

When in surfacing out of face as in the case of picking up low joints or other low places, the general level of the track should not be disturbed; but only raise the low places so much as is necessary to bring them up to the general surface of the track; and lifts should be regulated to avoid bending the splice bars or straining the joints.

Where surfacing must be done by using the spot board, the aim should be to raise track just enough to clear the high spots. This will provide for a slight settlement and will result in a good final surface. (This refers to surfacing short stretches of track, and not to surfacing done out of face where grade stakes are set as a guide.) The spot board should be placed directly over one of the properly leveled high points and at right angles with the track, and must be leveled accurately. When the spot board has been properly placed and leveled a track jack should be put in position at the first joint to be raised. One of the four inch blocks used to sight over should be placed on the rail where the jack is being used and another four inch block over the next joint back which has previously been leveled. Then sight over this latter block and across the one at the jack to the top of the black portion of the spot board, watching the block on the joint being raised until it shows up just a trifle above the direct line of sight. This trifling excess of raise is an allowance made for settlement of track on the fresh tamping. Just how much to allow for this settlement depends largely upon the kind of ballast, but, in ordinary practice, the allowance should be small and experience under varying conditions will furnish the correct guide.

Track foremen must never raise the general surface of the track in tunnels or subways when surfacing.

On lines carrying high speed traffic the track should be raised by making slight lifts not to exceed two inches.

The use of track jacks on the inside of the rail is positively prohibited. Whenever possible, raising bars should be used in preference to track jacks.

The shimming of track to preserve its good surface will be allowed only in winter weather and should not be resorted to unless unavoidable. Track foreman shall give as prompt notice as possible to the Roadmaster of the use, or of the necessity to use, shims of greater thickness than one inch, and in such notice mention the location and the approximate number of such shims. No attempt should be made to correct heaving by adzing ties, because such practice will soon result in the ties being completely cut away. When track is shimmed the tendency of track to spread is increased, especially if thick shims are used. For this reason long spikes must be used with thick shims. Foreman must be particular to secure a uniform bearing on all shims used, both under rail and on ties. The placing of lumber under the ties is forbidden, except in case of accident and in such case must be removed as soon as possible.

Track foremen are directed to remove all shims from the track as early in the spring as possible and store the uninjured shims and long spikes in their tool house for future use.

Particular attention should be given to the drainage of such portions of the track as heaved badly during the previous winter. At points where the heaving has required the use of shims, exceeding one inch for two consecutive winters, foreman are directed to drive stakes to mark the location and consult with the Roadmaster as to proper means to reduce such tendency to heave.

Alignment of track should be established by the transit and the alignment of curves maintained by string method.

The string method of lining a curve is as follows:—

When a curve is even or circular a cord of any length stretched against the gauge side of the rail at different places anywhere along the curve will have a middle ordinate that measures always the same. A sixty-two-foot string is the most convenient to use, since the length of its middle ordinate expressed in inches is equal to the degree of the curvature expressed in degrees. If it is found that the middle ordinate to a sixty-two-foot string is an inch longer at one place than at another, then that part of the curve is a degree or more sharper than the other part, and this knowledge should suggest to the eye what portions of a curve are to be thrown in or out to make the curvature even. Stretch the string from point to point

around the curve so that one stretching overlaps the one previously taken by half its length; then if the middle ordinates do not vary appreciably, line it smooth and the curve will be both smooth and even in curvature and consequently in good alignment. If the middle ordinates vary considerable take an average of all the ordinates and line the rail to that. This procedure is not to be followed where the curve has been recentered by an instrument.

Any stake which may be given to establish the line of track must be carefully preserved in the necessary work and the accidental disturbance of such stake or monument must be immediately reported to Roadmaster or Engineer. When ballasted track is to be moved to conform to the line as given by stakes, the ballast in the vicinity of each stake is to be removed to the level of the bottom of the tie so that the stake shall not be disturbed by ballast moving with the ties.

When renewing or respacing cross ties, raising track or cleaning ballast, sufficient back-filling must be done to hold track in proper line and surface and prevent creeping. The raising of a main track should be made against the current of traffic and both rails lifted at the same time. Particular attention must be given to the above work when done during warm weather to avoid buckling of rails.

Whenever the line of track is in any way impaired by accident or by work done on track it must be relined at once.

When rails run or buckle in warm weather and track is thrown out of alignment, water from some nearby stream poured on the rails or damp earth banked along the rails near the point of the kink or buckle will usually cause the rails to resume their normal position.

Track which has been surfaced during the day must be left at night in perfect line.

Track foremen shall keep the track always in correct gauge; gauge kinks are as detrimental as low joints. In regauging track the spikes of not more than five ties are to remain withdrawn at one time.

SWITCHES, FROGS AND GUARD RAILS.

Switch stands shall be constructed so that they are snow proof and there shall be no lost motion in the parts. The connection between the throwing rod and the stand shall be so arranged that it will be impossible to separate the throwing rod from the stand when the stand is set up in working position.

The target should not show clear signal for main track movement unless the points are up snugly against the stock rail.

The stand should be so arranged that it can be easily inspected.

The head of the staff shall be so designed as to make a snug fit for the standard switch lamp socket.

The operating lever of ground stands should work parallel with the track.

The targets shall conform to standard drawings.

All frogs and guard rails shall conform to standard drawings.

Switches, frogs and guard rails must be placed in track in conformity to standard plans. If avoidable, turn-outs and cross-overs should not be located on curves nor placed to face the traffic in a double track road.

All switch stands shall be located in such a way that they may be seen by approaching trains for at least nine hundred yards in each direction.

Switches should not be laid on cross ties, but should have a full set of standard switch ties placed in such a manner as to give the best bearing under the frog and at the heel of switch points.

Following is a list of standard switch ties which shall be used on all number nine lateral turn-outs:

- 5 pieces 7 in.x9 in.x 8 ft. 3 in.
- 2 pieces 7 in.x9 in.x 8 ft. 6 in.
- 2 pieces 7 in.x9 in.x 8 ft. 9 in.
- 2 pieces 7 in.x9 in.x 9 ft.
- 2 pieces 7 in.x9 in.x 9 ft. 3 in.
- 3 pieces 7 in.x9 in.x 9 ft. 6 in.
- 2 pieces 7 in.x9 in.x 9 ft. 9 in.
- 2 pieces 7 in.x9 in.x10 ft.
- 2 pieces 7 in.x9 in.x10 ft. 3 in.
- 2 pieces 7 in.x9 in.x10 ft. 6 in.
- 1 piece 7 in.x9 in.x10 ft. 9 in.
- 2 pieces 7 in.x9 in.x11 ft.
- 1 piece 7 in.x9 in.x11 ft. 3 in.
- 1 piece 7 in.x9 in.x11 ft. 6 in.
- 2 pieces 7 in.x9 in.x11 ft. 9 in.
- 1 piece 7 in.x9 in.x12 ft.
- 1 piece 7 in.x9 in.x12 ft. 3 in.
- 1 piece 7 in.x9 in.x12 ft. 6 in.
- 1 piece 7 in.x9 in.x12 ft. 9 in.
- 1 piece 7 in.x9 in.x13 ft.
- 1 piece 7 in.x9 in.x13 ft. 3 in.
- 1 piece 7 in.x9 in.x13 ft. 6 in.
- 1 piece 7 in.x9 in.x13 ft. 9 in.
- 1 piece 7 in.x9 in.x14 ft.
- 1 piece 7 in.x9 in.x14 ft. 3 in.
- 3 pieces 7 in.x9 in.x14 ft. 6 in.
- 1 piece 7 in.x9 in.x14 ft. 9 in.
- 1 piece 7 in.x9 in.x15 ft.
- 1 piece 7 in.x9 in.x15 ft. 3 in.

47 pieces

All switch ties shall be of first-class timber, preferably of white oak and burr oak. The set to contain 2,733 feet board measure. Sawed timbers shall have a preference over hewed timbers.

Switches shall be spiked to perfect gauge except at the switch points and at the frog point on the side track where the gauge may be left one-eighth of an inch wide.

The most careful attention must be given to the switches by the track foremen and watchmen, all switches should work easily and have no lost motion and should be kept in perfect line and surface at all times, and for a distance of one hundred feet in each direction.

Track foremen shall notify Roadmaster at once when new switches are put in and the work completed or when old switches are taken out or whenever for any cause a switch is spiked or when switches that have been spiked have been repaired and ready for service.

Switches should be thrown by the track foremen, personally, once each week to know that the points fit up snug and that they are in perfect working condition. Whenever it is found that a switch point does not fit up properly and it is impossible to get sufficient adjustment in the head rod, the rod must be redrilled. At no time must a switch be cobbled up with nutlocks or washers between the clips and points in order to get the adjustment. The cause of lost motion must be carefully looked into and any material unduly worn must be replaced. Where rail of a different section is used in the main track than that used in the side track, the main track section of rail must extend on the side track at least as far as the switch ties extend. In other words no compromise joints must be placed on rails whose ends are on the switch ties. Cotter keys and keeper pins should always be used in connection with head rod bolts.

Track foremen or men working around a switch when trains are passing must stand on opposite side of track from switch.

All stock rails shall be bent by using a rail bender or Jim Crow eight inches ahead of switch point, as shown on standard drawing.

All switch stands of sidings leading from main track must have switch locks.

All slide plates, wing rails of all frogs and other movable parts of switches shall be oiled once in every thirty days.

Every frog shall have two guard rails not less than ten feet in length; they must be so placed that the center of the guard rail is located six inches ahead of the point of frog. Every guard rail shall be fastened to the traffic rail with three seven-eighths inch bolts and spacing or filler blocks to allow a one and seven-eighths inch flange-way and the guard rail must be fully spiked and bolts properly tightened.

Track foremen or track walkers must make a critical

inspection of all main line frogs every day. The guard rail braces holding either the guard rails or the loose wing rail of spring frogs must be maintained in their proper position. The loose wings of spring rail frogs must shut tight against frog points and must move freely through stop boxes. Occasional driving back of the loose wing may be required to secure such free movement. The nuts of bolted frogs must be kept tight. If the rivets of frog points or plates become loose, such looseness of parts must be reported to Roadmaster. If the wing rails, points or other parts of a frog become worn so much as to cause rough riding on main track, or be in any degree unsafe on main tracks or inferior tracks, its condition must be reported to the Roadmaster, who will determine the necessity for renewal. A broken wing rail is equivalent to any other broken rail in track and demands immediate renewal of frog.

All frogs must be maintained in perfect line. The frogs in other tracks than the main tracks and all crossing frogs are subject to the requirements cited for main track frogs and are to receive sufficient inspection to insure excellent condition.

Track foremen shall maintain suitable blocking at ends of guard rails, at frogs, at switches and at other points between rails where the feet of men are liable to be caught. The condition of this blocking must be at all times unquestionably good and the blocking must be firmly secured to the ties. Material for it will be furnished by Roadmaster upon receipt of request.

Where rail of a heavier pattern is used in the main track than in the side track, the main line pattern must extend at least as far on the side track as the switch extends. In other words, compromise joints must not be placed on switch ties.

Switch stands should be so located that, when switches are set for main track, connecting rods will be in tension; and, where possible, they should be on the right hand side of switches in the direction of the facing point movement.

SWITCH LAMPS

Care should be taken to keep switch lamps in proper adjustment on switch stands.

Switch lamps must be thoroughly cleaned and filled at least three times each week and oftener if necessity demands it to insure their burning at all times. The wick must reach the bottom of the fount and fit properly in the burner.

When the ratchet wheel will not work the wick must be drawn up through the burner with the fingers and

moved back to place by turning the ratchet wheel. If the wick is too thick, reduce it by removing a few threads.

If the ventilating holes in the burner become clogged with dirt they can be opened by putting the burner in boiling hot water.

The lamp must be lighted a short time before turning the flame to its full height and an examination must be made to see if the lamp smokes after the fount is put in place.

No alterations must be made in lamps. If they do not give satisfaction the trouble must be reported.

When lamps are placed on switches they shall not be left until the lighter is satisfied that the wicks are at the proper height to give a good light and not smoke.

Do not trim the wicks with scissors, but simply rub the crust off with the finger; this will give much better results.

The founts shall not be filled full with oil; they should never be filled higher than one-half inch below the top of the fount. After the lamp is cared for properly it shall be fastened to the stand firmly with the set screw at the bottom of the lamp.

Lamp lighters must be careful and not put their greasy hands on switch targets and disfigure them.

The head blocks of switches must be kept firmly tamped at all times or lamps will be shaken out.

Once every two weeks all oil must be removed from the fount before filling with new oil.

Oil founts and cans must be thoroughly rinsed with clean hot water at least once a month. Soap or soda must not be used in water, as either will leave a residue in the can that is injurious to the oil.

An approved type of an eighty-day burner lamp shall be used and a high grade long-time burner oil shall be used.

Should the section foreman or lamp lighter discover the lens broken out of a switch lamp, unless he can immediately replace same, he shall blow the light out and make immediate request on the Roadmaster for lens with which to replace the broken one.

DERAILS.

Derails or throw-off switches shall be placed on all sidings (except sidings used exclusively as passing tracks), where the grade does not descend from the main track.

Derails shall be placed on all sidings far enough back from the clearance point so that two passenger cars may go in on siding and clear the main track without handling the derail.

SIDINGS.

No siding shall be constructed with a curve of a radius less than fifty feet for passenger cars nor with a radius less than one hundred and twenty feet for foreign freight cars.

Sidings shall be constructed with the center of the siding not less than thirteen feet from center of main track and should the trolley suspension poles be placed between the siding and the main track the distance between the center of the siding and the center of the main track shall not be less than sixteen feet.

The unconnected ends of sidings adjacent to main tracks must be curved away from main tracks in the last seventy-five feet of the side track. The curve at the end of unconnected sidings shall be of a radius not more than two hundred feet.

In surfacing sidings, they shall not be raised up on the same level with the main track, but the level of the siding should be six inches below the level of the main track.

Foreman must inspect private sidings at frequent intervals and promptly report to the Roadmaster any defect noted.

SIGNALS, INTERLOCKING AND TRACK CIRCUITS.

Track foremen will exercise proper care in their work to avoid disturbing appliances connected with any signal, return circuit, lightning arrester or telephone ground.

Track foremen must see that all broken bond wires are repaired promptly, and the rails, splices and connecting wires in bonded track kept clear from contact with ballast or dirt.

Whenever any rails, switches, frogs or other special work is disconnected or removed, the new work must be drilled and new bonds immediately put in.

Track foremen shall remove, and forward to the point designated by Roadmaster, all bond wires from any rail or special work taken out of track.

Should the repairs on bond wires be extensive and in the judgment of the track foreman need the attention of a regular track bonding gang, then it shall be the duty of the track foreman to notify the Roadmaster at once.

Track foremen will see that insulating joints are kept in good order, the bolts tight, and ties well tamped and that the insulation is renewed when required. When work is to be done on bonded track that will interfere with circuits or any work which will interfere with the interlocking or signal appliances, Signal maintainer must first be notified.

Track foremen shall keep all track instruments clear of water and ice.

While working on track in a signal block, such care must be exercised in the handling of material and tools as to avoid a metallic circuit between the rails.

Hand cars and push cars which are not insulated shall not be used on bonded track.

It shall be the duty of the track foreman to immediately report any defect in any overhead circuit or track circuit which he may observe and no repairs shall be attempted on any overhead circuit by the track foreman unless he is given written orders explaining fully how the repairs shall be made or the trouble cleared up and those instructions, if given over the telephone shall be written down by the track foreman and repeated by the track foreman to the person issuing the instructions, the same as a train order is given and received, it being understood that the electrical current carried in overhead circuits are of a dangerous character and liable to result in injuries or loss of life.

FIRE PROTECTION.

All fires on or in the vicinity of the right of way must be promptly extinguished or closely watched and controlled to prevent damage being done to poles, fences, bridges, buildings or crops. All employes should render every assistance possible to extinguish fires on or adjacent to the property of the railroad company.

Track foreman must remove from bridges, cattle guards and trestles, all combustible matter, examine particularly the tops of piers and abutments and remove all chips.

When necessary the sod must be removed from around the base of trestles, poles, signs and mile posts and other wooden structures so that the dry grass may not carry fire to them. The grass, weeds and brush on the right of way must be burned as early in the season as they become dry enough and the right of way must be kept clear of all rubbish, especially old ties.

SNOW AND ICE.

At the approach of winter, ballast should be cleaned from the space between the ties under the rail at frogs, switches and guard rails, in order to facilitate the removal of snow and ice.

Switch connections, platforms at stations, subways, overhead foot bridges, road and street crossings, track in pavement and city streets, and interlocking pipes and wires must be kept clear of snow and ice.

Waterways in ditches must be kept open and freed from accumulation of ice.

Switches, frogs and spring boxes must be kept salted and well swept out, care being taken to keep salt or brine from touching copper bond wires.

Track sanders must be on duty with a supply of dry track sand and must at all times have the rail in excellent condition so long as trains are being run, and if necessary foremen will cause assistance to be rendered to track sanders to prevent slick rail.

POLICING.

Neatness and order on his section is most commendable to track foremen. A few hours devoted each week to cleaning up, putting things in order around section tool houses, station grounds, etc., will give an air of order to the section which will be complimented by officers and travelers.

Track foremen shall make themselves familiar with all the boundary lines of the company's ground on their respective sections, and see that no person encroaches upon them.

Track foremen must not allow any person to dig under the tracks on account of the laying or repairing of any drain, water, sewer or gas pipe of any description, nor, to erect any poles, fences, buildings, place signs or advertisements, string wires or rope, or otherwise occupy the company's property, without proper authority. Any attempted encroachment must be reported at once to the Roadmaster, giving full particulars.

Trespassers are forbidden to deposit ashes or rubbish of any kind upon the tracks or other premises of the Chicago, Ottawa & Peoria Railway Company. Track foremen will use all proper means to prevent such abuse and report such cases as they cannot control.

Station platforms, fences, tool houses, subways, overhead foot bridges and grounds at station and yards must be kept clean and in good order. Defective platforms which might cause injuries to persons, must be temporarily repaired and promptly reported to the Roadmaster.

Open culverts, ditches or drains near stations, or where shifting is done, must be protected to prevent passengers or others from falling into them.

All company buildings should be inspected regularly as to their sanitary conditions. Special attention should be given to the condition of cellars and attics.

Material stored upon right of way or station grounds for emergency or future use should be neatly piled in the prescribed manner.

All old ties, which are taken from the track, must be gathered up at the close of each day and put in some convenient place for burning, or use as fuel or fence posts.

When there are stumps close by, pile around them and thus get rid of both at one burning.

Grass, weeds and brush must be cut at least once a year, and the cuttings destroyed. Thistles, sweet clover, wild lettuce, parsley and other noxious weeds should be cut frequently to prevent flowering.

Trees near telephone and power lines should be kept trimmed to prevent interference with the wires or with the view of signals or highway crossings. No trees across power line shall be touched, by the track foreman or his men if any part of the tree is in contact with the power line, unless he shall receive instructions in writing as to the method of how to proceed in the matter, as a tree or wood is a conductor of electricity and may result in an injury or the loss of life.

All highway and farm crossings must be kept in the best possible repair and not obstructed by any material. Track foremen are especially directed not to leave hand cars or push cars on crossings.

All switch signals must be kept bright and in good order.

Section forces must pick up each day any material dropped from motors or cars, such as draw bars, car doors, brakes, trolley bases, trolley poles, bolts, nuts or other property belonging to the company and take it to the tool house, from where it will be shipped as directed.

All packages or articles of freight that may fall from any train must be taken to the nearest station agent, who will forward them to the proper officer.

PATROLLING.

Track foremen must make frequent and careful inspections of all track, fences and bridges on their sections.

Track foremen shall keep the nuts on all packing, bond timber and other bolts in the floor system of bridges, and report any looseness, chafing or rattling of rods, rivets or other parts of such structures. They are also instructed to keep the expansion rollers under the free ends of iron bridges free from gravel, cinders or other obstructions.

In case of severe storms or violent winds, track foremen will see that watchmen are properly detailed to patrol the track, watch bridges, pole lines and perform other duties pertaining to the safety of track and structures.

Track foremen shall frequently visit these men at such intervals, day or night, as may be necessary, to see that their duties are faithfully performed.

Track foremen shall order all trespassers off of right of way, this rule is particularly applicable to children and aged persons.

Track foremen shall see that all farm crossing gates are closed and shall notify parties using farm crossing that an open gate is a violation of the state law and a fineable offense, and in event of an accident resulting from an open gate, the parties leaving gate open will be liable for damages and prosecution according to law.

Particular care must be taken to see that sand does not wash down on tracks at road crossing or earth slides obstruct the track in cuts.

Trees, rocks, etc., if in danger of falling on the track, must be removed.

TOOLS AND MATERIAL.

Track foremen, as well as Roadmasters, will make requisition in writing for all necessary material, such as cross ties, spikes, angle bars, bolts, nuts, nut locks, tools and equipment and will hand them to their immediate superior officers, on a certain day of each month.

The Roadmaster will furnish each track foreman with list of the tools necessary for their section or gang, and will supply the tools according to their list. These tools must always be on hand and subject to inspection which may be made at any time.

Track foremen will be held strictly responsible for all tools, equipment and material left in their charge. They must report promptly any loss of the same to the Roadmaster on the printed form provided for this purpose. They will not be permitted to lend the tools or material of the company to any person, outside of fellow employes, under any circumstances.

All material, new or old, must be kept locked in tool house, as far as possible, or under the eye of the track foreman.

Track foremen will have care of and be responsible for all loose property of the company, such as wood, ties, lumber, coal, sand, scrap iron, etc., and will see that none of it is lost or stolen, nor shall they on their own responsibility, give anything away.

All spikes in the track must be carefully drawn with the view of using them again. No old ties are to be thrown aside with spikes left in them. All old spikes which cannot be used again must be carefully gathered up and taken to scrap pile each night. In uncoupling rails, no tight nuts or bolts must be knocked off with hammer. They must be oiled and taken off with a wrench.

Tools needing repairs shall be shipped to the company repair shop and a requisition shall be made by the foreman and forwarded to Roadmaster for repairs on these tools. Place a tag on each article showing to whom it is to be returned, and fill out the printed form provided, giving advise of shipment.

Track foremen will not ship their hand cars to shops for repairs until the Roadmaster has inspected them and decided they need shop work, but no track foreman, either before or after advising the Roadmaster of the bad condition of a hand car, will use the same, if to do so involves the risk of accident.

All scrap rails shall be piled up at side tracks ready for shipment. At the close of each day's work track foremen shall collect all small scrap and haul it to their storage bins or tool houses and once every month shall make a careful estimate of the number of pounds of such scrap in their care.

STANDARD LIST OF SECTION TOOLS TO BE PLACED IN THE POSSESSION OF EACH FOREMAN.

- One 4 lb. axe.
- Two adzes, 5 inch cut.
- Two Verona No. 4 claw bars.
- One Verona spike puller.
- Four Verona No. 2 tamping picks.
- Six tamping bars.
- Three Verona No. 7 clay picks.
- Five Verona No. 31 pinch or hinge bars.
- One common track level.
- Three snow brooms.
- One Sheffield hand car.
- One Sheffield rubble or push car.
- Three "Q" pattern Verona track chisels.
- Two red flags.
- Two yellow flags.
- Two white flags.
- Two red lanterns.
- Two yellow lanterns.
- Two white lanterns.
- One grinding stone.
- One 5 gallon oil can.
- One 1 gallon oil can.
- One hand saw.
- Three Verona No. 5 bell pattern spike mauls.
- Four scythes and snaths.
- Four scythe stones.
- One 4 foot 8½ inch Huntington track gauge.
- One No. 17 Simplex track jack.
- One 15 inch monkey wrench.
- Five No. 51 Verona track wrenches.
- Two pick handles.
- Two maul handles.
- Two adz handles.
- Six Old Hickory No. 2 track shovels.

R

ACCIDENTS.

In case of an accident to a train, the nearest track foreman will at once take his whole force to the assistance of the train, even if it is not on his own section. If notified of broken rails or anything else needing immediate attention on an adjacent section, he will at once go and make the track safe for the passage of trains.

When assisting a train delayed by an accident, track foremen will act under the direction of the conductor until the arrival of the Roadmaster.

In case of a wreck, track foremen must at once appoint the necessary watchmen to prevent freight or company property from being stolen. Said watchmen are to remain on duty until the goods are removed.

In case of injury of any kind, no matter how trivial, to anyone in their employ, track foremen must immediately make out report to the Roadmaster on the printed form furnished him for this purpose. No track foreman shall exercise his discretion as to what injury is or is not important enough to be reported. In event that the injury is of such nature as to need medical attention, the injured shall be taken at once to the nearest company physician and any further action toward relieving the injured shall only be done upon authority from the company physician. It must be understood that no criticism shall be made on the part of the track foreman of the treatment given the injured party by the company physician.

R

HAND AND PUSH CARS.

When hand or push cars are not in actual use they must be lifted off of the track and placed entirely clear of passing trains. Never at any time shall hand or push cars be left standing upon any track. When not within sight of the track foreman, hand or push cars must be locked, and no car shall be used without the knowledge of the track foreman.

Track foremen shall build such hand car run-offs as are necessary on their sections with a fall from the track of four inches in twelve feet. These run-offs must be excavated, if necessary, or made of earth embankment, and must be at least thirteen feet long and ten feet wide.

Loaded push cars shall not be run around curves on main track, or where there is not a tangent of at least half a mile, except under protection of red flags.

Hand or push cars must never be attached to a train in motion.

Rails must not be carried on hand cars except in cases of emergency.

Great care must be exercised when necessary to use hand or push cars during foggy weather or in the night.

Track foremen or trusted men must always accompany the cars.

No cars will be run at night or on Sunday, except in case of emergency.

Cars must be kept under lock and key, and in no case used for personal purposes, except by special permission of the Roadmaster.

Parties claiming to be officers of the road, cannot be taken on hand cars without an order signed by the proper officer.

Track foreman shall stop any person other than employes of this company from running hand cars, velocipedes or push cars on track without written permission to do so from the proper officer.

REPORTS.

The time roll book must be written up every night for the day just closed. The time of the foreman and men must be given and the same distributed to each kind of work performed, under the proper heading. Time roll books as well as monthly reports of all tools and material received during the month, and on hand at the end of the month must be sent to the Roadmaster on the morning of the last day of the period for which time is given.

When an employe is discharged the track foreman will make out and forward to the Roadmaster an application for a time check and enter on the page of the time roll book opposite the name of the employe, "Discharged, time given." Upon receipt of application for time check, Roadmaster will certify to its correctness and forward at once to the Engineer Maintenance of Way, who will have time check issued and forwarded to the agent at the station nearest the section for payment to the employe, who must be identified by an identification check and the track foreman.

In case the employe has not received pay for work done in the previous time period, the Roadmaster will request the Engineer Maintenance of Way, giving the number of roll upon which the name appears and the date of the period, to forward the amount due the discharged employe to the agent nearest the section for payment to him.

Track foremen will promptly report in writing to the Roadmaster any failure of trainmen to respect their signals and to answer the same with the whistle, giving the number of the train and the motor.

Track foremen will report all accidents occurring on their sections by telephone to the Roadmaster, as soon as possible, according to special instructions, giving in brief the nature of the accident. The telephone message must be followed by a full written report, given or sent by the track foreman to the Roadmaster. In case of very seri-

ous accidents requiring a collection of forces and materials, track foreman must immediately report in full to the Engineer Maintenance of Way and Roadmaster.

Track foremen will promptly report all stock killed or crippled by a train on their section on proper blanks furnished them, and immediate report on proper form must be made by track foremen to the Roadmaster of all fences burnt, or other property or material, whether belonging to the company or to private parties, destroyed or damaged by fire or otherwise.

Broken rail must be at once reported to the Roadmaster. State manufacturer's marks on the rail, when laid, when broken, the nature of the break and its cause, and at what part of the rail it occurred, and between what mile posts, and whether on curve or tangent, and what disposition is made of broken rail, also condition of the road bed where break occurred.

It must be borne in mind by track foreman that the proper method of handling all matters is by making complete reports in writing.

SIGNALS.

All track foremen, foremen of extra gangs, repair foremen and construction trains, must never obstruct the track in any way whatever, without protecting themselves with the proper signals.

Red signifies danger and is a signal to stop. Red signals must be used when track is obstructed or so unsafe that trains cannot pass. An English speaking man with a red flag by day or a red light by night must be stationed nine hundred yards each way from point of obstruction or defectiveness, when trains cannot pass obstruction or defect and signal all approaching trains to full stop; and personally inform the motorman of approaching trains of the location and nature of the trouble. In no case and under no conditions must the flagman place or allow the red flag or light to be placed on the ground or on any staff, or pole as a signal for trains to stop, but must personally use the signal to "swing down" a train approaching a danger point and he must personally remain at his post until he has been relieved by a messenger sent by his foreman or by the foreman himself.

All signals to approaching trains must be given on straight track.

A yellow flag by day and a yellow light by night displayed on the right hand side of track to approaching trains indicates that the track is not in perfect order and should be run over slowly and with caution. If yellow signals are required, they must be placed 500 yards in both directions from the obstruction and firmly conspicuously lo-

cated, so that there is at least five feet clearance between the passing train and the nearest point of the signal.

The above two rules apply when track is not absolutely safe for the usual speed, but over which trains may pass without actual danger.

When a curve, the grade or condition of weather makes it doubtful whether the train can be stopped in running the distance covered in five hundred yards, the signals must be displayed enough farther to insure sufficient distance to stop the train before reaching the obstruction.

Whenever there is a doubt that a flag may not be seen by reason of fog, storm, etc., a light must be displayed.

No red light or flag shall be displayed unless accompanied by a man.

In all cases the signal must be so placed as to fully display the whole flag in windy or calm weather.

A support or holder for a signal staff shall be made of a two by four inch piece of timber or other suitable material and shall contain a hole, pocket or other fit appliance for securely holding signal staff on a horizontal position, the holder shall be of sufficient length to admit of the signal being seen by the motorman under all conditions and the base of the holder shall be so sharpened as to firmly plant it in the earth and insure it remaining vertically upright under all surface and weather conditions.

Signal staffs shall not be fastened to wire poles.

In case of impassable or unsafe track, flagging is the first duty and repairs must wait, if necessary, until signals have been placed.

SPECIFICATIONS FOR SPECIAL WORK.

Curves—All curves having a radius less than one hundred feet shall have an easement on each end, and they shall be single guarded by rail of same section, and the throat way shall be two inches wide to accommodate M. C. B. wheels. All rails shall be bent to true radius without wind and the ends shall be cut square to provide good joints.

Switch Fixtures—All drawing and orders for special work shall be accompanied by a drawing showing the typical flange and tread of the large and small cars using same.

The central radius of all lateral turn-outs shall be one hundred feet and the central radius of all equi-lateral turn-outs shall be two hundred feet.

All tongue switches and mates shall be twelve feet long. All tongue switches shall be equipped with anti-kicking spring box, similar to the Gerlach box in design; and except in various special cases the tongue switch should be on the inside of the curve and should be on the left-hand side of the track on entering an equi-lateral turn-out;

(this is to be so that when a car trails through a turn-out for right-hand operation, the weight of the car is not on the tongue when the trailing car throws same.)

All switch pieces shall be of solid manganese steel throughout, cast in one piece with outside arm conforming to section of connecting rail, drilled two and one-half inches by five inches for one inch bolts, all vertical webs shall be three-fourths of an inch thick, except at point of connecting with rolled section, in which case it must be one-eighth inch thicker than the web of the connecting rail, and all frogs shall be iron bound manganese center construction.

All standard tongue switches to have reinforced tongue and a circular heel not less than seven inches in diameter, with mechanism for holding the heel firmly against the bed, the pressure to be exerted at or near the center of rotation.

Fittings—All external joints must be furnished and shall be of the angle type wherever possible. All ends must be ground to fit with connecting sections. In all cases where rolled rail connects with manganese castings fish plates shall be furnished for each side of web or at the option of the manufacturer, manganese may be extended to form fish plates on one side of web, in which case fish plates must be furnished for the other side as well.

Railroad Crossings—All railroad crossings built of solid manganese steel should be constructed in two pieces, that is, two half crossings making a complete intersection, unless in very special cases where it may be necessary to cast them in four pieces on account of the long angle. In cast manganese railroad crossings, the web must be one inch thick or not less than one inch tapering to seven-eighths of an inch. The flanges shall not be less than seven-eighths of an inch thick at the junction of the web and flange, tapering to five-eighths of an inch at the outside edge.

All solid manganese railroad crossings shall be of the double web type of construction throughout and the intersection of flangeways shall be reinforced by solid metal. All steam road crossings shall have extended easers to protect all outside joints. The easers shall be omitted on electric road crossings.

All street railway crossings shall be cast iron bound and have renewable inserts of manganese steel, positively bolted in place, with bolts splattered and no wedges are to be used as a means of holding the centers, and the centers are to be so designed that when necessary these centers may be renewed without any disturbance whatever of the adjacent paving.

General—All manganese castings shall be free from surface checks or shrinkage cracks and sand holes especially on gauge lines.

No special work shall be painted.

Fences, Road Crossings, Signs and Cattle Guards.

Fence.

DEFINITIONS:

Fence—Any barrier that serves to guard against unrestricted ingress and egress, especially a structure of posts, rails, wires, board or pickets.

Fence Post—An upright piece of timber, metal or other material used as a support for the attachment of the longitudinal members of the fence.

End Post—A post at the end of a line or section of fence.

Corner Post—A post at the corner of a line or section of fence.

Brace Post or Kicker Post—A post next to the end or corner post.

Intermediate Post—A post placed between end posts.

Gate Post—A post to which a gate is hung or latched.

Cleat—A piece of wood fastened transversely to the side of a post below the ground line to give it greater stability.

Stay Wire—A vertical wire serving the purpose of keeping the longitudinal wires the proper distance apart and stiffening the fence.

Panel—A section of fence between adjacent posts.

Brace Panel—A panel in which a brace, or tie, or both, are introduced.

Top Wire—The highest longitudinal wire of a fence.

Intermediate Wire—A longitudinal wire located between top and bottom wires.

Bottom Wire—The lowest longitudinal wire of a fence.

Tie Wire—A wire in tension between any two posts.

Gate—A movable barrier consisting of a frame or structure of wood, metal or other material for closing a passage or opening in a fence.

Gate Latch—A device for fastening the free end of a gate to a gate post.

Gate Brace—A piece of wood or metal serving the purpose of stiffening the frame of a gate.

Gate Hinge—A device for attaching a gate to a post and upon which the gate swings.

Snow Fence—A structure erected for the purpose of accumulating drifting snow.

Anchor—A device to prevent a fence or post from being raised or moved.

Anchor Post—A fence post fixed or fastened in position.

SPECIFICATIONS FOR STANDARD STEEL, WOVEN WIRE RIGHT OF WAY FENCES, BUILT WITH WOODEN POSTS.

There shall be two types of standard fence, they shall be designated as class "A" and class "B" respectively.

Class "A" fence shall be a ten bar, 47-inch woven wire fence with one strand of barbed wire placed above the woven wire, and shall consist of ten longitudinal, smooth, coil, galvanized steel wires, the top and bottom and intermediate wires and stay wires shall be No. 9 gauge. The spacing of the longitudinal wires shall be, commencing at the bottom, 3 inches, 3½ inches, 4 inches, 4½ inches, 5 inches, 5½ inches, 6 inches, 7 inches and 8 inches, and the stay wires shall be placed twelve inches apart. The bottom wire shall be two inches above the ground. The barbed wire strand shall be placed four inches above the top of the woven wire.

Class "B" fence shall be a seven bar, 26-inch woven wire fence with three strands of barbed wire placed above the woven wire, and shall consist of seven longitudinal, smooth, coil, galvanized steel wire, the top and bottom and intermediate wires and stay wires shall be No. 9 gauge. The spacing of the longitudinal wires shall be, commencing at the bottom, 3 inches, 3½ inches, 4 inches, 4½ inches, 5 inches and 5½ inches, and the stay wires shall be placed twelve inches apart. The bottom wire shall be two inches above the ground. The lower barbed wire strand shall be placed four inches above the top of the woven wire, the middle barbed wire strand shall be placed eight inches above the lower barbed wire strand, and the top barbed wire strand shall be placed ten inches above the middle barbed wire strand.

Woven wire shall be constructed of galvanized steel wire; longitudinal wires shall be coiled. The elastic limit of No. 9 galvanized steel wire shall be at least ten hundred twenty (1,020) pounds. The ultimate tensile strength of No. 9 galvanized steel wire shall be at least seventeen hundred (1,700) pounds. It must stand without sign of fracture, winding tight around wire of the same size. Stay wires shall be straight and of No. 9 gauge.

The hinge joints, locks or fastenings at the intersection of the longitudinal and stay wires shall be of such design as will prevent them from slipping either longitudinally or vertically.

All woven wire fencing shall be bought in forty rod rolls.

Staples used in posts shall be one inch long for hard wood and one and one-half inches long for soft wood, and be made of No. 9 galvanized steel wire.

No. 9 soft galvanized wire shall be used for bracing and for heavy work it shall be doubled.

A two point No. 12 galvanized barbed wire strand shall be used and the barbs shall be three inches apart.

Galvanizing shall consist of a heavy even coating of zinc which shall withstand a one minute emersion test in a dilute solution of copper sulphate, and after the emersion, the sample shall be washed in water and wiped dry. After repeating this process four times, there should be no copper colored deposit, nor should any portion of the zinc be eaten away. If either of the last mentioned occurs, the lot of material from which the sample is taken shall be rejected.

The fencing shall be so manufactured as not to remove the galvanizing nor impair the tensile strength of the wire.

Galvanized fencing shall not be left on cinders in salt or any alkalies of any kind. Fencing shall be piled on timber stringers high enough off the ground to admit of free circulation of air under and around same.

Construction—Corner posts, end posts and gate posts shall be preferably of round white cedar, 6 inches by 8 feet. Intermediate posts shall be preferably of round white cedar, 5 inches by 7 feet.

Almost any wood which will make good cross ties is suitable for fence posts, but wherever timber is used, it should always be stripped of its bark before planting. Posts shall be straight and free from rot or other defects. Split or sawed posts where same are used when round posts are not economically available shall be of dimensions equal to those herein specified for round posts.

Braces for end posts, corner posts, gate posts and intermediate brace panels shall be common fence posts or 4 inches by 12 feet, round white cedar, free from large knots, splits or rot.

Cleats for anchor posts shall be of any common sound lumber 2 inches by 6 inches by 3 feet.

The stakes for all fencing shall be set by the engineer of company with the fence foreman and the fence foreman shall then stake out all anchor post holes, gate post holes,

etc. Where there is soil the foreman shall use a sixteen-inch tile spade and top all holes to a depth of one foot to sixteen inches. In average digging one man will be expected to lay out and top holes for three diggers.

End posts shall be set vertical and placed at least three feet, six inches into the ground, thoroughly tamped, braced and anchored. The post next to the end post on the strain side of the end post is called a brace post or kicker post, and shall be set vertically into the ground to a depth of three feet six inches and thoroughly tamped. Gate posts shall be set vertical and braced and anchored in a similar manner to the end post. Intermediate posts shall be set two feet six inches in the ground and sixteen and one-half feet apart on class "A" fence. Class "B" fence shall be built the same as class "A" fence, except in particular cases where only temporary fence is desired, at such places the intermediate post shall be set thirty-three feet apart. This last spacing of posts will largely depend upon the nature of the ground and the service required.

Holes shall be provided for all posts. Where rock is encountered, thirteen gauge galvanized steel fence posts shall be used, and a rock drill shall be used to provide holes. The galvanized steel post shall be concreted in the rock or if the rock is found to admit of tamping and packing, then every fifth intermediate post shall be set in concrete and the balance of the intermediate posts shall be tamped with a mixture of rock and soil. A special tamping bar shall be furnished for tamping steel posts in the rock, which tamping bar will have a two inch square, steel head, and a three-quarter inch rod handle, and shall be seven feet in length. A two-inch steel spoon shall be made out of one-quarter inch by one and one-half inch strap steel, which spoon is to be used for cleaning out the hole in drilling.

All posts shall be set with large end down. Posts shall be set in perfect line on the side on which the wire is to be strung.

End, corner and gate posts shall be anchored by spiking two cleats to the sides of the post at right angles to the line of the fence. One at the bottom and one just below the surface of the ground. The cleat near the ground surface shall be put on the side of the post next the fence or the pulling side of the post, and the bottom cleat shall be put on the opposite side. In order to get the bearing surface for the cleats only so much of the post shall be dressed off as is necessary. Posts must not be gained. Spike the cleats securely to the post with two forty-penny spikes.

Tamp the posts well at the bottom so that they will set solid. A good job of tamping is essential and foremen

shall compel it. Intermediate posts set in depressions of the ground shall be anchored by spiking with two forty-penny spikes, a cleat on the side near the bottom of the post. Intermediate posts set in depressions shall be selected so that the best post for the purpose is obtained. They shall be set two and one-half feet into the ground, thoroughly tamped and in perfect line.

End, corner and gate posts shall be braced by using a common fence post or round piece of four-inch cedar twelve feet long. A twelve foot brace shall be placed diagonally between the two posts and the ends of the brace shall be sawed to an angle so as to fit the two posts. No post shall be gained or mortised for a brace. The brace shall be marked for sawing by holding the brace against the post about where it is to go, which is to be ten inches from the top of the end, corner or gate post and ten inches from the ground on the brace or kicker post; mark the angle at which the ends must be sawed. With a hand axe dress off just enough of the corner and kicker post to get a slight shoulder above the end of the brace on the corner post, and below the end of the brace on kicker post, the brace to have a solid bearing on both posts. Spike both ends of the brace securely. This arrangement affords the least chance possible for holding moisture, while a mortise weakens the post and is sure to cause decay by holding moisture. A cable made of a double strand of No. 9 soft galvanized wire, looped around the end post three inches above the ground line, and around the brace or kicker post, ten inches below the top, shall be put on and twisted until the top of the brace or kicker post is thrown back at least two inches.

Longitudinal wires shall be stretched uniformly tight, and be parallel; stays shall be straight and vertical and shall be uniformly spaced. In erecting the wire, unroll enough of the woven fabric so that it can be placed against the end post leaving sufficient wire to go clear around the end post and twisted around the corresponding wire of the fence.

To make a splice when the end of the roll is reached, leave about six inches of the line wire from the stays and splice the same to the corresponding line wires of the next roll, bringing the two stays together and wrapping the ends in opposite directions around the line wires, making what is commonly known as a telegraph splice.

Wires shall be placed on the side of the post away from the track, except on curves, where they shall be so placed that the pull of the wires is against the posts.

A Dillon woven wire fence stretcher shall be used. Attach the stretcher to the end post by the post chain, so that in stretching the brace will not interfere with the working of the stretcher. Drop the hook end of the

stretching chain over one of the lengths, so that the length slides into the slot on the hook. By laying the chain on the ground, the operator can measure where the wooden clamp bar should be placed on the fence. Attach the wooden clamp bar between the stays, turning down the nuts on the bolts so tightly that slipping of the wires will be impossible. Open the clevis frame on the stretcher into which the wooden clamp bar fastens, place the clevis frame on the wooden clamp bar so that it is in the center of the fence, clevis being the same distance from the top of the woven fabric as from the bottom of the woven fabric. Throw the two dogs over the ratchet on the stretcher, then use the lever in operating the stretcher.

If the ground is rolling, the fence may incline to crush at top of hill, and this should be avoided by raising the fence to position and driving the staples over second bar from top not so tight, however, that the wire cannot have good play. If the fence raises from the ground in low places, step on the bottom bar, putting the fence in place and staple over the bottom bar. Work the stretcher until the fabric is under strong tension. The fence must be pulled tight to make a good job, and the operator must not be afraid to work the stretcher. After the fabric has been well stretched the longitudinal wires shall be wrapped around the end post, and twisted around the corresponding wire of the fence, then the fabric shall be stapled to the end post and the stretcher removed. Forty rods of fence shall be stretched at one time.

The bottom wire of the woven fabric shall not be more than two inches above the ground as placing it higher would allow a hog to get his nose under the fence and start routing and in a short time he would be able to escape the inclosure.

Staples shall be set diagonally with the grain of the wood and be driven home tight. The top wire shall be double stapled.

In constructing fence over swampy or boggy land where posts are liable to heave by frost, a barbed wire shall be stretched from the top of the corner post to the ground line of the second post and from the ground line of the second post to the top of the third post, and this repetition kept up through the entire boggy strip. A second strand of barbed wire shall be stretched from the ground line of the corner post to the top of the second post and from the top of the second post to the ground line of the third post, so that between each panel there will be a wire cross brace through the entire boggy strip. Two staples shall be used to fasten wire to the post.

In the building of fence, fence foremen shall exercise care that stock does not enter on the right of way or

escape the enclosure which he is building and should the stock by accident escape, he will be held responsible for the stock and shall exercise every effort to get the stock back in the enclosure immediately.

Fence foremen shall see that no supplies are wasted and that all tools are kept in proper condition for good work.

Fence foremen shall distribute their posts and material in a careful manner and at the points where the same are to be used so that no carrying backward and forward of material is necessary.

All old fence posts shall be neatly piled and shall be disposed of in the manner instructed by Roadmaster.

No fence wire, posts or other material shall be left lying on any land adjoining the right of way.

All old wire shall be neatly rolled or put in hand coils and piled and shall not be left scattered on the right of way.

Fence foremen shall not dispose of any material to anyone whomsoever, unless first having been instructed by Roadmaster.

All posts shall be piled in the following manner:—

Two posts shall be laid on the ground and the posts piled thereon. Each alternate layer consisting of from two to five posts and the top of the pile shall have the top layer so placed so as to form a water shed.

Air must circulate freely through all piles of posts.

Posts shall not be piled nearer than ten feet from the rail of track.

Fence foremen shall report to and receive instruction from Roadmaster.

A fence gang shall consist of a foreman and four men.

All fence gangs shall be possessed of the following tools:—

Three Buckeye digging bars.

Three Standard earth augurs, No. 5.

Three Kohler Hercules post hole diggers.

Three steel tamping bars having a two-inch square steel tamp three inches long.

One hand axe.

One eight-point hand saw.

Three claw hammers.

One Dillon woven wire stretcher.

One American Steel & Wire Company's single wire stretcher.

Two sixteen-inch tile spades.

One long handled round point shovel.

One No. 2 dirt shovel.

One pair heavy wire pliers.

FARM GATES.

The width of farm gates shall not afford less than fourteen feet of clear opening and they shall be constructed of either wood or metal. If of metal they shall be fourteen feet wide and fifty inches high of similar type to the American Steel & Wire Company's non-climbable, pipe frame, railroad gate, equipped with hinges and latches for wooden posts. If constructed of wood, they shall be built up of one inch by six inches by sixteen feet rough yellow pine lumber, with proper vertical and sash braces and shall be four feet in height with fourteen inch slides on one end, and all to conform with the standard drawing. Farm gates shall be hung so as to open away from the track.

DEFINITIONS.

Cattle Guard—A barrier placed at the intersection of a wing-fence with a railway track to prevent the passage of live stock along the track.

Apron—The flaring panel of fence set parallel with the track between the cattle guard and the wing fence.

Wing-Fence—The line of fence making connection between the apron of the cattle guard and the right of way or line fence.

Section—A group of slats or strips which go to make up a surface cattle guard.

Filler—A piece of timber, metal or other material placed between the slats composing a section of the surface cattle guard to space and stiffen them.

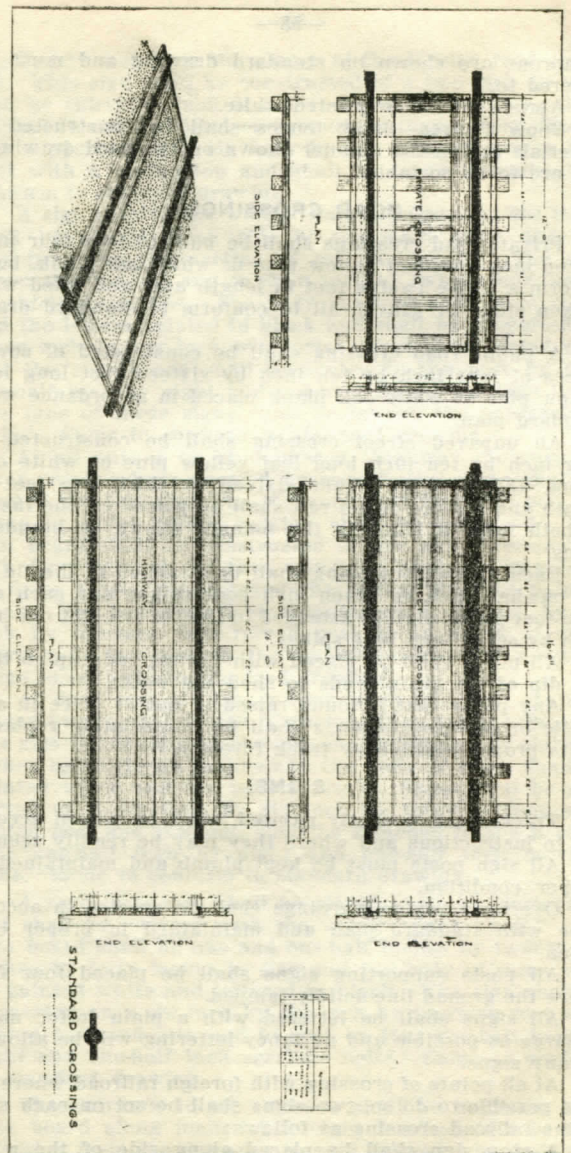
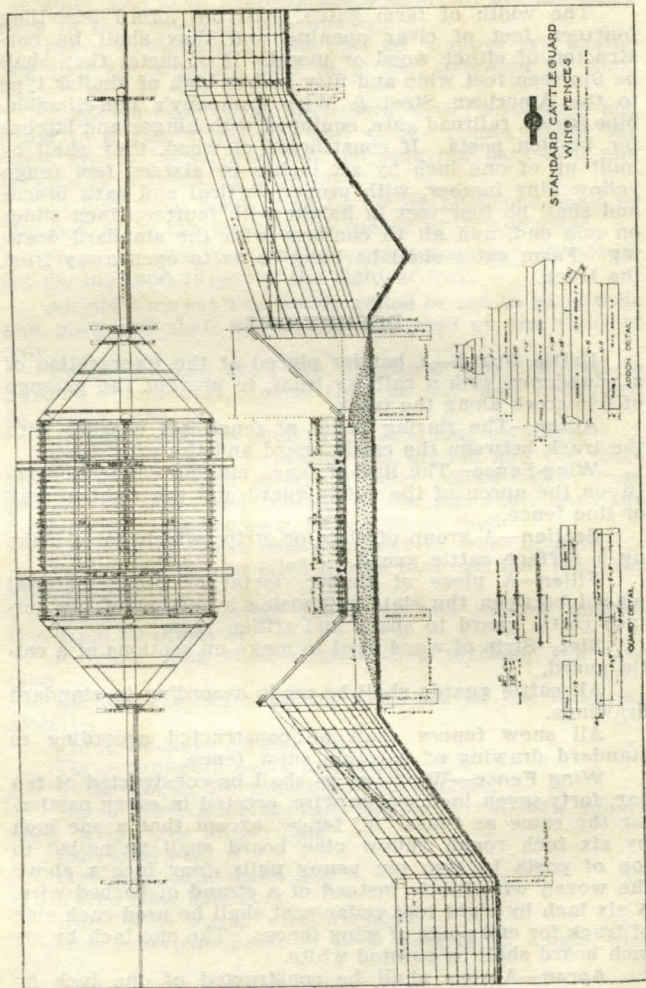
Slat—Strip of wood used to make up sections of a cattle guard.

All cattle guards shall be made according to standard drawings.

All snow fences shall be constructed according to standard drawing of portable snow fence.

Wing Fence—Wing fences shall be constructed of ten bar, forty-seven inch woven wire, erected in every particular the same as Class "A" fence; except that a one inch by six inch rough yellow pine board shall be nailed to top of posts by two ten penny nails, four inches above the woven wire fabric instead of a strand of barbed wire. A six inch by eight foot cedar post shall be used each side of track for end posts of wing fences. The one inch by six inch board shall be painted white.

Apron—Aprons shall be constructed of one inch by six inch rough yellow pine boards, held together by ten penny nails, and the lower ends of the apron shall be spiked by twenty penny spikes to cedar post four feet long set in the ground two feet six inches. The design



of aprons are shown on standard drawing and must be adhered to.

Aprons are to be painted white.

Snow Fences—Snow fences shall be constructed of materials and in the manner shown on standard drawings, and are to be portable.

ROAD CROSSINGS.

Private road crossings shall be built of four four inch by ten inch long leaf yellow pine or white oak plank, built to form a frame twelve feet in length and well filled with broken stone or gravel, all to conform to standard drawing.

A public road crossing shall be constructed of seven pieces of four inch by ten inch by sixteen feet long leaf yellow pine or white oak plank placed in accordance with standard plan.

An unpaved street crossing shall be constructed of four inch by ten inch long leaf yellow pine or white oak plank, and shall be either sixteen or thirty-two feet in length and a piece of old rail shall be placed on the inside of both rails of track in the manner shown on standard plans.

Each twelve foot plank shall be attached to the tie by six one-half inch by seven inch boat spikes and each sixteen foot plank shall be attached to the tie by eight one-half inch by seven inch boat spikes.

All plank shall be placed with the sap side up so that the dip of the grain tends to shed the water.

Any plank that is found raised or out of place in any public or private crossings shall be immediately replaced in its proper position by track foremen.

SIGNS.

Track signs, properly painted, must be placed according to instructions and where they may be readily seen.

All sign posts must be kept plumb and maintained in proper condition.

Overhead bridge warnings shall be erected in accordance with standard plan and maintained in proper condition.

All posts supporting signs shall be placed four feet below the ground line solidly tamped.

All signs shall be lettered with a plain letter made as large as possible and no fancy lettering will be allowed on any signs.

At all points of crossing with foreign railroad wherever it is possible to do so, two signs shall be set on each side of the railroad crossing as follows:

A stop sign shall be placed along side of the main

track sixty feet from the center of the foreign road crossing. This sign shall be constructed of a two inch by nine inch by thirty-six inch board, the body of which shall be painted in red and lettered in white with the word "Stop," and supported on a six inch by six inch by twelve foot post with a roofed top and shall be made throughout to conform to standard drawing.

A sign bearing the words "Railroad Crossing 800 Feet" shall be placed along side of the main track and 800 feet from the intersection of the two tracks. The sign board shall be one and one-half inch by twenty-four inches by thirty-six inches. The body shall be painted in white and the letters painted in black and shall be supported on a six inch by six inch by fourteen foot shed roofed post and the sign board shall be bolted to the post by four one-half inch by eight and one-half inches carriage bolts. The face of these signs shall be toward the approaching trains. Same to conform to standard drawing.

At all curves or at dangerous highway crossings or other points where deemed necessary slow signs shall be erected not less than one thousand feet from the point of curve or point where caution shall be exercised. The sign board shall be constructed of one and three-quarter inch by nine inch by thirty-six inch lumber. The body shall be painted yellow and the letters shall be painted black. The board shall be mounted on a six inch by six inch by fourteen foot roofed post at an angle of sixty degrees to the post in the upper quadrant of a circle. Same to conform to standard drawing.

At each end of long or high bridges a sign shall be placed bearing the words "Danger! Keep Off the Bridge." The sign board shall be one and one-half inches by eighteen inches by thirty-six inches and the body of same shall be painted white and the letters black. Same shall be supported on a six inch by six inch by fourteen foot shed roofed post and the sign shall be attached to the post by four one-half inch by eight and one-half inch carriage bolts. Same to conform to standard drawing.

A yard limit sign shall be placed at points designated and shall be lettered with the words "Yard Limit." The sign board shall be one and one-half inches by twenty-two inches by forty inches in size and the body of same shall be painted white and lettered in black. The sign shall be supported on a six inch by six inch by fourteen foot shed roofed post and attached to post by four one-half inch by eight and one-half inch carriage bolts. Same to conform to standard drawing.

The entrance to all subways shall be indicated by a sign board along main track eight hundred feet in each direction from the entrance to said subway and shall bear

the words "Subway 800 Feet." The sign board shall be one and one-half inches by eighteen inches by thirty-six inches and the body shall be painted in white and the letters in black. The sign shall be supported on a six inch by six inch by fourteen foot shed roofed post and attached to post by four one-half inch by eight and one-half inch carriage bolts.

A sign shall be located at each entrance to property where it is desired that the public shall not trespass, which sign shall bear the words "No Trespassing—Property of C., O. & P. Ry. Co." The sign board shall be one and one-half inches by twenty inches by forty-two inches and the body shall be painted white and the letters painted black. Sign board shall be attached to a six inch by six inch by fourteen foot shed roofed post by four one-half inch by eight and one-half inch carriage bolts.

At all highway crossings sign boards bearing the words "Look Out for the Cars" lettered on both sides of the board so that it may be read from either direction, shall be placed at the side of the highway crossing twenty-five feet from the track at right angles to the highway. There shall be two boards one and one-half inch by eleven inch by six feet. The body shall be painted in white and the letters painted in black and attached in "X" fashion to a six inch by six inch by fourteen foot roofed post by two one-half inch by seven inch carriage bolts. Same to conform to standard drawing.

All stations and intermediate points where local cars stop shall have a sign placed on the nearest trolley suspension pole to the stop or station. It shall be a sign made of one and three-eighths inch by eight inches by thirty inch boards constructed V-shaped, the large end of the "V" being attached to the trolley suspension pole sixteen feet above the top of the rail with four three-eighths by four inch galvanized cone pointed lag screws. The ends of the sign board opposite the pole attachment ends shall be nailed to a wedge-shaped separator block by ten penny nails. The name of the station or stop shall be painted on the sign in black letters and the body of the sign shall be painted white.

Five cent fare limit signs shall be constructed and attached to the pole in exactly the same manner as the station or intermediate stop signs. These sign boards shall be constructed of one and three-eighths inch by eleven inch by thirty inch boards and shall bear the name of the station or intermediate stop and directly beneath this shall appear the letters "5c Fare Limit." Five cent fare limit signs shall be placed at stations approximately two and one-half miles apart in the State of Illinois.

Mile marker signs shall be installed on the pole near-

est each mile point along the line. Chainage for the location of mile markers shall have been started at the end of the track at one of the terminals of the main track. Mile markers shall be constructed of eighteen gauge galvanized sheet iron eight inches wide and twenty-four inches long bent in a V-shape at the exact middle of its length. It shall be attached to the pole by four eight penny galvanized steel wire nails by means of holes one inch from the top and bottom edges and six inches from the back edge of the sign and shall be fourteen feet above the top of the rail.

Sign boards shall be erected on the division line of each track section. Section signs shall be constructed of two boards one and three-eighths inches by six inches by eighteen inches attached to the opposite side of a three inch by four inch by twelve foot roofed post with four three-eighths by three inch cone lag screws. Section signs shall be lettered with the letters "Sec.," and the number of the section, one on one side and similar lettering on the other side with the number of the adjacent section. The body of the sign shall be painted white and the letters black.

Right of way posts or markers shall be placed at the prominent corners and five hundred or one thousand feet apart in line on the boundary lines of unfenced property. Right of way posts or markers shall be constructed of four inch by four inch by ten foot roofed posts and shall bear the letters "C., O. & P. Ry. Co." on two opposite faces and the words "Property Line" on the other two opposite faces. The body bearing the letters shall be painted white and the lower end black. The letters shall be painted black. Same to conform to standard drawing.

A depot sign shall be attached to each depot building in a prominent place where same may be easily and quickly read by the passengers of the cars. The depot sign shall be constructed of one and one-fourth inch by eleven and one-half inch fir board and the length of the board to vary with the name. The board shall have a three-eighths inch chamfer on all four edges and the body of the board shall be black sanded, the letters painted yellow and the chamfer red. Same to conform to standard drawing.

A whistle sign shall be constructed and placed on the right hand side of the track on the trolley suspension poles approaching and eight hundred feet from all road crossings and all sharp curves. They shall be constructed of one and one-eighth inch by ten inch square board with a three-quarter inch by one and five-eighth inch half round boxed shoulder nailed to the edges. They shall be attached to the pole fourteen feet above the top of the rail and dia-

mond-wise, on the pole. A black letter "W" seven inches high and eight and one-half inches wide shall be painted on a white back-ground.

The approach to all sidings shall be marked by a siding sign-board erected on the trolley suspension poles sixteen feet above the top of the rail eight poles from the switch points or ends of all sidings. Siding sign boards shall be constructed of one piece of one and three-quarter inch by sixteen inch by thirty-six inch lumber and shall have a right angled brace of one and one-quarter inch by eight inch by eight inches attached to the back of the sign board, twelve inches from the back end of the sign board. Siding sign boards shall be attached to the pole by two three-eighths inch by four inch cone pointed lag screws through the sign board and one three-eighths by four inch cone pointed lag screw through the brace board. Siding sign boards shall bear the name of the siding in letters six inches high and directly underneath that in letters four inches high shall appear the word "Siding."

Bridges and Buildings.

DEFINITIONS.

Angle Block—A block of cast iron or wood, having a triangular cross section, against which the braces and counters of a Howe bridge truss abut.

Apron—A covering at the foot of a spillway to protect the ground from scour.

Batter Piles—Piles driven inclined, as distinguished from plumb piles.

Bent—The group of members forming a single verticle support of a trestle, designated as pile bent where the principal members are piles, and as framed bent where of framed timbers.

Batter—A deviation from the verticle in upright members of a bent.

Block and Tackle—A pulley block and rope.

Box Culvert—A culvert having a water way of rectangular cross section.

Brace—A diagonal compression member of a truss, also any stick used to resist compression, like the horizontal timbers running from one side of a trench to another. Sway braces are the diagonal braces of a trestle bent. Lateral (or wind) braces are the diagonal braces between the lower, or the upper, chords of a Howe truss bridge.

Bridging—The small diagonal braces between two joists or stringers of a floor system, which prevent the joists from turning over on their sides, or from bucking laterally.

Bulkhead—A wall of timber placed against the side of an end bent to retain the embankment.

Batter Pile—One driven at an inclination to resist forces which are not vertical.

Calk—To fill joints with oakum, or the like, to prevent leakage.

Can—To tip or lean.

Cap—A horizontal member upon the top of piles or posts, connecting them in the form of a bent.

Centers—The falsework that supports an arch during construction, or, more strictly, the arch ribs of this falsework.

Check—A crack in timber due to shrinkage from seasoning.

Corbel—A projecting beam acting as a cantilever supporting another beam.

Crib—A log cabin structure built of timbers whose ends are notched and drift bolted together.

Cross Grain—The gnarly mass of wood surrounding a knot, or grain injuriously out of parallel with the axis.

Dap—A notch cut into the side of a stick of timber.

Deck—The wooden floor system of a railway bridge, consisting of the stringers, cross ties and guard rails.

Docking—A retaining wall of piles sheathed with plank, and capped with a "dock stick" bolted thereto.

Dovetail—A timber joint made by cutting the end of a stick so that it is narrower a few inches back of the end, and it is let into a cross timber notched to fit it.

Dowel—An iron or wooden pin, extending into, but not through, two members of a structure to connect them.

Drift Bolt—A piece of round or square iron of specified length, with or without head or point, driven as a spike.

Dry rot—Rotting of timber not exposed to rain. The moisture is supplied by the sap of the timber. Dry rot often occurs when green timber is painted, the paint preventing the evaporation of the sap.

Dubb—To cut the end of a stick to a bevel around the edge. It is usually good practice to dubb the end of a pile preparatory to ringing it.

Decay—Complete or partial disintegration of the cell walls, due to the growth of fungi.

Douglas Fir—The term "Douglas Fir" is to cover the timber known likewise as yellow fir, red fir, western fir, Washington fir, Oregon or Puget Sound fir or pine, north-west and west coast fir.

Falsework—The temporary frame work or staging built to support a bridge or other structure during its erection.

Follower—A short length of pile placed on top of a pile that is being driven, to protect it from the blows of the hammer, or to force it down below the bottom of the leaders as when driving under water.

Frame Trestle—A structure in which the upright members or supports are framed timbers.

Forms—The mold in which concrete is cast.

Frame—To shape the members of a timber structure. Sometimes the term is used to include the erection and fastening together members.

Frap—To bind together with a rope.

Fish-Plate—A short piece lapping a joint, secured to the side of two members, to connect them end to end.

Gib or Gib Plate—A large flat piece of wrought iron or steel, used like a washer between the nut heads of rods in a Howe truss.

Gin or Gin Pole—A mast with a pulley at the top, guyed with three or four ropes, and used to raise heavy timbers, etc.

Guard Rail—A longitudinal member, usually a metal rail, secured on top of the ties inside of the track rail, to guide derailed car wheels.

Guard Timber—A longitudinal member framed over the ties outside of the track rail, to maintain the spacing of ties.

Heartwood—The older and central part of a log, usually darker in color than the sapwood. It appears in strong contrast to the sapwood in some species, while in others it is but slightly different in color.

Hemlock—To cover southern or eastern hemlock; that is, hemlock from all states east of and including Minnesota.

Western Hemlock—To cover hemlock from the Pacific Coast.

Intermediate Sill—A horizontal member in the plane of a bent between the cap and sill to which posts are framed.

Jack Stringer—A stringer placed outside of the line of main stringer.

Sound Knot—A sound knot is one which is solid across its face and is as hard as the wood surrounding it. It may be either red or black, and is so fixed by growth or position that it will retain its place in the piece.

Loose Knot—A loose knot is one not firmly held in place by growth or position.

Pith Knot—A pith knot is a sound knot with a pith hole not more than one-quarter inch in diameter in the center.

Encased Knot—An encased knot is one which is surrounded wholly or in part by bark or pitch. Where the encasement is less than one-eighth inch in width on each side, nor exceeding one-half the circumference of the knot, it shall be considered a sound knot.

Rotten Knot—A rotten knot is one not as hard as the wood surrounding it.

Pin Knot—A pin knot is a sound knot not over one-half inch in diameter.

Standard Knot—A standard knot is a sound knot not over one and one-half inch in diameter.

Large Knot—A large knot is a sound knot, more than one and one-half inch in diameter.

Round Knot—A round knot is one which is circular in form.

Spike Knot—A spike knot is one sawn lengthwise. The mean or average diameter shall be taken as the size of these knots.

Leads or Leaders—The vertical guides that guide a pile driver hammer during its rise and fall. Also called gins, ways, etc.

Longitudinal Strut or Girt—A stiff member running horizontally or nearly so, from bent to bent.

Longitudinal X Brace—A member extending diagonally from bent to bent in a vertical or battered plane.

Western Larch—To cover the species of larch or tamarack from the Rocky mountain and Pacific coast regions.

Mattress—A brush mattress consists either of facines bound together, or of strands or brush woven together, ballasted with stone and sunk in a river bed to prevent scour.

Mud Sills—Short pieces of timber (usually cedar) laid beneath the sill of a trestle bent to keep it from contact with the ground.

Oak—Under this heading three classes of timber are used, (a) white oak, to include white oak, burr oak and post oak; (b) red oak, to include red oak, scarlet oak, black oak, and all bastard oaks; (c) chestnut oak, to include only chestnut oak.

Pitch Pockets—Pitch pockets are openings between the grain of the wood, containing more or less pitch or bark. These shall be classified as small, standard and large pitch pockets.

Small Pitch Pocket—(a) A small pitch pocket is one not over one-eighth inch wide.

Standard Pitch Pocket—(b) A standard pitch pocket is one not over three-eighths of an inch wide nor over three inches in length.

Large Pitch Pocket—(c) A large pitch pocket is one over three-eighths of an inch wide or over three inches in length.

Pitch Streak—A pitch streak is a well-defined accumulation of pitch at one point in the piece. When not sufficient to develop a well-defined streak, or where the fiber between grains, that is, the coarse grained fiber, usually termed "spring wood," is not saturated with pitch, it shall not be considered a defect.

Pile—A stick driven into the earth. Foundation piles are driven to support a bridge, building or other structures. Sheet piles are sawed timber piles driven touching another so as to form a tight diaphragm. Wakefield piles are sheet piles made by bolting or spiking three planks together, so as to form a tongue or groove. When driven, this gives a triple lap sheet piling.

Head of Pile—The upper end of a pile.

Foot of Pile—The lower end of a pile.

Butt of Pile—The larger end of a pile.

Tip of Pile—The smaller end of a pile.

Bearing Pile—One used to carry a superimposed load.

Pile Driver—A free-fall pile driver has a hammer held by nippers which, when tripped, allow the hammer to fall freely. A friction clutch driver has its hammer always attached to the hoisting rope, which is operated by the drum of a friction clutch. A steam hammer is raised by steam acting directly upon a piston attached to the hammer. An overhang driver is one mounted in a frame whose leads project eight to 20 feet beyond the base support.

Plank—In the lumber trade, the term plank is applied to pieces one and one-half to five inches thick by seven inches wide or wider.

Post—One of the vertical or battered members of the bent of a framed trestle.

Packing Block—A small member, usually of wood, used to secure the parts of a composite member in their proper positions.

Packing Spool or Separator—A small casting used in connection with packing bolts to secure several parts of composite member in their proper relative positions.

Southern Yellow Pine—Under this heading three classes of timber are used; (a) longleaf pine, (b) shortleaf pine, (c) loblolly pine.

Norway Pine—To cover what is known also as "red pine."

White Pine—To cover the timber which has hitherto been known as white pine, from Maine, Michigan, Wisconsin and Minnesota.

Idaho White Pine—The variety of white pine from Western Montana, Northern Idaho and Eastern Washington.

Western Pine—To cover the timber sold as white pine coming from Arizona, California, New Mexico, Colorado, Oregon and Washington. This is the timber some times known as "western yellow pine," or "ponderosa pine," or "California white pine," or "western white pine."

Ring—An iron band around the head of a pile to protect it from splitting or brooming.

Rot, Dote and Red Heart—Any form of decay which may be evident either as a dark red discoloration not found in the sound wood or by the presence of white or red rotten spits, shall be considered as a defect.

Redwood—To include the California wood usually known by that name.

Shoe—An iron point over the lower end of a pile.

Sill—The horizontal timber of a trestle bent on which the posts rest.

Sheeting or Sheathing—Plank or boards forming a wall or a diaphragm.

Sub-Sill—A timber bedded in the ground to support a framed bent.

Sway Braces—A member bolted or spiked to the bent and extending diagonally across its face.

Stringer—A longitudinal member, extending from bent to bent and supporting the ties.

Sash Brace—A horizontal member secured to the posts or piles of a bent.

Shim—A small piece of wood or metal placed between two members of a structure to bring them to a desired relative position.

Screw Pile—One having a broad-bladed screw attached to its foot to provide a larger bearing area.

Sheet Piles—Piles driven in close contact in order to provide a tight wall, to prevent leakage of water and soft materials, or driven to resist the lateral pressure of adjacent ground.

Sapwood—A cylinder of wood next to the bark and of lighter color than the wood within. It may be of uneven thickness.

Sound—Free from decay.

Solid—Without cavities, free from loose heart, wind shakes, bad checks, splits or breaks, loose slivers, and worm or insect holes.

Square Cornered—Free from wane.

Wind Shake—A crack or fissure, or a series of them, caused during growth.

Shakes—Shakes are splits or checks in timbers which usually cause a separation of the wood between annual rings.

Ring Shake—An opening between annual rings.

Through Shake—A shake which extends between two faces of timber.

Spruce—To cover eastern spruce, that is, the spruce timber coming from points of Minnesota.

Western Spruce—To cover spruce timber from the Pacific Coast.

Trestle—A bridge consisting of bents supporting a floor system. A frame trestle consists entirely of sawed timber. A pole trestle is made largely of round poles, none of which, however, are used as piles. A pile trestle has bents composed of piles.

Tie—A transverse timber resting on the stringers and supporting the rails.

Tamarack—To cover the timber known as "tamarack," or "eastern tamarack," from states east of and including Minnesota.

Wooden Trestle—A wooden structure composed of up-

right members supporting simple horizontal members or beams, the whole forming a support for loads applied to the horizontal members.

Wane—A deficient corner due to curvature or to taper of the log.

STANDARD SPECIFICATIONS FOR SOUTHERN YELLOW PINE BRIDGE AND TRESTLE TIMBERS.

(To be applied to single sticks and not to composite members.)

GENERAL REQUIREMENTS.

Except as noted, all timbers shall be sound, sawed to standard size, full length, square cornered and straight; shall be close grained and free from defects such as injurious ring shakes and cross grain, unsound or loose knots, knots in groups, decay, or other defects that will materially impair its strength.

Rough timbers sawed to standard size means that they shall not be over one-fourth ($\frac{1}{4}$) inch scant from the actual size specified. For instance, a twelve by twelve (12x12) inch timber shall measure not less than eleven and three-fourths by eleven and three-fourths ($11\frac{3}{4} \times 11\frac{3}{4}$) inches.

Standard dressing means that not more than one-fourth ($\frac{1}{4}$) inch shall be allowed for dressing each surface. For instance, a twelve by twelve (12x12) inch timber, after being dressed on four sides, shall measure not less than eleven and one-half by eleven and one-half ($11\frac{1}{2} \times 11\frac{1}{2}$) inches.

Standard Heart Grade, Longleaf Yellow Pine.

Stringers shall show not less than eighty-five (85) per cent heart on the girth anywhere in the length of the piece; provided, however, that if the maximum amount of sap is shown on either narrow face of the stringer, the average depth of sap shall not exceed one-half ($\frac{1}{2}$) inch. Knots greater than one and one-half ($1\frac{1}{2}$) inches in diameter will not be permitted at any section within four (4) inches of the edge of the piece, but knots shall in no case exceed four (4) inches in their largest diameter.

Caps and sills shall show not less than eighty-five (85) per cent heart on each of the four sides, measured across the sides anywhere in the length of the piece; to be free from knots over two and one-half ($2\frac{1}{2}$) inches in diameter.

Posts shall show not less than seventy-five (75) per cent heart on each of the four sides, measured across the sides anywhere in the length of the piece, and to be free

from knots over two and one-half (2½) inches in diameter.

Longitudinal Struts and Girts—One side shall show all heart; the other side shall show not less than eighty-five (85) per cent heart, measured across the side anywhere in the length of the piece, and shall be free from any large knots or other defects that will materially injure its strength.

Longitudinal X braces, sash braces and sway braces shall show four square corners and not less than eighty (80) per cent heart on two sides, and shall be free from any large knots or other defects that will materially injure their strength.

Ties and timber guards shall show one side all heart; the other side and two edges shall show not less than seventy-five (75) per cent heart, measured across the surface anywhere in the length of the piece; shall be free from any large knots or other defects that will materially injure its strength, and where surfaced the remaining rough side, or face, shall show all heart.

Standard Grade, Longleaf and Shortleaf Yellow Pine.

Stringers shall be square cornered, with the exception of one (1) inch wane on one corner or one-half (½) inch wane on two corners. Knots shall not exceed in their largest diameter one-fourth (¼) of the width of the surface of the stick in which they occur, and shall in no case exceed four (4) inches. Ring shakes shall not exceed over one-eighth of the length of the piece.

Caps and sills shall be square cornered, with the exception of one (1) inch wane on one corner, or one-half (½) inch wane on two corners. Knots shall not exceed in their largest diameter one-fourth (¼) of the width of the surface of the stick in which they occur, and in no case shall exceed four (4) inches. Ring shakes shall not extend over one-eighth (⅛) of the length of the piece.

Posts shall be square cornered, with the exception of one (1) inch wane on one corner, or one-half (½) inch wane on two corners. Knots shall not exceed in their largest diameter, one-fourth (¼) of the width of the surface of the stick in which they occur and in no case shall exceed four (4) inches. Ring shakes shall not exceed over one-eighth (⅛) of the length of the piece.

Longitudinal struts and girts shall be square cornered and sound, and shall be free from any large knots or other defects that will materially injure their strength.

Longitudinal X braces, sash braces and sway braces shall be square cornered and sound, and shall be free from any large knots or other defects that will materially injure their strength.

STANDARD SPECIFICATIONS FOR DOUGLAS FIR AND WESTERN HEMLOCK BRIDGE AND TRESTLE TIMBERS.

(To be applied to single sticks and not to composite members.)

Standard Heart Grade.

Standard heart grade shall include yellow and red Douglas fir and western hemlock. White Douglas fir will not be accepted.

GENERAL REQUIREMENTS.

All timber shall be live, sound, straight and close grained, cut square cornered, full length, not more than one-fourth (¼) inch scant in any dimension for rough timber or one-half (½) inch for dressed timber; free from large, loose or unsound knots, knots in groups, or other defects that will materially impair its strength for the purpose for which it is intended. Subject to inspection before loading.

Stringers shall show not less than ninety (90) per cent heart on each side and edge, measured across the surface anywhere in the length of the piece. Shall be out of wind and free from shakes, splits, or pitch pockets over three-eighths (¾) inch wide or five (5) inches long. Knots greater than two (2) inches in diameter will not be permitted within one-fourth (¼) of the depth of the stringer from any corner nor upon the edge of any piece; knots shall in no case exceed three (3) inches in diameter.

Caps, sills and posts shall show not less than eighty-five (85) per cent heart on each of the four sides, measured across the surface anywhere in the length of the piece. Shall be out of wind and free from shakes, splits, or pitch pockets over one-half (½) inch wide or five (5) inches long. Knots shall not exceed one-fourth (¼) of the width of the surface of the piece in which they occur and shall in no case exceed three (3) inches in diameter.

Longitudinal struts or girts, X braces, sash and sway braces shall show one side all heart, the other side and two edges shall show not less than eighty-five (85) per cent heart, measured across the surface anywhere in the length of the piece.

Ties and guard timbers shall show one side and one edge all heart, the other side and edge shall show not less than eighty-five (85) per cent heart, measured across the surface anywhere in the length of the piece.

Timbers for Howe truss chords shall show not less than ninety (90) per cent heart on each side and edge, measured anywhere in the length of the piece. Shall be out

of wind and free from shakes, splits, or pitch pockets over one-eighth ($\frac{1}{8}$) inch wide or three (3) inches long. Knots shall not be over one and one-half ($1\frac{1}{2}$) inches in diameter nor be closer together on each surface than one in any four linear feet, but if knots are one (1) inch or less in diameter, one in any three linear feet will be allowed.

Standard Grade.

Standard grade shall include yellow, red and white Douglas fir and western hemlock.

GENERAL REQUIREMENTS.

All timbers shall be sound and cut square cornered, except that timbers ten by ten (10x10) inches in size may have a two (2) inch wane on one corner or its equivalent on two or more corners. Other sizes may have proportionate defects. Must be free from defects which will impair its utility for temporary work. Knots shall not exceed one-fourth ($\frac{1}{4}$) the width of the surface of the piece in which they occur. Subject to inspection before loading.

Stringers, caps, sills and posts shall be out of wind, free from shakes or splits extending over more than one-eighth ($\frac{1}{8}$) of the length of the piece, or knots more than four (4) inches in diameter. Knots greater than three (3) inches in diameter will not be permitted on the edge of any stringer.

RULES GOVERNING MASTER CARPENTER.

The Master Carpenter shall report to and receive instructions from the Engineer Maintenance of Way.

The Master Carpenter shall have charge of the construction and maintenance of all bridges, buildings, water tanks, coal sheds, stock pens, track scales, etc., and they shall make temporary repairs of such defects as may endanger or delay the movement of trains, and report defective conditions to the Engineer Maintenance of Way.

They must make frequent inspections of structures and have necessary repairs made as promptly as conditions require.

They shall, as necessary, employ men for carrying out the duties for which they are responsible.

They must know that foremen are familiar with the operating rules in regard to train signals and flagging, and that they fully understand and comply with them. They shall co-operate with the Road Master in regard to the distribution of material, and call upon him whenever they require assistance.

They must, in case of damage to structures, promptly assemble forces, tools and materials, and make these repairs.

They shall investigate damage to structures, result-

ing from train accidents or other causes, and make prompt report to the Engineer Maintenance of Way.

They shall conform to the prescribed standards and plans in the execution of work under their charge.

They must know that foremen are supplied with tools and materials necessary for the efficient performance of their duties, and see that these are properly used and cared for.

They must not, except by proper authority, permit experimental trials of appliances or devices, nor give information of the results of any trial.

They shall keep themselves informed in regard to all work performed on bridges and structures in their districts by contractors, or others who do not come under their charge, see that nothing is done by them that will interfere with the safety of structures, and report promptly to the Engineer Maintenance of Way if the work is not done in accordance with the prescribed standards.

They shall have immediate supervision of work-train service for the maintenance of structures, and employ such service only when authorized by the Engineer Maintenance of Way.

They must know that foremen are provided with the rules, circulars forms and special instructions pertaining to their duties, and that they will fully understand and comply with them.

They shall see that all water barrel rests at all bridges and trestles are in repair and supplied with barrels and buckets, and that the stations and other structures are equipped with the necessary water barrels, buckets and other fire-fighting appliances.

They shall, in period of flood, observe and record the flow of water of the various streams passing under the track and report to the proper officer any case in which the openings seem insufficient.

RULES GOVERNING BRIDGE AND BUILDING

FOREMEN.

Bridge and building foremen shall report to and receive instructions from the Master Carpenter.

They shall be responsible for the proper inspection and safe condition of the structures under their charge and shall do not work thereon that will interfere with the safe passage of trains, except under proper protection.

They must make such inspections of the structures in their district as the Master Carpenter may direct, and report their condition on the proper form.

They shall employ men as the Master Carpenter directs. They must treat employees with consideration and see that they properly perform their duties. They must

discharge men who are incompetent or who neglect their duties, but in no case shall they discharge men without cause. They must keep the required records of the time of their men and of the materials used.

They must each have a copy of the current time table and be thoroughly familiar with the rules and regulations therein, and with the time of trains over their district. They must carefully observe signals displayed by all trains and assure themselves before obstructing track that all trains and sections due have passed. No notice will be given of extra trains and employees must protect themselves as prescribed by the rules.

Foremen must provide themselves with reliable watches and when possible verify time daily with a standard clock or with the watches of other employees who are required to have the standard time.

They must, in case of damage to structures in their districts, promptly proceed to the place with the men, tools and material at their command, and do all in their power to make the necessary repairs.

They must, in case of accident coming under their observation, report the facts to the Master Carpenter.

In event of a personal injury or a sudden illness of their men, while employed in their duties, they shall provide him with the proper orders for medical attention, and, if necessary, they shall summons the company physician to take care of the injured or sick man, making a report of same upon the printed forms furnished for that purpose.

They shall conform to the prescribed standards and plans in the execution of work under their charge.

They shall be responsible for the proper care and use of tools and material necessary for the efficient performance of their duties and shall make requisition to the Master Carpenter from time to time as additional supply becomes necessary.

They must not, except by proper authority, permit experimental trials of appliances or devices, nor give out information of the results of any trial.

RULES GOVERNING BRIDGE WATCHMEN.

Bridge watchmen shall report to and receive their instructions from the Master Carpenter.

They must keep a supply of water upon the bridges at close intervals, and must go over the bridges under their charge after the passing of each train, and carefully examine same, they shall also make frequent examinations of the entire structure and report any defects to the Master Carpenter and bridge and building foreman, making minor repairs themselves when possible.

If a bridge watchman considers that a bridge from any cause is unsafe for the passage of trains, he shall take every precaution to prevent trains from crossing and report unsafe condition to the train dispatcher, the Master Carpenter and the bridge and building foreman without delay.

They must keep the coping of the abutments and the piers clean, and see that all drift and combustible matter are removed from the bridges so as not to obstruct the passage of water or endanger the bridge by fire.

They must prevent all persons, except employees, from crossing the bridges.

Where special rules are given for the reducing speed of trains over bridges under his charge, the bridge watchman shall report any violation of such speed rules to the Master Carpenter, giving date and direction of train, number of motor or engine, and rate of speed.

When their time is not wholly occupied by watching they will be required to attend to such other duties as the Master Carpenter may direct.

Draw-bridge watchmen shall be governed by rules relative to bridge watchmen and shall in addition pay particular attention to special signal rules for draw bridges.

The laws of the State of Illinois require all trains to come to a full stop before reaching a draw span and not to cross the same until signaled to do so by the bridge watchman.

Draw-bridge watchmen shall promptly report to the Master Carpenter any violation of this rule, giving date, direction of train and number of motor car or engine.

RULES FOR BRIDGE AND BUILDING INSPECTION AND REPORTS.

Daily inspection shall be made by track forces as elsewhere herein specified.

A monthly inspection of all timber bridges shall be made by bridge and building foreman. He shall report, in writing, on proper form, all derangements and defects and in case immediate repairs are needed, shall so notify the Master Carpenter, without delay, giving, if required, a list of such material as will be needed for immediate repairs.

It shall be the duty of the bridge and building foreman, making the monthly inspection, to dig around the pile and timber bents to show indications of decaying, and chop away all decayed material to its full depth, leaving the earth excavated so that the Master Carpenter may determine the extent of the decay without labor. This work shall be done once each year in time for the spring

inspection by the Master Carpenter. The foreman may take such laborers with him for this purpose as are necessary. Particular attention must be paid to the caps and every cap which shows any signs of decay or weakness shall be bored or otherwise thoroughly explored. This monthly inspection may be done by the bridge foreman in the course of other work over the bridges.

All bridges carrying traffic of the company shall be inspected at least semi-annually by the Master Carpenter in person. All other bridges and all culverts maintained by or at the expense of the company shall be inspected at least annually by the Master Carpenter in person.

The notes of these inspections shall be kept in bridge inspection note books and shall show the condition of every bridge and culvert in both main and side tracks.

Enter in this book the length and height (ground surface to top of tie at greatest height) of all bridges; enter culverts and overhead bridges between the proper waterway numbers, showing the length, width and height of all overhead bridges and the length, width and height of all overhead bridges and the length, width and height of box, timber culverts, stone or concrete box, stone or concrete arch, brick arch, iron or concrete or tile pipe, etc., as the case may be.

Where the structure is in good condition, requiring no repairs for one year, it will be sufficient to mark O. K. in columns "Condition of Structure." Where structure requires repairs or renewals within one year enter into notes a concise statement of condition of various parts of the structure, the piles, trestle bents, caps, stringers, ties, etc. At truss bridges, note the condition of the various members, the camber, alignment, etc., of the trusses. Note whether the waterways need cleaning out or straightening or whether any rip-rapping is required.

The notes of the fall inspection must show material required for repairs or renewals in the ensuing year, measurements being made for the length of piles or timbers required, and where the ground is soft, soundings taken and notes recorded.

Where the structure requires renewal or extensive repairs, the notes must show whether any filling in can be done, stating what kind and size of opening is required to carry the water. In this connection, note whether the structure is used as a cattle pass or under crossing for teams. In case of wooden culverts requiring renewals, show what size and length of pipe or other permanent structure will be required to carry the water, also show the approximate height of embankment at point where culvert is located. Note whether pipe can be placed inside of wooden culvert or whether it is necessary to ex-

cavate down from top of roadbed in order to place the pipe.

A copy of the notes of fall inspection as made by the Master Carpenter must be made and forwarded to the Engineer Maintenance of Way as soon as possible after the inspection is completed.

Spring inspection shall be made as early as possible and the notes of same should show whether the work outlined is sufficient to keep the structure in safe condition until the following spring.

A copy of notes of spring inspection as made by the Master Carpenter must be made and forwarded to the Engineer Maintenance of Way as soon as possible after inspection is completed.

Enter stations and mile posts so that all bridges and culverts will show between what stations and mile posts they are located.

A condensed report of the fall inspection shall be made by the Master Carpenter, showing every bridge or culvert upon which it will probably be necessary to spend any money during the year succeeding the one in which the inspection was made, with the recommendation of the Master Carpenter thereupon.

Copies will be sent out by the Engineer Maintenance of Way to assistant engineers for information as to the drainage, cattle pass and crossing contracts, etc., which information shall be sent to the Engineer Maintenance of Way as soon as possible.

Whenever possible, Master Carpenter will show on this report the cost of carrying over or repairing such bridge and culverts as are reported, with the length of time for which such repairs will make this structure safe.

The Master Carpenter and bridge building foreman shall be provided with the following tools in making inspection of structures:

- Fifty foot tape line.
- Plumb-bob and line.
- Two foot rule.
- Hatchet.
- Brace and bit.
- Monkey wrench.
- Small broom.
- Small riveting hammer.
- Necessary paint pots, brushes and stencil.
- Note book for inspection notes in the field.

The inspector shall carefully examine all timbers and piling, and its condition as to soundness, cracks or flaws noted. The condition of piles or posts near the surface of the ground or water line will be particularly observed.

See if the bents are plumb, and if the stringers have a

full bearing on the caps, and the caps on the piles or posts.

See if the bridge is in good line and surface and if the foundations or supports are solid and unyielding.

See if sway bracing is well bolted and spiked.

See if bank walls and supports are in good condition and if earth or ballast is kept away from ends of stringers and wall plates.

See that bolts, nuts and washers are in their proper places.

Give the same care and attention to the woodwork of iron bridges as is given wooden bridges and see that the rollers and bed plates of iron bridges are kept free from dust, cinders or other materials.

All the rivets of steel bridges must be tried every inspection and the loose ones replaced on all truss bridges. The adjustable diagonals and the counters must be subject to test and the tension ascertained. If it is found that they are not equally taut, the adjustable diagonals shall be tightened and adjusted at the turn buckles until the correct amount of tension remains in the bar.

If it is found that laterals rub one another, causing a wear, a piece of split rubber hose shall be wrapped around the rod at point of wear; sometimes it may be found necessary to insert a spreader between laterals to prevent this wear and to assist in tightening lateral. Laterals must not be too loose but too heavy strains must not be put on them.

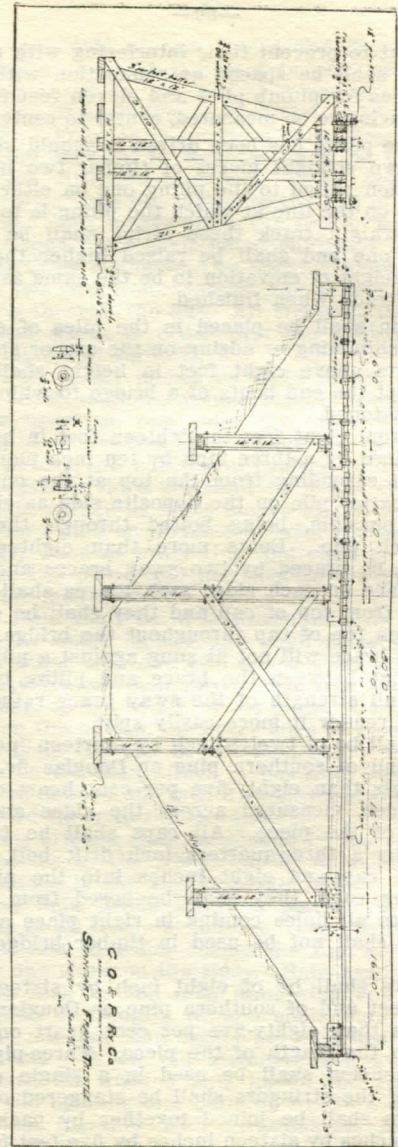
Watch the action of truss spans under moving trains and report any undue lateral or vertical movement.

The condition of the paint on all bridges shall be carefully inspected and any rust scale that is forming shall be removed and notes should show the approximate number of gallons of paint required for the structure.

Report holes or defects in platforms, broken glass (with size), condition of stock yard fences, gates, chutes, section houses, stations, shops and other buildings, being careful to note condition of electric wiring, heating apparatus, attics and flues.

WOODEN BRIDGES.

Pile trestles shall consist of four piles per bent, the two inside piles are called plumb piles, while the outer ones are called batter piles. Plumb piles shall always be driven plumb. When a bent does not exceed the height of 15 feet, the outer piles may be driven plumb. When the bent is higher than fifteen feet the outer piles shall be driven on a batter of at least two and one-half inches per foot of height. Care shall be taken when driving piles to see that all curves in piling are placed in line



Frame Trestle.

with the bent to prevent their interfering with sway bracing. Piling shall be spaced at connection with cap four feet six inches for plumb piles and eleven feet for the batter piles, spacing to be measured, center to center of piling.

After the piling has been driven it should be drawn to place and two straight pieces of timber two inch by six inch dimension nailed to the piling one on either side, the upper edges on the line at which the piling is to be sawed. When on straight track these strips shall be level, but on a curve one end shall be raised higher than the opposite, the height of elevation to be the same as the elevation of the track when finished.

Elevation shall be placed in the piles of all trestles and not by shimming or adzing on the cap or stringers.

All bents above eight feet in height shall be sway braced except the end bents of a bridge to which the bulk heads are fastened.

Bents from eight feet to eighteen feet in height shall be sway braced by a three inch by ten inch plank on each side of bent extending from the top at the outer end of cap to the batter pile on the opposite side as close to the ground as possible, being bolted through the cap and through each pile. Bents more than eighteen feet in height shall be braced by two sway braces and one sash or collar brace on each side; sash braces shall be placed eleven feet from top of cap and they shall be of uniform distance from top of cap throughout the bridge.

When a brace will not fit snug against a piling, blocks should be put between the brace and piling in order to retain the full strength of the sway brace rather than to bend it and render it more easily split.

Caps shall be of twelve inch by fourteen inch by fourteen feet, and of southern pine or Douglas fir, and shall not show less than eighty-five per cent heart on each of the four sides, measured across the sides anywhere in the length of the piece. All caps shall be fastened to the piling by a three-quarters inch drift bolt, extending through the cap and eight inches into the piling head. When boring caps, they shall be bored from bottom of cap to insure all holes coming in right place on piling.

Corbels shall not be used in timber bridge construction.

Stringers shall be of eight inch by sixteen inch by thirty-two feet and of southern pine or Douglas fir, showing not less than eighty-five per cent heart on the girth anywhere in the length of the piece. Three-ply stringers of this dimension shall be used in a single chord, and the joints of the stringers shall be staggered on the cap. All stringers shall be joined together by packing or tie block four inches by sixteen inches by five feet four inches,

placed on each side of each chord and dapped over the cap two inches to hold the bent in position. Stringers shall be separated by the use of a packer or separator spool, one and one-half inches in thickness by three inches in diameter. Four three-quarters inch chord bolts and three-quarters inch O. G. washers shall be used at each joint to pack stringers together. These bolts shall not be placed closer than ten inches to the end of the stringer nor less than four inches from the top or bottom of the stringer. Chord bolts shall be of sufficient length to go through the three stringers, two packing blocks, two packing spools, two cast iron washers, and extend at least one-quarter inch through the nut. All stringers must be sized to a uniform width in order that the deck may get an equal bearing on all surfaces.

Ties shall be six inches by eight inches by ten feet, and shall be of southern yellow pine or Douglas fir and shall show heart on one side; the other side and two edges shall show not less than seventy-five per cent heart, measured across the surface any place in the length of the piece. Every third tie shall be a key tie. Key ties shall be eight inches by eight inches by ten feet and shall be of southern pine or Douglas fir with the same percentage of heart wood as other ties, and shall be dapped two inches over the chord and attached to the guard rail by three-quarter inch bolts.

Guard rails shall be of southern pine or Douglas fir, six inches by eight inches, and shall show one side all heart; the other side and two edges shall show not less than seventy-five per cent heart, measured across the surface anywhere in the length of the piece. Guard rails shall be placed on top of ties, the outer edge of guard rail being six inches from the end of the ties, in no instance shall guard rails be less than fifteen inches from the rail. Guard rails shall be dapped one inch over ties and shall be bolted to every third tie or to the key ties.

Rails on bridges shall be spiked in the same method as other places in the track, but in no instance shall a spike be placed in the slot of a rail joint.

Wooden bulk heads shall be placed on the end or dump bents of all frame structures, these bulk heads shall be fourteen feet in width across the top with a one and one-half to one slope on the sides. Bulk head timber shall be of three inch by ten inch dimension and shall be of southern pine or Douglas fir and shall show four square corners and not less than eighty per cent heart on each of the two sides. When old stringers are available they shall be used for wooden bulk heads and started at the bottom of the opening and built up to the top of the ties, drifting them together with three-quarter inch bolts as they are built up.

Piling shall be painted eighteen inches above and below the ground line with a creosote oil preservative. In no case shall paint or any preservative treatment be used on any wet or green lumber, as it is not so much the dampness that causes the decay as it is the non-circulation of atmosphere, and a preservative applied to wet or green timber fills the pores and renders it difficult for the timber to thoroughly dry out.

The construction of frame trestles shall be similar to the construction of a pile trestle except that posts shall be used in the bents instead of piles.

Frame trestles shall be built upon concrete piers wherever possible, which piers shall extend at least eighteen inches above the ground line. A mud sill six inches by twelve inches shall be placed on this pier and anchored thereto by use of three-quarter inch bolts. Short sills being anchored by the use of two bolts and longer ones by the use of three bolts. The sill shall be placed upon the fresh concrete as soon as the pier is brought to the top and shall be leveled. All posts shall be fastened to the mud sill with three-quarter by twelve inch drift bolts which shall extend six inches into the sill. Plumb posts may be drifted when set up, but it is best to let the drifts of batter posts go until after cap is put in place, as a little crown in cap or sill may throw the batter posts a little long or short, in such case the post, if not too long, may be moved out a little at the bottom, or vice versa. The above may apply in placing braces on frame bridges, nuts should be placed on the brace side as otherwise the entire bolt must be taken out when cap is to be placed.

All timber in pile and frame bridges shall be rough sawn and not dressed. The following specifications shall generally apply wherein the foregoing rules are not specific.

SPECIFICATIONS FOR PILING AND WORKMANSHIP.

All piles shall be made from white oak and burr oak timber.

Pile shall be cut from sound trees; shall be close grained and solid, free from defects, such as injurious ring shakes, large and unsound and loose knots, decay or other defects, which may materially impair their strength or durability.

Piles must be cut above the ground swell, and have a uniform taper from butt to tip. Short bends will not be allowed. A line drawn from the center of the butt to center of the tip shall lie within the body of the pile.

Unless otherwise allowed, piles must be cut when

sap is down. Piles must be peeled soon after cutting. All knots shall be trimmed close to the body of the pile.

For round piles, the minimum diameter at the tip shall be nine inches for lengths not exceeding thirty feet; eight inches for lengths over thirty feet, but not exceeding fifty feet, and seven inches for lengths over fifty feet.

The minimum diameter at one-quarter of the length from the butt shall be twelve inches, and the maximum diameter at the butt twenty inches.

For square piles, the minimum width of inside of the tip shall be nine inches for lengths not exceeding thirty feet; eight inches for lengths over thirty feet but not exceeding fifty feet, and seven inches for lengths over fifty feet. The minimum width of any side at one-quarter of the length from the butt shall be twelve inches.

Square piles shall show at least eighty per cent heart on each side on any cross section of the stick, and all round piles shall be at least ten and one-half inches in diameter at the butt.

Piles shall be carefully selected to suit the place and ground where they are to be driven. When required by the engineer, pile butts shall be banded with iron or steel for driving, and the tips with suitable iron or steel shoes; such shoes will be furnished by the railroad company.

Piles shall be driven to a firm bearing, satisfactory to the engineer or until five blows of a hammer weighing 3,000 lbs., falling fifteen feet (or a hammer and fall producing the same mechanical effect) are required to cause an average penetration of one-half (1/2) inch per blow, except in soft bottom, where special instructions will be given.

Batter piles shall be driven to the inclination shown by the plans and shall require but slight bending before framing.

Butts of all piles in a bent shall be sawed off to one plane and trimmed so as not to leave any horizontal projection outside of the cap.

Piles injured in driving, or driven out of place, shall either be pulled out or cut off and replaced by new piles.

Caps shall be sized over the piles or posts to a uniform thickness and even bearing on piles or posts. The side with most sap shall be placed downward.

Posts shall be sawed to proper length for their position (vertical or batter) and to an even bearing on cap and sill.

Sill shall be sized at the bearing of posts to one plane.

Sway bracing shall be properly framed and securely

fastened to piles or posts. When necessary for pile bents, filling pieces shall be used between the braces and the piles on account of the variation in size of piles and securely fastened and faced to obtain a bearing against all piles.

Longitudinal X braces shall be properly framed and securely fastened to piles or posts.

Girts shall be properly framed and securely fastened to caps, sub-sills, posts or piles, as the plans may require.

Stringers shall be sized to a uniform height at supports. The edges with most sap shall be placed downward.

Jack stringers, if required on the plans, shall be neatly framed on caps and their tops shall be in the same plane as the track stringers.

Ties shall be framed to a uniform thickness over bearings and shall be placed with the rough side upward. They shall be spaced regularly, cut to even length and line as called for on the plans.

Guard timbers shall be framed as called for on the plans, laid to line and to a uniform surface. They shall be firmly fastened to the ties as required.

Bulkheads shall be of sufficient dimensions to keep the embankment clear of the caps, stringers and ties at the end bents of the trestle. There shall be a space of not less than two (2) inches between the back of the end bent and the face of the bulkhead. The projecting ends of the bulkhead shall be sawed off to conform to the slope of the embankment, unless otherwise specified.

In the building and repairing of timber bridges the following is suggested for handling work efficiently:

In placing ties on a structure, after the spikes have been pulled in the ties that are to be replaced, the rails should be raised by track jacks, one rail raised only enough to clear the ties, while the other rail is raised two inches higher. To take out the old tie, slip it endways until it passes the low rail, when it can then be raised over low rail and slipped back from under high rail, and taken entirely out. Place new tie under the high rail first and then slide it back under the low rail to place.

To replace a cap, take the braces off of the bent and build a scaffold about four feet below the stringers to enable the men to work without cramping, and to make a short lift in placing the new cap. When the scaffold is placed, a block should be attached to a post to set the jack on so that cap may be raised and drift bolts cut. Each block shall be fastened to post or pile with a large clevis made of one and one-half inch round iron, and made large enough to reach around the average post or pile and a six inch wedge-shaped block; the pressure from the

jacks keeping the wedge block so tight that the clevis cannot slip down. A three inch plank should be bolted to each post to hold them in their right position or this plank may be replaced by a six inch by eight inch timber, in which case it may be placed a sufficient distance below the stringers to allow a jack to set on it to lift the chord while the change is made of the cap.

The stringers should also be raised at least one and one-half inches to insure easy work in taking out old cap and putting in new one. Stringers should be framed on racks built along side of the track at the end of the bridge, placing the stringers on the racks in the same position as they are to be when in the bridge.

The crowns or tops should be placed from the track and made flush with each other. This will always allow the getting of the inside stringer off the pile first.

In this position, the stringers should be bored, and when taken down, each stringer must be sized to a certain width, and the thickness must be the same at all holes, which can be done by adzing and running a rule through the hole to measure. If this is not done the stringers will not be the same when packed up and it is impossible to put a tight packing block on the outside or inside of the chord. A forked, bent wire is a good tool to hold packing spools in place while bolt is put in.

After all ties have been properly spaced on the deck, the timber guard should be laid on its side at the exact spot where it belongs and marked for the daps at each tie, this assures having all daps fit at their individual places, as all ties vary in width. The timber guards should extend at least four inches over last tie at ends of bridge and should be rounded one-quarter and slightly sloped.

All ties shall be framed in the material yard and a wooden template shall be used for marking the daps in the ties. The template shall be made of a one inch by six inch board and shall be laid off from the center, thereby doing away with any confusion in the daps if the tie is turned end for end when being placed in the structure. Mark one side of the tie, then square across the bottom and mark the other side with the template or pattern.

When placing ties at the end of the bridge always pull spikes in the track ties on the dump for a distance of about ten feet; this will allow the rail to go back to place when let down, otherwise, if spikes are not pulled, the ties will raise and ballast run under them, which will cause bad surface at the end of the bridge. On a steel bridge or where hook bolts are used, it is better to pull spikes out of good ties than to loosen hook bolts.

On replacing old stringers, take out old bolts and drifts, and be sure stringers are entirely loose; then place screw jack under a tie on each cap just inside of the stringers or lift ties with a track jack about four inches and place block between the cap and tie. Investigation should be made that all ties are well spiked to the rails, as a loose tie might fall with a man's weight on it. Fasten a rope around the ties at each end of the stringer and run the rope over the timber guard, then under the stringer, and up to the top of the deck outside of the stringer; by pulling on loose ends of rope, the stringer will roll out top of the bridge deck. Take out enough stringers to admit a new one after which leave the ropes as first arranged and roll the new stringer on them; take a snub around the tie with the loose ends of the rope and slack the stringer on to the caps, after which it can be placed in position with a timber bar.

When all stringers are in, take a jack at one end and jack stringers endways to place, instead of using a bar on top, as it is much quicker and does not mar the stringer. When possible, all chord bolts should be put in from the inside, then in case an outside stringer is broken the bolt can be slipped back to clear it, the broken one taken out and the new one put in place; then strike the bolts with a sledge which will make an indentation on the new stringer, turn the new stringer flat and bore it at the indentation.

When jacking stringers or caps, never allow the weight of a train or car on the bridge so that the load comes upon the jacks. The jacks shall always be removed and timber blocking placed to uphold the load.

Never leave a saw in a stick of timber while a train passes over the structure as the vibration is apt to break the saw or take the set out of the teeth.

When a bridge is low and ties are of an even thickness, never shim on top of ties or between stringers and ties, but always raise stringers and shim on the cap.

Care shall be taken that all ties have an even bearing on stringers or the stringer is liable to be broken.

No bulk-head on any bridge shall be to exceed eight feet in height.

SPECIFICATIONS FOR PORTLAND CEMENT.

General Conditions.

All cement shall be inspected.

Cement may be inspected either at the place of manufacture or on the work.

In order to allow ample time for inspecting and testing, the cement should be stored in a suitable weather-tight building having the floor properly blocked or raised from the ground.

The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

Every facility shall be provided by the contractor and a period of at least twelve days allowed for the inspection and necessary tests.

Cement shall be delivered in suitable packages with the brand and name of manufacturer plainly marked thereon.

A bag of cement shall contain ninety-four pounds of cement net. Each barrel of Portland cement shall contain 4 bags of the above net weight.

Cement failing to meet the seven-day requirements may be held awaiting the results of the twenty-eight day test before rejection.

All tests shall be made in accordance with the methods proposed by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the Society January 21, 1903, and amended January 20, 1904, and January 15, 1908, with all subsequent amendments thereto.

The acceptance or rejection shall be based on the following requirements:

Portland Cement.

Definition—This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials and to which no addition greater than three per cent has been made subsequent to calcination.

Specific Gravity.

The specific gravity of cement shall not be less than 3.10. Should the test of cement as received fall below this requirement a second test may be made upon a sample ignited at a low red heat. The loss in weight of the ignited cement shall not exceed 4 per cent.

Fineness.

It shall leave by weight a residue of not more than eight per cent on the No. 100 and not more than twenty-five per cent on the No. 200 sieve.

Time of Setting.

It shall not develop initial set in less than thirty minutes, and must develop hard set in not less than one hour, nor more than ten hours.

Tensile Strength.

The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

Neat Cement.

Age.	Strength.
24 hours in moist air	175 lbs.
7 days (1 day in moist air, 6 days in water)	500 lbs.
28 days (1 day in moist air, 27 days in water)	600 lbs.
One part cement, three parts Standard Ottawa Sand.	
7 days (1 day in moist air, 6 days in water)	200 lbs.
28 days (1 day in moist air, 27 days in water)	275 lbs.

Constancy of Volume.

Pats of neat cement about three inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(a) A pat is then kept in air at normal temperature and observed at intervals for at least 28 days.

(b) Another pat is kept in water maintained as near 70 degrees F. as practicable and observed at intervals for at least 28 days.

(c) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

These pats, to satisfactorily pass the requirements, shall remain firm and hard and show no signs of distortion, checking, cracking, or disintegrating.

Sulphuric Acid and Magnesia.

The cement shall not contain more than 1.75 per cent of anhydrous sulphuric acid (SO₃), nor more than 4 per cent magnesia (MgO).

If shall leave by weight a residue of not more than 1.75 per cent on the 100 mesh and not more than 1.75 per cent on the 200 sieve.

MATERIALS REQUIRED FOR ONE CUBIC YARD OF RAMMED CONCRETE.

Proportions	A—Broken Stone Screened to Uniform Size			B—Broken Stone with Dust Screened Out.			C—Gravel, or Stone and Gravel Mixed		
	Cement	Sand	Stone	Cement	Sand	Stone	Cement	Sand	Gravel
	cu. yds. loose	cu. yds. loose	cu. yds. loose	cu. yds. loose	cu. yds. loose	cu. yds. loose	cu. yds. loose	cu. yds. loose	cu. yds. loose
1 1.0 2.0	2.85	0.40	0.80	2.73	0.38	0.77	2.62	0.37	0.74
1 1.0 3.0	2.34	0.33	0.99	2.22	0.31	0.94	2.12	0.30	0.90
1 1.5 3.0	2.09	0.44	0.88	2.00	0.42	0.84	1.91	0.40	0.81
1 1.5 4.0	1.80	0.38	1.01	1.71	0.36	0.96	1.63	0.34	0.92
1 2.0 3.5	1.76	0.49	0.87	1.68	0.47	0.83	1.61	0.45	0.79
1 2.0 4.0	1.65	0.46	0.93	1.57	0.44	0.83	1.50	0.42	0.84
1 2.0 4.5	1.55	0.44	0.98	1.48	0.42	0.94	1.41	0.40	0.89
1 2.0 5.0	1.47	0.41	1.03	1.39	0.39	0.98	1.32	0.37	0.93
1 2.5 3.5	1.62	0.57	0.80	1.55	0.55	0.76	1.49	0.52	0.73
1 2.5 4.0	1.52	0.54	0.86	1.46	0.51	0.82	1.40	0.49	0.79
1 2.5 5.0	1.37	0.48	0.96	1.30	0.46	0.92	1.24	0.44	0.87
1 2.5 6.0	1.24	0.44	1.05	1.17	0.41	0.99	1.11	0.39	0.94
1 3.0 4.0	1.42	0.60	0.80	1.36	0.57	0.77	1.30	0.55	0.73
1 3.0 5.0	1.28	0.54	0.90	1.22	0.52	0.86	1.17	0.49	0.82
1 3.0 6.0	1.16	0.49	0.98	1.11	0.47	0.94	1.05	0.44	0.89
1 3.0 7.0	1.07	0.45	1.05	1.01	0.43	0.99	0.96	0.40	0.95
1 4.0 6.0	1.04	0.59	0.88	0.99	0.56	0.84	0.95	0.54	0.80
1 4.0 7.0	0.96	0.54	0.95	0.92	0.52	0.91	0.88	0.50	0.87
1 4.0 8.0	0.90	0.51	1.01	0.85	0.48	0.96	0.81	0.46	0.91
1 4.0 9.0	0.84	0.47	1.06	0.80	0.45	1.01	0.76	0.43	0.96

NOTE—The voids in stone approximate 50% in column A, 45% in column B, and 40% in column C. Use column B for estimating where the nature of the stone to be used cannot be determined. The above quantities may be affected as much as 10% either way by irregularities in the fineness of the sand and manner of laying the concrete. The capacity of the average cement barrel is 3.8 cubic feet.

Portland cement should be of a dull bluish or greenish gray color. Any variation from this color indicates some degree of impurity. If cement possesses too much of a brownish color the indications are that an excess of clay was used in proportioning the ingredients; and, if

a yellow color is present, it indicates usually that the materials were insufficiently burned.

All empty cotton cement sacks are redeemed by the manufacturers at a certain price and care must be taken not to cut or tear them. Care should also be used to keep empty sacks in a dry place until a sufficient quantity has accumulated to warrant returning them. The sacks should be carefully shaken out, neatly piled and tied in bundles containing the same number of sacks in each bundle.

When cement is received at the locality where it is to be used and it is necessary to store it for some time, precaution should be taken to protect the material from moisture. Sacks of cement should never be piled upon the ground. Blocks of some kind should be laid on the ground and planks placed on these blocks to form a rough floor a sufficient distance from the ground to keep the cement from absorbing moisture. Whenever cement that has been stored for any length of time is opened for use all hard lumps should be rejected, as this is an indication of a change having taken place in the material, which destroys its efficiency as a cementing medium.

In concrete, sand is usually called the fine aggregate. Fine stone screenings are frequently employed when available instead of sand, as the fine aggregate of a concrete mixture.

Sand shall possess the quality of "sharpness," which means having a roughly fractured surface, sand which is to be used for concrete mixtures must be practically free from loam or clay. Sand from river beds usually acquire more or less of a smooth surface, as a result of the continual agitation caused by the water, and therefore, not fitted for concrete work.

Sand may be tested for the presence of clay or loam by pressing the sand between the fingers while it is damp. If the sand is reasonably clean, only a little will stick to the fingers, the remainder immediately falling apart when the pressure is removed. The sharpness of sand can be approximately judged by holding a part of the handful near one's ear and rubbing or crushing it, and noting whether a grating sound is produced.

While sand which is to be used as a part of the aggregate for a mass of concrete should, if possible, possess the quality of sharpness, this feature is not nearly so important as having the particles of which the sand is composed of graduated sizes; that is, ranging from moderately fine grains to moderately coarse ones, or, to be more exact, the particles should range from one twenty-fourth to one-eighth of an inch in diameter. This graduated assortment of sizes in the particles of sand insures that there will be

fewer voids, and consequently a more dense concrete mixture.

The coarse aggregate of a concrete mixture may be either gravel or broken stone or a mixture of both.

Gravel shall be sharp and clean and free from vegetable matter, loam or clay.

The coarse aggregate shall be retained on a screen having one-fourth inch diameter holes, and where concrete is used in a mass, the maximum of the coarse aggregate may be such as to pass a three inch ring. For reinforced concrete a size to pass a one inch ring or a smaller size may be used. Gravel which is to be used as an aggregate for concrete should consist of pebbles of graded sizes, similar to the graduation of the sizes spoken of for sand so that the percentage of voids in a given bulk will be reduced to a minimum.

Broken trap-rock of graduated sizes is the best aggregate for concrete work. The next in value is broken granite. Cement will adhere well to the clean, round pebbles of gravel, but it will adhere much better to the fractured surfaces of crushed stone and granite.

Crushed lime-stone and most granites are not desirable aggregates if it is desired to have the resulting concrete resist fire effectively on account of the change which such rock undergoes when exposed to heat. In fire-proof construction trap-rock and crushed slag make the best aggregates for walls and partitions which must be both strong and fire resisting.

The water used in mixing concrete shall be free from oil, acid, strong alkalies or vegetable matter.

The metal reinforcement for concrete shall be a mild steel such as fills the specifications for structural steel of the American Railway Engineering and Maintenance of Way Association.

If steel of higher elastic limit is used it must be of first-class quality and subjected to special tests even if used at the same working stress as mild steel. It should be required to pass the following test:

Test specimens for bending shall be bent cold under the following conditions without fracture on the outside of the bent portion:

Around twice their own diameter: 1 inch diameter, 80 degrees; 3/4 inch diameter, 90 degrees; 1/2 inch diameter, 110 degrees.

Around their own diameter: 1/4 inch diameter, 130 degrees; 3-16 inch diameter, 140 degrees; 1/8 inch diameter or less, 180 degrees.

The reinforcement should be free from rust, scale or coatings of any character which would tend to reduce or destroy the bond.

The materials to be used in concrete shall be carefully selected of uniform quality and proportioned with a view to securing as nearly as possible a maximum density.

Concrete will generally be made, by measure, in the following proportions: For reinforced floors, beams and columns, for arches, for reinforced engine or machine foundations subject to vibration, for tanks, sewers, conduits and other water-tight work, the proportions shall be one part Portland cement, two parts sand, and four parts stone.

A medium mixture for ordinary machine foundations, retaining walls, abutments, piers, thin foundation walls, building walls, ordinary floors, side walks and sewers with heavy walls; the proportions shall be one part Portland cement, two and one-half parts sand and five parts broken stone.

In the mixing of concrete accurate measurements are of the greatest importance. Not only shall the cement and aggregates be accurately measured, but successive batches of concrete can be made much more uniform in consistency if the water used is accurately measured and this can better be done by using a definite number of pailfuls with each batch of known volume.

Tight platforms should be provided for mixing and these platforms should be of sufficient size to accommodate the men and materials required for the convenience and rapid mixing of at least two "batches" of concrete at the same time. Where possible to do so, the platforms shall be arranged convenient to the point where the concrete is to be deposited so that the mixture will not have to be wheeled or moved any considerable distance from the point where mixing is carried on, because concrete must be deposited as soon after mixing as possible. Batches mixed by hand should not exceed one cubic yard and smaller ones are preferable.

One-half yard and one yard batches can be more accurately measured by the use of a box form built to the proper dimensions, into which form the cement aggregates are placed and the form then removed for the mixing.

The cement and sand shall be spread upon a platform and mixed and tempered with water, and then stone which has previously been wetted shall be added and the whole batch thoroughly mixed with the stone by turning the whole mass over and over. In wetting the mixture of sand and cement to make the mortar and in wetting the mixture of stone, sand and cement, the water must not be dashed upon the mass from buckets or in large quantities. Concrete should be mixed sufficiently dry so as not to quake in ramming, but should show water on the surface when it has been thoroughly rammed in position, where

it should be placed with shovels or barrows in layers not exceeding eight inches thick. If, after ramming, water does not show on the surface, that batch of cement must be rejected and cast out of the forms and not again used. No concrete or mortar shall be used after it has attained or is about to attain its initial set.

In mixing concrete the entire mass shall be turned over with shovels at least four times until the broken stone has been so thoroughly mixed with the mortar that each piece of stone is entirely coated with it and the whole mass has a uniform color.

Small jobs shall usually be mixed by hand mixing, but whenever the quantity of concrete to be placed will justify the installation of a machine mixer same shall be installed.

In mixing with a machine, a special care shall be taken that the materials are used in their proportions. In certain types of continuous mixers, the cement source of supply is apt to become clogged, allowing no cement in the mixing barrel. This may be equally true of the coarse aggregate supply. For this reason, it is preferable to use a batch mixer rather than a continuous mixer.

It shall be the duty of the foreman and inspector to carefully and continually observe the mixture and see that same is properly proportioned. If the concrete is not properly proportioned or the material is not as specified, the work shall be stopped immediately and not proceeded with until these matters are rectified.

All concrete work shall be cast in molds or forms, constructed of metal or lumber, above the surface of the ground; sometimes below the ground, concrete can be deposited in a foundation trench without using any specially constructed form or mold.

Lumber which is to be used for concrete form construction shall be neither green nor kiln-dried. Fairly well air seasoned lumber is the best. For all finished concrete surfaces that are to be exposed to the view when the forms are removed, the lumber used in form construction shall be planed on one side, the planed side being the one against which the concrete is rammed in order to secure a surface having a finished appearance. The lumber used shall be free from knots and shall be thick enough to withstand the ramming of the concrete so that the forms will not bulge out of line and cause the finished work to have an irregular surface. For foundation work and for finished surfaces which are not to be exposed to view, planed lumber is not necessary, although it may sometimes be more economical to use it, as the labor required to clean the forms each time after use will be considerably lessened.

Anchorage bolts shall be held in a templet until they

are properly embedded in the concrete. They shall be held at the proper height by a "sleeve" of pipe between the nut and the head of the bolt and the piece of board or trestle in which they are placed.

Concrete should always be deposited in layers, which, when rammed, should not exceed six inches in thickness and as dumped into the forms should be leveled off so that when tamped, each layer deposited will lie practically horizontal or level. Wet mixtures of concrete will partially flow into place, and, therefore, require less tamping than dry mixtures. A rammer used for compacting the concrete shall be constructed of a six inch by eight inch by twelve inch block with a handle set in one end and a cross bar placed in the end of the handle which will allow two men to wield it. Where a rammer of this size cannot be used, a smaller rammer shall be constructed, preferably of steel in order to secure the weight needed to perform a thorough job of ramming.

One layer of concrete shall be entirely compacted before beginning to deposit another layer. If the concrete is delivered by wheel barrows it should be dumped as closely as possible to where it is to be rammed in place, so as to avoid unnecessary handling or turning over of the mass by means of shovels within the excavation or forms. Where it is not practicable to entirely complete one layer of concrete before commencing the second one, a plank, six inches or more in width, should be securely fastened in and across the excavation or form and the end of the layer of concrete being laid should be firmly rammed against this piece of plank, thus providing for a vertical joint in the layer of concrete. Great care should be taken that this plank header is removed. If allowed to remain in the structure after the completion of the structure it will rot and may result in serious defects.

Whenever concrete is to be put into a foundation below water level, all water as far as possible must be removed from the excavation before depositing the concrete; but when it is impossible to remove it by means of ordinary pumping facilities excavation shall be done in sections and the concrete placed in the foundation section by section. Special care must be taken to thoroughly ram the bottom layer of concrete and also to remove all mud and clay from the vertical face of each section of concrete deposited, when additional sections of the foundation are excavated preparatory to depositing the next section of concrete. When depositing concrete under such a condition as this, that is, where a surplus of water is encountered, interfering with the work, a somewhat dry mixture of concrete shall be used. In such cases no concrete shall be placed that has not been thoroughly mixed and no abso-

lutely dry mixtures shall be placed in an excavation of this kind no matter how thoroughly mixed. The fine, dry cement, unwetted will leave the aggregate when being deposited. No concrete shall be placed in forms or excavations through which running water seeps, as the seeping water will wash the cement from the aggregate.

Concrete should neither be mixed nor put in place when the temperature is low enough to freeze the fresh concrete before it can be thoroughly tamped and consolidated with the layer beneath it. Concrete work shall not be carried on after severe freezing weather has commenced, except under certain conditions prescribed by the Engineer Maintenance of Way.

Ordinarily, if the temperature is below twenty-five degrees, concrete work should not be carried on.

The face of all concrete work shall be thoroughly spaded.

"Spading" concrete consists of running a spade, flattened shovel, or other similar tool, up and down between the form and concrete. This action causes the stone or gravel to be pushed back slightly from the form, thereby bringing the cement or mortar in the concrete against the form, filling in voids which may be there and thus giving the face of the work a smooth appearance when the forms are removed. If the concrete mixture being deposited is a dry one, spading must be done with the greatest care in order to get uniform results; but with a medium or wet mixture such extreme skill is not required. Keep the face work always high so that any of the concrete water which may accumulate will not go to the face work; if this occurs it will weaken the face work and carry to it a lot of laitance or slime.

Temperature changes and shrinkage during setting necessitate joints at frequent intervals or else effective reinforcement, depending upon the range in temperature and the design of the structure.

In massive work, such as retaining walls, abutments, etc., built without reinforcements, joints should be provided approximately every thirty to fifty feet throughout the length of the structure. Detailed instructions covering provision for expansion joints will be furnished by the Engineer Maintenance of Way.

Expansion joints must not be "flushed" with mortar, nor must any attempt be made to make the fresh concrete adhere to the older work. A small beveled strip of wood must be set in the angle next to the temporary partition so as to make a "V"-shaped groove three-quarters of an inch deep on the finished surface of the work, thus indicating expansion joint.

After a mass of concrete has been deposited the forms

should be left in position until the concrete has thoroughly set. The length of time which forms must be left in place is governed largely by the nature of the work, the consistency of the concrete deposited and other conditions such as the prevailing temperature, the amount of moisture in the air, etc., and it is therefore impossible to definitely state the length of time which forms on any structure must be left in position. Whatever the class of the structure, the forms shall not be removed until the concrete has hardened to such a degree as to be able to support its own weight. Forms for arches or beams must be left in position longer than forms for retaining walls and abutments. Many failures of concrete structures have been due solely to the lack of judgment as to the proper time for removing forms.

No forms shall be removed in freezing weather, nor until after the concrete has had the advantage of being exposed at least sixty hours to a temperature at or above forty degrees Fahrenheit. Forms for large arches, where the mass of concrete deposited is considerable, should not be removed under two weeks.

All work connected with removing forms shall be done with extreme care. The concrete, even though set sufficiently to sustain its own weight, may be more or less "green" and therefore susceptible to injury from such knocks and blows as may be caused by striking it with tools or by hammering on the forms when knocking them apart and the finished surface, through carelessness, may be considerably injured and marred in appearance, especially at projecting corners or edges.

Care shall be taken when knocking the planks and studding apart to carefully handle the lumber of which the forms are made to avoid such injury as will prevent its further use in form construction. The forms or planks shall be thoroughly cleaned so they are free from adhering particles of cement.

Immediately after forms have been removed any small holes or openings on the exposed surface of the structure should be neatly filled with "pointing" mortar. Pointing mortar shall be composed of the same proportions of ingredients as the facing mortar. If made richer than facing mortar the spots where the pointing mortar is used will dry darker in color than the surrounding surface.

Avoid plastering or washing the face of concrete work because the plaster or wash in setting up shrinks. The richer the mixture the more it shrinks. This allows the frost to get in between the wash or plaster and the concrete work, causing, in a year or two, a rough appearing job.

At the discretion of the Engineer Maintenance of

Way, concrete shall be water proofed either by a superficial method or by a membrain method, consisting of coal tar pitch and tar felt.

The backs of concrete structures may be water-proofed by either the coal tar or a Sarco product; the face of concrete work may be water-proofed by the Sylvester method.

Coal tar, heated in an open kettle to a temperature of about 360 degrees Fahrenheit and then applied with a brush or mop makes a very good water-proofing.

The Sylvester method of water-proofing consists in using two washes or solutions for covering the surface of the walls—one composed of castile soap and water and one of alum and water. The proportions are three-quarters of a pound of soap to one gallon of water and a half a pound of alum to four gallons of water, both substances being perfectly dissolved in the water before being used. The walls should be perfectly clean and dry and the temperature of the air not above fifty degrees Fahrenheit when the composition is applied. Apply the soap solution boiling hot, with a flat brush, taking care not to form a froth. Wait twenty-four hours so that the solution will become dry and hard upon the walls, then apply the alum solution in the same way. Wait twenty-four hours and repeat with alternating coats of soap and alum. From two to four coats of this solution is necessary to do a thorough job of water-proofing.

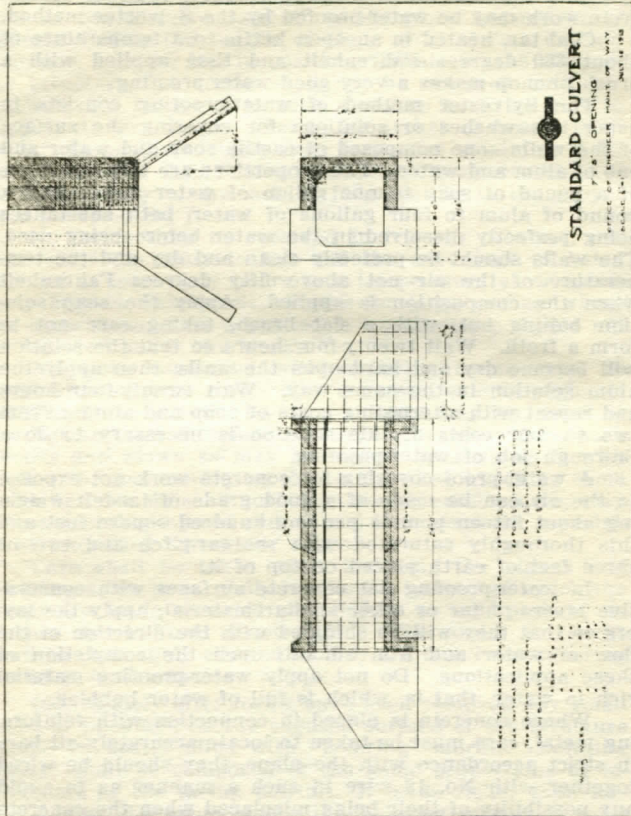
A water-proof covering for concrete work not exposed to the air can be made of a good grade of tar-felt weighing about fifteen pounds per one hundred square feet and this thoroughly saturated with coal-tar-pitch and two or three feet of earth placed on top of it.

In water-proofing flat concrete surfaces with consecutive layers of tar or other similar material, apply the layers so that they will be shingled with the direction of the flow of water and iron smooth upon the completion of these applications. Do not apply water-proofing material rich in water, that is, which is full of water bubbles.

Where concrete is placed in connection with reinforcing metal, care must be taken to locate accurately all bars in strict accordance with the plans, they should be wired together with No. 18 wire in such a manner as to avoid any possibility of their being misplaced when the concrete is deposited.

Foreman in charge or inspector shall see that all protruding bars from piers and arches to which other bars are to be spliced and which will be exposed to the action of the weather for any indefinite period are protected from rusting by a coat of thin, neat cement grout.

The steel used shall be clean and free from dirt, oil, paint or injurious rust.



In general, no reinforcing bars larger than one inch in diameter will be used, and these may be bent cold, when necessary, about a radius of not less than six inches.

Reinforced concrete work should be, as far as possible, monolithic, but when joints are necessary, they shall be made at such points and in such a manner as to meet the approval of the Engineer in charge.

In reinforced beam work, such as floor beams, floor slabs or culvert covers, the bars should be first entirely surrounded with a cement mortar composed of one part cement to two parts sand with the concrete deposited immediately afterwards.

RULES FOR DESIGN OF CONCRETE CULVERTS.

In giving the size of culverts, the width shall be named first and then the height.

Wherever the bearing on the soil makes it necessary, solid floors shall be used. Solid floors should be avoided wherever possible by extending the footings under the side walls.

Cross struts at intervals of about ten feet shall be provided.

In general, the end struts and the footings under the wing walls shall be carried lower than the footings under the barrel culvert.

Transverse vertical joints shall be provided in culvert barrels every thirty-two feet.

Wing walls under eight feet in height shall be made continuous with culvert walls.

Wing walls higher than eight feet shall be made self-supporting and a joint shall be provided between the wing and culvert barrel.

Wing walls on the up-side of a stream shall be at an angle of from thirty degrees to forty-five degrees with the culvert walls; on the down side of the stream they shall be in the same straight line as the culvert walls and shall be a continuation of the culvert walls.

Longitudinal steel reinforcement of a sectional area about 1-700 of the concrete section shall be provided in culvert barrels.

The thickness of the cover shall be decreased and the amount of steel diminished from the edge of the live load spread to the parapet.

In skew culverts the cover shall be designed for the span in the direction parallel to the track and the bars shall be placed in this direction.

PAINING.

There are certain times of the year when outside painting should not be done if satisfactory results are to be ex-

pected. Painting too early in the spring is liable to find the surface full of frost and moisture and the pores closed through contraction, thus producing an uneven absorption. The side of the building exposed to the heat of the sun will expand and the pores open to a greater extent than the protected side of the building. All paints and oils are much heavier in cold than in warm weather and if applied under a low temperature there is apt to be too heavy a coat over the contracted surface, which will crack through expansion under the summer heat.

Do not paint after a frost or in the early spring when frost is leaving the ground, filling every part of the building with dampness. Remember that heat ascends and brings the dampness with it.

Paint should never be applied to extremely hot surfaces. Paint applied under extreme heat sets and dries very rapidly and under the direct heat of the sun's rays is very apt to blister, especially on old work.

In spring painting follow the sun with your work. In summer painting let the sun follow you. Switch your work according to the time of the day.

Do not paint while the plaster is drying out; allow time for it to harden through. Remember there are eighty to ninety gallons of water used in every one hundred yards of plastering, most of which must escape some place. If the building is tightly closed or is being dried by heat the moisture will largely be driven out through the siding, causing the paint to break away, blister or peel.

Do not paint buildings having damp basements without first removing the cellar windows and ventilators so as to have a free circulation of air.

Do not paint near fresh mortar beds. The heat, moisture and fumes from the lime will be absorbed by the oil in drying, causing it to flatten out and destroying its life.

Do not paint in sultry weather or in a heavy, wet atmosphere, as the moisture from such conditions penetrates the surface to such an extent that it takes several days of good drying weather for the building to again be in condition to receive paint.

Do not paint during or immediately after a rain storm or a heavy fog or dew.

TOOLS.

A painter's kit should consist of a good full stock body brushes for each color, a 3½ inch to 4 inch long stock brush is the one usually used. A good trimming brush is just as essential as a good body brush, as it is impossible to cut in on cornice, corner boards and ash frames with a ragged edged brush. A good chisel sash tool or a 1 inch or 1½ inch chiseled varnish brush should

be used for brackets, mouldings, etc., and a ½ inch flat chiseled varnish brush for sash colors. A kit must also contain a good duster and a putty and scraping knife.

CARE OF TOOLS.

Never put new brushes into water. When through with the day's work lay them out smoothly full of paint on a board; repeat this for several days, or until the brush is thoroughly broken in; then keep it in a brush trough. Do not stand brushes on end or keep them in the paint.

Never let brushes become lousy through allowing paint to dry or skin around the brushes or handles. Should brushes become hard by being neglected, they can soon be cleaned by putting them in a liquid paint or varnish remover. After a few hours brush out on a rough board, then thoroughly clean the bristles with benzine or turpentine. This will not injure brushes of the finest quality.

Always use a brush in a manner as to wear the bristles to a chiseled point.

Never jam a brush into a corner, thereby making stubby tools. Work it into the corner in place of jamming it in.

MIXING.

Provide a mixing keg large enough to hold sufficient paint for the coat to be applied and allow a lot of stirring without danger of slopping over the side. A flat paddle proportionate to the size of the mixing keg, a good strainer and a set of measures are essential for the proper preparing of the paint.

In breaking up paste paints the thinners should be added gradually to insure smooth and uniform results in the mixture. If all of the thinners are dumped in at once the mixture will be lumpy. Where Japan is used, always get the best and use it sparingly. Never add Japan last or after the mixture has been thinned down. Japan, when added in this way, is very apt to cause curdling and it is almost impossible to work the Japan into the mixture. First, the paint should be reduced to a heavy consistency with part of the oil and the Japan and turpentine added while in this consistency. A good rule to follow is to mix the Japan and turpentine in a can together, shaking well and adding this to the lead when breaking up. The balance of the oil can then be gradually added until the consistency has been obtained, without danger of lumping or curdling the mixture. Where it is practicable, better results can be obtained by breaking up in the oil one or two days before using.

All paint from priming to finishing coat should be

strained. This assists in more thoroughly combining the pigments with the thinners, also assures a more uniform mixture in tints than can be obtained in any other way.

Prevent the paint from skinning over as much as possible, but keep the mixing keg tightly covered. Paint from which the skin is being continually removed will soon become very slow in drying properties.

Do not allow paint to become fatty by leaving it exposed from one day to another. Paint which has been exposed for several days is not fit to be applied on wood as it will only surface dry, if it ever dries at all. A great deal of the trouble in portions of buildings going wrong after the second or third coat has been applied can be traced to fatty priming.

Always keep the paint clean, free from skin and dirt and well strained. In mixing paint for hard or yellow pine, excess of turpentine shall be used if the surface of the wood is very fat, if the wood is fairly clear the turpentine can be cut down.

The free use of turpentine on this lumber restores the life or vitality which nature gave the lumber. Turpentine assists in opening the pores of the wood and gives a greater depth of penetration as well as carrying or driving the sap into the wood to a greater depth.

Heavy coats of full oil reduction should never be applied on hard or yellow pine, otherwise peeling or scaling will soon take place.

In mixing paint for cypress, the primer should be mixed to a thin consistency, at least twenty per cent of the total amount of thinners should be turpentine. This would insure depth of penetration.

For priming white pine, the reduction should be to a medium thin consistency, carrying enough turpentine to assist in penetration and working.

For priming oak the primer should be mixed very thin, carrying a liberal percentage of turpentine to assist in penetration and working.

Dry colors mixed by hand is an extremely hard process and a pigment in oil should be bought and used for primer. The primer should be of the best and of the same material as the intermediate and finishing coats.

It is impossible to thoroughly combine dry ochre and oil by simply mixing them with a paddle. The ochre cannot be satisfied with oil under these conditions and when applied to a soft surface will absorb the oil from the wood, destroying the binders. On hard wood such a mixture will spread or slip over the surface without penetration and if elastic finishing coats are applied they will break loose and peel off in large flakes in a comparatively short time.

If ready mixed paint or prepared paint is to be used

note carefully the directions given by the manufacturer. All paints shall be kept thoroughly mixed.

PRIMING.

This is the most important paint coat applied to any surface. It must fill and satisfy the surface and leave a foundation upon which future paint coats can be successfully built. It must carry sufficient linseed oil to not only satisfy the surface, but bind or hold the pigment to the surface. It must carry sufficient turpentine to cause penetration and assist in forcing, by absorption, the oil and pigment into the surface. The formation of the pigment must be such as to allow of penetration into the surface and above all the primer must be well and evenly brushed out and into the surface.

The painter must use much care in applying the priming coat, he must brush the paint into the wood, satisfying the soft grain and carefully brush the hard grain where there is less absorption, leaving an even, uniform coating.

In priming soft wood, the paint should be applied with a full brush and enough paint used at all times to satisfy the surface. It should be well brushed and especially on the harder grain to assist or force the paint into this close grain and remove by hard brushing any surplus paint that remains on the surface.

On hard or close grained wood, a medium full brush should be used in applying the paint, as this class of wood does not possess the absorbing properties of softer wood, but requires more brushing in order to force a sufficient amount of oil and binder into the wood and at the same time not leave an excess of paint on the surface.

The priming or thin coat will allow the second coat to penetrate through and satisfy any part of the wood which was not fully filled at the time the priming coat was applied, also allow the second coat to bind itself to the wood and priming coat.

An excess of paint on very porous woods will cause peeling or chipping. This heavy coat prevents the oil from penetrating the woods and assists in holding the coat on the surface. The oil and binder in the second coat penetrates into this heavy coat only and does not reach the wood so as to assist in forming a solid coat well bound to the surface.

Paint heavily applied to a hard or close grained surface will dry with a gloss, forming a hard glaze over the surface into which the second coat cannot penetrate to any depth; it will only fasten itself to the outside of this glaze coat, whereas it should go through to the wood so as to help strengthen the second and subsequent coats.

Do not prime a building and allow it to stand any

longer than is necessary in order to thoroughly harden the paint and allow of full absorption. If allowed to weather the priming coat will become porous and absorb the life of the second coating and there will not be sufficient binder left to properly adhere to the surface.

BRUSHING.

All paint shall be applied with a thorough brushing.

One of the most important facts in thorough brushing of paint is the forcing of the air through the paint by the aid of the bristle and in this manner thoroughly mixing the oxygen with the paint, also forcing the confined air out of the surface to which the paint is being applied and in its place forcing the oil, turpentine and pigment, thereby sealing the pores or grain of the wood against dampness, also causing deep penetration of the paint and its proper drying and hardening.

GENERAL DIRECTIONS.

If a new surface is to be painted, carefully consider the character of the surface to be painted and whether two or three coats are necessary in order to produce satisfactory work. Study the character of the lumber as to its drying and absorbing properties. Reduce and apply the paint accordingly.

Knotty, pitchy and sappy places should receive a thin coat of shellac before painting.

After priming, hard drying putty shall be knifed into all nail holes, cracks and crevices.

If an old surface is to be repainted, remove all grease, dirt, dust and loose paint.

If a ready mixed paint is to be used, shake the package thoroughly before opening; if a sealed can, remove the slip cover and carefully note any printed directions under it. Remove the entire top of buckets and barrels so as to facilitate the stirring process. Paint cannot be thoroughly stirred with a round stick, neither can it be thoroughly stirred by a circular motion nor through a bung hole or small opening. Use a flat paddle for stirring of a width proportionate to the size of the package. Always stirring from the bottom up.

Be sure the undercoatings are hard dry before applying subsequent coats. When painting inside do not tightly close the room; the paint will not dry.

Do not lean the ladder against gutters or down spouts, and care must be taken that the lower end of the ladders are firmly planted where they will not slip or be struck by passing vehicles or trains.

Care shall be taken that the ends of scaffolding boards are in the clear of passing trains.

A steel scraper and a stiff iron brush shall be used in painting steel work. All rust and scales must be removed from steel work first by the use of the scraper and steel work must be thoroughly brushed before paint is applied. A special care must be taken in the removal of all rust from around rivets, bolt heads, nuts and in all corners and seams before paint is applied. All structural steel shall be painted with two different colors, the first coat shall be a red color and the second coat shall be a black color. This in order to distinguish complete second coating of the entire structure.

GENERAL RULES TO FOREMAN OF PAINTERS.

The foreman of painters shall report to and receive instructions from the Master Carpenter.

He has charge of the painting of all bridges, buildings and other structures and will hire such force of men to assist him as the Master Carpenter shall designate.

The foreman of painters shall be familiar with all rules and with the use and meaning of signals and see that their subordinates understand all rules and properly use the signals.

The foreman of painters shall himself personally see to the tying of all knots and to the condition of all rope, chains, pulley blocks, scaffolding boards, etc., upon which men are suspended from in their work.

The foreman of painters shall see that all deposit is thoroughly cleaned from any metal work of any bridges and deposited at such distance as it will not again be liable to come in contact with the metal of the structure.

Foreman of painters shall engage in the work personally with his men and shall observe any rules or regulations which apply to any other men in the maintenance organization affecting any work they are engaged in.

Foreman of painters shall make requisition upon the Master Carpenter for all supplies and material needed by them in their work. Foreman of painters shall see that the date of painting is marked in small letters upon all bridges and structures which shall have been painted. This date of painting shall state whether it is one coat, two coat, or three coat work, and the name or initials of the paint manufacturer whose paint is used shall also appear.

Overhead Lines and Signals.

DEFINITIONS.

- Aerial Conductor**—An overhead conductor.
- Anchor Strain-Ear**—In an overhead trolley system a trolley ear or insulator employed for anchoring the trolley wire, or maintaining it taut, so as to ensure good and continuous contact with the trolley wheel.
- Battery, Dry**—A number of separate dry voltaic cells combined so as to act as a single source.
- Bracket-Arm**—An arm supported by a bracket for carrying a line insulator.
- Braided-Wire**—A wire covered with a braiding of insulating material.
- Burn-Out**—The destruction of any part of an electric apparatus by the passing of an excessive current due to short circuit or other causes.
- Cable**—A stranded conductor or a combination of conductors insulated from one another.
- Cable Clip**—A term sometimes used for cable hanger.
- Cable Well**—A cable tank.
- Candle-Power**—The intensity of light emitted by a luminous body estimated in standard candles.
- Catenary Curve**—The curve described by the sagging of a wire, under its own weight, when stretched between two points of support.
- Catenary Trolley Construction**—A trolley wire that is suspended at frequent intervals from a messenger wire.
- Circuit Breaker**—Any device for opening or breaking a circuit.
- "Come Along"**—A small portable vise capable of ready attachment to an aerial conductor and used to pull the conductor to its proper tension.
- Conductor**—Any substance which will permit the so-called passage of an electric current.
- Connecting Jack**—A jack for introducing a loop into a telephone circuit.
- Connecting Sleeve**—A metallic sleeve employed as a connector for readily joining the ends of two or more wires.
- Cord, Electric**—A flexible insulated electric conductor containing two parallel wires.
- Cross-Arm**—A horizontal beam attached to a pole for the support of the insulators or aerial conductors.

Cross Bonding—The bonding between the ground feeder and the track for the purpose of ensuring a good conducting return circuit or the bonding between the rail on one side of a track and the rail on the opposite side.

Cross, Electric—A connection accidentally established between two conducting lines, caused by two wires coming in contact by crossing each other.

Crow-Foot Zinc—A crow-foot-shaped zinc employed in the gravity voltaic cell.

Current, Electric—The quantity of electricity per second which passes through any conductor or circuit when the flow is uniform.

Cut-Out—A device for removing an electro-receptive device or loop from the circuit of an electric source.

Clinch Ear—An ear in a trolley system to which the trolley is secured by clinching the lips of the ear into a groove of trolley wire.

Copper-Clad—Protected or covered with copper.

Dead Ended Conductor—A conductor whose end is deliberately left open or insulated by being wound around an insulator.

Dead Ground—Such a ground as will ensure a ground of negligible resistance.

Dead-Man—A timber buried in the earth for the purpose of attaching an anchor or guy.

Disconnecter—A key or other device for opening or breaking an electric circuit or for removing an electro-receptive device therefrom.

Double-Pole Switch—A switch which simultaneously breaks the circuit of both positive and negative leads.

Double-Throw Switch—A switch capable of being thrown into either of two contacts or pairs of contacts. A switch which has three positions.

Duplex Wire—An insulated conductor containing two small insulated conductors twisted together, having a common covering.

Electricity—The name given to the unknown cause of electric phenomena.

Electrode—Either of the terminals of an electric source.

Electrolysis—Chemical decomposition effected by means of an electric current.

End-to-End Joint—A term frequently employed in place of butt-joint.

Expansion Joint—A joint suitable for tubes or pipes exposed to considerable changes of temperature in which a sliding joint is provided to safely permit a change in length of expansion or contraction.

Feeder—An electric circuit used to supply power to a station or service as distinguished from circuits con-

lined to a single station or used for other purposes than supplying power.

? **Feeder Distribution**—A feeder-and-main system of distribution.

? **Feeding Point**—A point of connection between a feeder and the mains.

? **Fuse Block**—A block containing a safety fuse.

? **Fuse Box**—A box containing a safety fuse.

? **Gains**—The spaces cut in the faces of poles for the support and placing of the cross-arm.

? **Galvanizing**—Covering iron with an adherent coating of zinc by dipping in a bath of molten metal.

? **Ground**—A general term for the earth when employed as a return conductor.

? **Ground Return**—A general term used to indicate the use of the ground for part of an electric circuit.

? **Ground Wire**—The wire or conductor leading to or connected with the ground or earth in a grounded circuit.

? **Grounding**—Connecting a circuit to earth or ground.

? **Guard Wire**—A wire hung above any active conductor such as a trolley wire in order to prevent it from coming into electric contact with falling wires.

? **Guy**—A rod, chain, rope or wire employed for supporting or stiffening any structure such as a pole.

? **Guy Wire**—A wire employed as a guy.

? **Hard Drawn Copper Wire**—Copper wire not annealed after leaving the die.

? **High-Tension Circuit**—A circuit employed in connection with high electric pressures.

? **Impedance**—Generally, opposition to current flow.

? **Incandescent Electric Lamp**—An electric lamp whose light is produced by the electric incandescence of a strip or filament of some refractory substance.

? **Induction**—The influence exerted by a charged body or by a magnetic field on neighboring bodies without apparent communication.

? **Inside Wiring**—Any conductors placed inside a building.

? **Insulate**—To so cover or protect a body as to prevent electricity from being conducted to or removed from it.

? **Insulated Wires**—Wires provided with insulating coverings or coatings.

? **Insulating Joint**—A joint in an insulating material or covering in which the continuity of the insulating material is ensured.

? **Insulator, Electric**—A body or substance which offers such resistance to the passage of electric current that it is used to prevent the passage of current.

Insulator Pin—The bolt by which an insulator is attached to a bracket, pole-arm or support.

Interrupter—Any device for interrupting or breaking a circuit.

Joint Resistance—The combined resistance of a number of parallel-connected resistances.

Jumper—A temporary shunt or short circuit put around a source, lamp or receptive device on a series-connected, circuit, to enable it to be readily removed or repaired.

Knife-Switch—A switch which is opened or closed by the motion of a knife contact between parallel contact plates.

Lamp Circuit—A circuit containing an electric lamp or lamps.

Lamp Cord—A flexible cord containing two separately insulated wires suitable for use in connection with an incandescent lamp.

Leads—In a system of parallel distribution the conductors connect to the positive and negative terminals of a source. Conductors which lead the current to or from any source, circuit or device.

Lightning Arrester—A device by means of which the apparatus placed in any electric current is protected from the destructive effects of a flash or discharge of lightning.

Line Circuit—The wires or other conductors in the main line of a circuit.

Live Wire—A wire through which current is passing.

Low Tension—A relative term used to designate a winding or conductor of less voltage than that with which it is related or compared.

Magnet—Any body producing a magnetic flux. A body possessing the power of attracting the unlike pole of another magnet or of repelling the like pole or of inducing magnetism in magnetizable bodies.

Magneto—A magneto-generator. A small magneto-electric dynamo machine.

Mains—In a parallel system of distribution the parallel conductors carrying the main current and to which translating devices are connected.

Mouth-Pieces—Circular openings into air chambers placed over the diaphragms of telephones to permit the ready application of the mouth in speaking so as to set the diaphragm in vibration.

Negative Conductor—The conductor connected to the negative terminal of an electric source.

Neutral Wire—In a three-wire system of electric distribution the wire connected to the neutral dynamo-terminal. The balance wire of a three-wire system.

Petticoat Insulator—An insulator provided with a petticoat or deep external groove around its lower extremity or stalk.

Phase—The fractional part of a period which has elapsed since a vibrating body last passed through the extreme point of its path in the positive direction.

Plug Switch—A switch operated by the insertion of a metallic plug between two insulated metallic segments connected to a circuit and separated by air spaces for the reception of the plug key.

Pole Changer—A generator of alternating currents at a telephone exchange consisting of an electro-magnetically driven pendulum which periodically reversed a call battery.

Pole Guy—A guy employed for stiffening a pole.

Pole Steps—Steps permanently fastened to a wooden or iron pole to facilitate climbing.

Pony Insulator—A name given to a particular type of glass or porcelain telephone insulator.

Porcelain—A variety of insulating substance made from kaolin.

Portable Conductors—Flexible cords containing insulated wires suitable for use with portable lamps, motors or other devices.

Power Circuits—Circuits employed for the electric transmission of power.

Power House—A house provided with a plant necessary for the production of the electric power required in a system of electric distribution.

Primary Currents—Currents flowing in a primary circuit as distinguished from current flowing in a secondary circuit.

Parallel, Brail or Backbone—A messenger wire strung parallel with curve with pull-off wires attached for the purpose of holding trolley wire in alignment on curves.

Rail-bond, Electric—Any device whereby the ends of continuous rails are placed in good electrical contact with one another so that the resistance of the rails, employed as a portion of the return circuit, may be as small as possible.

Railway Return Circuit—A term frequently employed for the ground return of a trolley system.

Receiver—A name given to a receiving instrument of a gramophone, graphophone, telephone or telegraph instrument.

Return Circuit—That part of a circuit by which an electric current returns to the source.

Ring Key—In a telephone switch board, a key employed to ring up a subscriber.

Section Insulator—An insulator in a trolley wire system which electrically disconnects one trolley section from another.

Side-Pole Trolley Line Construction—A method for the suspension of aerial trolley lines in which the trolley and feeder wires are suspended from poles placed on one side of a street or road.

Single Pole Switch—A switch which opens or closes a circuit at one of its leads only.

Single-Throw Switch—A switch having but two positions, one for opening, and the other for closing the circuit it controls, as distinguished from a double-throw switch.

Sleeve Joint—A junction of the ends of conducting wires obtained by passing them through tubes and subsequently twisting and soldering.

Snap Switch—A switch in which the transfer of the contact points from one position to another is accomplished by a quick motion obtained by the operation of a spring.

Soft-Drawn Copper Wire—Copper wire that is softened by annealing after being drawn.

Solder Ear—An ear or hanger in a trolley system to which the trolley is secured by solder.

Span Wires—Wires tightly stretched across a street from pole to pole for the purpose of supporting trolley wires.

Spider—A pull-off wire attached to trolley wire for purpose of securing better alignment on a curve.

Splicing Ear—A trolley ear for uniting the ends of a trolley wire.

Splicing Sleeve—A tube of conducting materials employed for covering a splice in a conducting wire.

Straight Line Trolley Hangers—A trolley hanger employed on a straight trolley line, suitably supported by a span wire so as to have a vertical strain only.

Strain Insulator—An insulator used for the double purpose of taking the mechanical strain at a bend or at the end of a conductor and also insulating the same electrically.

Stranded Conductor—A conductor formed of a number of small interlaced or twisted conductors, either for the

purpose of reducing self-induction or eddy currents or for increasing its flexibility.

Switch—Any device for readily opening or closing an electric circuit.

Tap—A derived circuit for carrying off a share of the main current.

Taping—Covering a wire or a joint with an insulating tape.

Telephone—An instrument for the electric transmission of articulate speech.

Telephone Set—A general term for the apparatus employed by a telephone subscriber at his office.

Three-Phase Transmission—Transmission by means of three phase currents.

Transmission—The transference of energy from one point to another by means of electric currents.

Transmission Line—A transmission circuit.

Transposing—In a system of telephonic communication, a device for avoiding the bad effects of mutual induction by alternately crossing equal lengths of consecutive sections of the line.

Trolley—A rolling contact-wheel that moves over a trolley line and carries off the current required to drive the motor cars.

Trolley Ear—A metal piece supported by an insulator to which the trolley wire is fastened.

Trolley Hanger—A device for supporting and properly insulating a trolley wire.

Trolley Insulator—A name sometimes applied to a trolley ear.

Trolley Wire—A bare overhead wire employed in a trolley system for supplying the driving current to the car motors through the intervention of the trolley mechanism.

Twisted Pair Cable—A cable containing one, several or many twisted pairs of conductors, suitable for metallic circuits.

Twisted Pair Conductors—An assemblage of twisted pairs of conductors for metallic circuits.

Two-Way Switch—A switch provided with two contacts connected with two separate and distinct circuits.

Twin Wire—Two small insulated conductors laid parallel, having a common covering.

Wall Bracket—An insulator bracket attached to a wall. A more or less ornamental support for one or more incandescent lamps attached to a wall of a room, hall or corridor.

Wall Socket—A socket placed in a wall and provided with openings for the insertion of a wall plug with which the ends of a flexible twin-lead are connected.

Weather-Proof Wire—A wire provided with weather-proof insulation.

Welding Electric—Effecting the welding union of metals by means of heat of electric origin.

Wire—A slender rod or filament of metal. A conductor that forms a part of a circuit.

ORGANIZATION OF OVERHEAD LINES AND SIGNAL DIVISION OF MAINTENANCE DEPARTMENT.

The superintendent of overhead lines and signals shall report to and receive instructions from the Engineer of Maintenance of Way. He has charge of the construction and repairs of all overhead line work, including transmission, trolley, feeder, signal and telephone lines, the wiring and lighting of buildings, the construction and maintenance of all automatic signals, crossing bells and track return bonding. He will employ such workmen as may be necessary, subject to the approval of the Engineer of Maintenance of Way and see that they perform their duties properly.

The superintendent of overhead lines and signals are forbidden to pass employees on this Company's trains, except on Company business.

The superintendent of overhead lines and signals must make frequent inspections of all overhead lines and their supports, of all automatic signals, bells, and track bonding, and have necessary repairs made as promptly as conditions require.

The superintendent of overhead lines and signals must know that all foremen reporting to him are familiar with the operating rules in regard to train signals and flagging and that they fully understand and comply with them.

The superintendent of overhead lines and signals will carefully see that the time of the men and the rate of pay are correctly reported and properly classified on the check rolls. They will note the time each foreman or inspector is absent from work and make proper deductions on check rolls.

The superintendent of overhead lines and signals must in case of obstructions or damage to the overhead lines or signals proceed to the place with the forces at their command and do all in their power to promptly clear and repair the damage.

The superintendent of overhead lines and signals must spend a portion of each day with the foremen re-

porting to him and instruct them in the proper and efficient methods of doing whatever work they find the foreman and his men engaged in and they shall personally handle the gang in an explanation to the foreman of any efficient manner of doing work which he does not understand.

The superintendent of overhead lines and signals must pay strict attention to the proper condition of all overhead lines and signals and to the track return bonding.

The superintendent of overhead lines and signals should keep a memorandum of the number of men at work on the various gangs reporting to him and compare with the reports returned by the foremen.

All requisitions for material must be made in writing to the Engineer of Maintenance of Way.

The superintendent of overhead lines and signals must keep the Engineer of Maintenance of Way advised of his whereabouts and probable movements.

The superintendent of overhead lines and signals shall work in connection with and furnish assistance to all other heads of any divisions of the Maintenance of Way Department.

GENERAL LINE FOREMAN.

The general line foreman reports to and receives orders from the superintendent of overhead lines and signals.

He has charge of the construction and repairs of all overhead line work, including transmission, trolley, feeder and telephone lines; the care of all telephone instruments and the wiring and lighting of buildings. He will employ such foremen as may be necessary, subject to the approval of the superintendent of overhead lines and signals and see that they perform their duties properly.

He must be familiar with the use and meaning of signals and see that they are properly used and understood by the persons employed under him, and he must furthermore be familiar with instructions issued for the government of trains and trainmen and report any neglect of duty or violation of the rules that come under his notice.

He must frequently go over all of his lines and observe the condition of all the overhead construction, the condition of the poles, wires and instruments under his care and do everything necessary to insure safety and uninterrupted use of all overhead lines.

OVERHEAD LINE FOREMAN.

Overhead line foremen report to and receive orders from the general line foreman.

They shall be responsible for the construction and repairs of all overhead line work, and shall do no work to

overhead lines that will interfere with the safe passage of trains, unless under proper protection.

Overhead line foremen must personally pass over the whole extent of their district at least once a week.

Overhead line foremen must engage in the work personally and they shall employ men as the general line foreman directs. They must treat employees with consideration and see that they properly perform their duties. They must discharge men who are incompetent or neglect their duties, but in no case shall they discharge men without cause. They must keep the required records of the time of their men and of the material used.

Overhead line foremen must each have a copy of the current time table and be thoroughly familiar with the rules and regulations therein and with the time of trains over their districts. They must carefully observe signals displayed by all trains and assure themselves before obstructing track that all trains and sections due have passed.

Overhead line foremen must provide themselves with reliable watches, and, when possible, verify time daily with the standard clock or with the watch of the general line foreman or of other employes who are required to have the standard time.

Overhead line foremen are forbidden to pass their men on this company's trains, except on Company business.

If, in the judgment of the overhead line foremen, the overhead line is in a dangerous condition for the passage of trains, notice must be given immediately to the general line foreman and the train dispatchers. In such notices the place of danger, its nature and the speed at which trains may pass must be stated.

In addition to sending this notice yellow slow signals must be displayed. When repairs have been made the person making them must at once notify the general line foreman and train dispatchers that the slow order may be recalled.

Except in cases of emergency, no work that will obstruct the track shall be done during fogs or storms.

Overhead line foremen shall conform to the prescribed standards, plans and instructions hereinafter contained or hereafter prescribed by the proper officer in the execution of the work under their charge.

Overhead line foremen must not, except by proper authority, permit experimental trials of appliances or devices, nor give out information of the results of any trial.

Overhead line foremen shall keep themselves informed in regard to all work performed on their districts by foreign companies, or others who do not come under their charge, and see that nothing is done by them that will in-

terfere with the safety of the overhead lines, or employees or the movement of trains.

GENERAL RULES OF OVERHEAD LINES AND SIGNAL DIVISION.

R } The attention of linemen, inspectors, groundmen and all other employees of this Company having occasion to climb poles or work upon or near same is hereby called to the hazardous condition surrounding such work and to the fact that all poles are liable to decay beneath the surface of the ground; that cross-arms or pins may rot or crack; that messenger or guy wires are often grounded and in contact with high voltage lines. Every such employee is hereby notified to carefully inspect each pole before climbing the same and thoroughly test each pole, BOTH ABOVE AND BELOW GROUND, and before and after going up any pole to inspect each cross-arm, pin, guy wire and all foreign companies' wires, near any such work to avoid accident. The Company makes no inspections or tests of these structures, but every employee must make his own inspections or tests. Employees will be held responsible for any failure to observe this rule.

✓ All work shall be done in a neat and workman-like manner and wherever possible shall be in strict conformity to the rules and methods therein set forth.

R } When one or more lineman, inspectors or maintainers are riding over the line it shall be their duty to select certain circuits, supports or apparatus and inspect them carefully for any defects or displacements which may interfere with their usefulness, and if any are noted they shall immediately repair same and make a report describing the condition and what in their opinion would prevent a recurrence of the trouble of the character found.

R } It shall be the duty of every employee of this division of the Maintenance Department to keep their foreman advised of their whereabouts during the day, report before going off duty at night; and keep their home address in writing at the chief dispatcher's office.

R } All overhead lines must be kept well insulated from all foreign companies' wires, trees, buildings, poles, etc.

R } Tress must be trimmed each year so as to afford sufficient clearance of all overhead lines.

R } Broken insulators must be replaced as soon as possible.

R } On each occasion for helping any other department, a report of same stating the time thus employed must be made out and sent to the general line foreman or inspector of signals. Only in cases of emergency shall assistance be rendered to other departments without first obtaining

the authority from superiors, because, frequently important work may be neglected or assistance rendered where head of another department does not desire it.

A correct daily report must be made of all work done, material used and time spent on each job and sent to the general line foreman or supervisor of interlocking and signals. R

Each foreman must keep accurate account in hours of the time of each man in his charge and on the fifteenth and last day of each month figure each man at his rating and forward the time books to the general line foreman or supervisor of interlocking and signals. R

The use of the dispatcher's telephone line is forbidden unless it is absolutely necessary. R

Each lineman or other employee of this Company having occasion to climb poles must have a belt and safety strap, climbers, pliers and connectors. ✓

Belts and safety straps and climbers must bear inspection. R

Scraps, empty reels, broken insulators, broken poles, etc., must be picked up and valuable or useful material shall be taken to the store yards and returned to store-keeper on a credit memo, all waste material shall be either burned or buried in the ground at the completion of every job. R

Whenever employees of the overhead line and signal division are riding over the line in work cars and they are not engaged in observing the condition of line, they should be employed in straightening up the tools, material in car and in making up strains in strand wire, etc., for the next job. R

The engineer of Company shall accompany general foreman of overhead over the proposed alignment of any new track and shall be sure that the general foreman thoroughly understands the center stakes which the engineer shall have set for said new track. X

All pole holes shall be staked by general foreman or by a line foreman whom the general foreman shall designate. X

In bracket construction the inside of poles shall be spaced at a minimum distance of seven feet six inches from center of track and shall not exceed this measurement to appreciable extent unless conditions so require, such as allowing for rail elevation on curves and car overhang. R

In span wire construction the side of the pole nearest the track shall be at a distance of seven feet six inches from the center line thereof, except where the Engineer Maintenance of Way shall direct that they be set at a greater distance and on curves where allowance must be made for rail elevation and car overhang. R

In cities where curb lines are established, poles shall be set just behind curbs unless local ordinances or conditions prescribe other location.

All poles on single trolley suspension on tangent track and curve track not to exceed two degree curvature, shall be spaced one hundred ten feet apart.

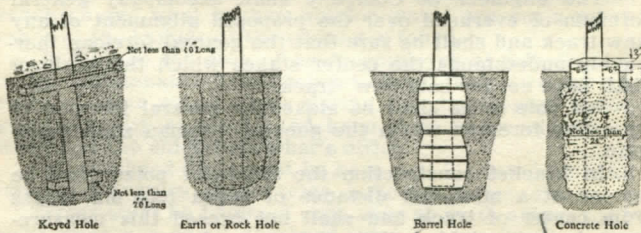
On curves all poles on single trolley suspension shall be spaced one hundred ten feet apart, when curves exceed two degrees, and not over six degrees. When curve exceeds six degrees pole spacing shall be decided by Engineer Maintenance of Way.

All poles on catenary suspension on tangent track and curve track not to exceed two degrees curvature, shall be spaced one hundred thirty-two feet apart.

All poles on catenary suspension on curve track shall be spaced one hundred feet apart when curve exceeds two degrees and not over six degrees. When curve exceeds six degrees pole spacing shall be decided by Engineer Maintenance of Way.

Poles shall be set at the depth shown in the following table, except on side banks and fills, where the depth shall be determined by general line foreman.

Length of Pole.	Depth in Earth in Feet.	Depth in Rock in Feet.
30 feet	5 feet 6 inches	5 feet
35 feet	6 feet	5 feet
40 feet	6 feet	5 feet 6 inches
45 feet	6 feet 6 inches	5 feet 6 inches
50 feet	7 feet	6 feet
55 feet	7 feet 6 inches	6 feet 6 inches
60 feet	8 feet	7 feet



All holes shall be dug as large in bottom as in top and large enough to give ample room to shift poles with crooked butts.

The hole shall be of such diameter that the pole can be thoroughly tamped all around its circumference.

In digging a hole where quick sand is encountered or material which caves freely to the detriment of setting a

pole, casing shall be provided either by building square ones out of one inch lumber or by carefully knocking out the bottoms of oil barrels and the casing provided shall be of sufficient size to give clear tamping room of at least six inches around the pole, and casing shall be settled into position in the holes and the pole immediately set before any shifting of the casing occurs.

All bracket poles on curves sharper than two degrees and all wooden poles on street and highways, either of bracket arm or span wire construction shall be keyed or anchored by the use of two key timbers of six inches by eight inches cross section. One key, two feet long, shall be placed on edge behind the pole at bottom of pole; the other key, four feet long, shall be placed on edge against the track side or front of the pole twelve inches below the surface of the ground.

All steel poles on street and highway, either of bracket arm or span wire construction, shall be set in concrete, mixed wet, and consisting of one part Portland cement, three parts clean, sharp sand, and five parts good, hard gravel or broken stone of size sufficient to pass through screen with holes two inches in diameter and to be retained by screen with holes three-quarter inch in diameter.

Concrete settings shall have a diameter at least twelve inches greater than that of pole and shall completely fill pole hole to a level six inches below surface of ground. The concrete from a level six inches below the ground to a level six inches above the surface of the ground shall be smoothly finished to a diameter eight inches greater than that of pole and from the upper level shall slope up to pole on an angle of forty-five degrees.

In setting poles in rock, dynamite shall be used for blasting and shall be exploded by means of a battery located at a safe distance from point of explosion.

All blasting shall be handled by an experienced man and it shall be the duty of the line foreman to see that all other men are safely out of distance from the explosion.

In tamping dynamite in a blast hole no metal bars shall be used. All tamping shall be done with a wooden bar.

When blasting in the vicinity of buildings or other structures several logs or heavy pieces of timber shall be chained together to form a trammel work to prevent a violent scattering of the discharged material. Any damage which shall occur growing out of the blasting of a hole shall be immediately reported in detail to the general foreman of overhead.

Wherever there is any traffic all holes shall be carefully covered and guarded against the possibility of anyone

falling into same and at night they shall be covered and guarded by a red lantern.

The line foreman shall select his best men to do all framing of poles and shall himself supervise all framing and see that all crooked poles are so framed that when the poles are set the crooks will be longitudinal to the line. (A poor framer can spoil a fairly good lot of poles so that it will be impossible to get a uniform line.) The butts of all poles shall be squared and they shall be measured and the tops sawed off so that the poles are all uniform length. The pole top shall be placed in a framing jack and turned until the straightest side of the pole from the top to the butt shows on top of pole with the belly down and a gain not more than one-half inch deep shall then be cut. Care shall be taken in cutting gains to cut them so that there is a tight fit, the width of the gain shall be measured by the width of the cross arm. The distance from top of pole roof to top of gain shall be eight inches.

A round or cone pointed roof shall be cut on the pole with an axe or hand axe and dressed with a draw knife.

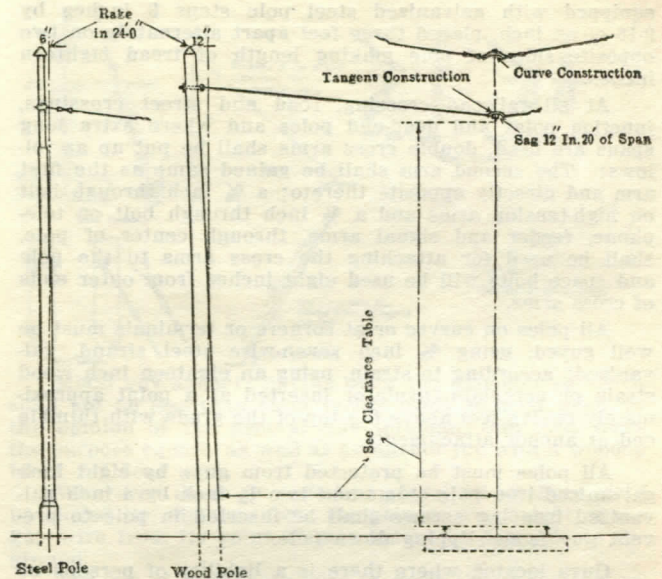
A hole shall be bored for the through bolt in the exact center of the gain from top to bottom and in center of pole from side to side.

Unless wire or other structures interfere in the raising of poles, all cross arms, cross arm braces and pins shall be applied to pole before same is raised. Care shall be taken to distribute the smaller diameter poles so that the best average stability of the line shall be maintained throughout.

In setting poles the butt shall be placed over hole and the top of pole in raising gin. The pole shall then be raised by hand to the height it is possible to get the pikes into the pole to a good advantage. Each time the pole is raised the man operating the gin shall move it up to support the pole while a fresh hold in the pole is made by the pike men.

In operating the gin the operator shall first set the top of the gin against the pole, maintaining the gin at an angle against the pole. After the top has caught the pole the bottom shall be carried ahead as far as possible so that the pole does not have to be lowered on to the gin. Occasionally poles with large butts or of considerable length necessitate a trenching from side of hole to facilitate the raising of the pole and prevent the butt from shooting beyond top of hole.

With bracket construction all poles shall have a rake of six inches away from track at a height of twenty-four feet above top of rail; steel poles with brackets, of three inches in twenty-four feet. With span construction, the



rake shall be twelve inches at same height above rail; steel poles with span shall have rake of six inches in twenty-four feet, poles to have above rakes after taking final strain.

Poles are to be lined by foreman to the position they are to occupy and in lining care shall be taken that all cross arms are at right angles with line or center line of track as the case may be.

Poles shall be faced alternately ahead and back. In case of double line of poles, poles shall be faced alike.

After accurately setting and lining poles as aforesaid, the tops shall be parallel with the track grade.

Poles shall be braced to the position as lined by foreman and then tamped.

There shall be at least two men tamping at each pole to one shoveler and care shall be taken that a thorough job of tamping is done, particularly near the bottom of the pole, in fact, a thorough job of tamping must be done the full depth of the hole and the amount of dirt the shoveler puts in shall be governed by the advice of the tampers.

All test poles, poles bearing signal and any other poles that are liable to be climbed frequently shall be

equipped with galvanized steel pole steps 9 inches by 9-16 of an inch, placed three feet apart alternately on two opposite sides of pole making length of tread eighteen inches.

At all railroad crossing, road and street crossings, junction poles and dead-end poles and where extra long spans are used, double cross arms shall be put up as follows: The second arm shall be gained same as the first arm and directly opposite thereto; a 3/4 inch through bolt on high-tension arms and a 5/8 inch through bolt on telephone, feeder and signal arms. through center of pole, shall be used for attaching the cross arms to the pole and space bolts will be used eight inches from outer ends of cross arms.

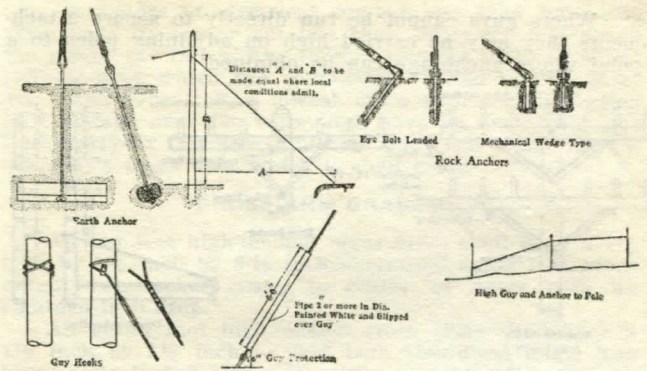
All poles on curves or at corners or terminals must be well guyed. using 3/8 inch seven-wire steel strand, galvanized; according to strain, using an eighteen inch wood strain or porcelain insulator inserted at a point approximately twelve feet above the top of the grade with thimble end at anchor attachments.

All poles must be protected from guys by eight inch galvanized iron pole shims and two 1/2 inch by 4 inch galvanized iron lag screws shall be inserted in pole to prevent guy from slipping down pole.

Guys located where there is a liability of persons or animals running into them shall be made conspicuous by a piece of pipe two inches or more in diameter and six feet long, painted white and slipped over guy, resting on anchor rod eye. Where guy is already installed a wooden casing, three inches in diameter or square and six inches long, may be used in place of the pipe. The halves shall be well white-leaded and shall clamp the guy tightly when screwed together, the bottom resting on anchor rod eye.

All guys must have two wraps around pole and each strand must have four wraps around main wire, the lower end of the guy to be inserted in the eye of the anchor rod and "made up" or served as above designated. The necks of all guys shall be of same length as thickness of pole at point where guy is placed.

Galvanized iron anchor rods 3/4 inch by 8 feet in length, capped with a wooden block, four feet long and six inches by eight inches in cross section, protected from nut of anchor by a two inch galvanized washer, shall be buried not less than five feet deep with earth solidly tamped around it, or if rock is reasonably obtainable, two feet of rock and earth shall be well packed into hole and the earth filling above thoroughly tamped. The anchor rod shall pass through center of dead man and must be in line of pull of guy to prevent bending.



Metal guy anchors having discs the diameter of which shall not be less than eight inches shall be used when, in the opinion of the general line foreman, they will serve the purpose equally as well as an anchor rod with a wooden block for dead man.

Wherever there is sufficient room, all anchors shall be buried the distance from the pole, as the height of the guy wire from its point of attachment on the pole to the ground.

The use of messenger wire to serve the purpose of an anchor rod is condemned, except for a temporary line, when it may be used together with three-bolt clamp to save tying or making up ends.

Anchors in rock shall consist of eye-bolt securely leaded or sulphured for entire length of shank in hole inclined at right angles to pull of guy. In rock of sufficient strength to withstand safely the action, mechanical wedge type eye bolts may be used, and the lead or sulphur omitted.

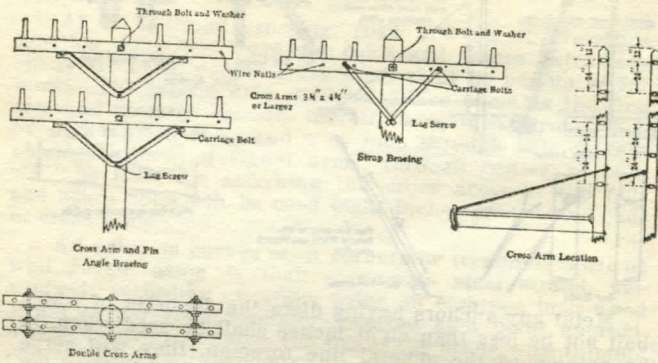
The foreman in charge shall so arrange his work that without any special detailing of his groundmen they will always find time to dig holes for the burying of slugs or dead men for the purpose of guying poles.

Where practicable guys shall be anchored to adjacent pole at point not less than seven feet above ground.

All guy stub poles shall have a round roof and shall be set to a depth of not less than five feet and shall be set so that the belly of the guy stub faces the pole to which the guy is attached. All guy stubs shall be raked at least eighteen inches toward the anchor.

When exceptional corners or terminals are met with and guy stubs are found necessary, it is a good plan to put twice as many guys between the anchor and the guy stub as between the pole and guy stub.

Where guys cannot be run directly to secure attachments they may be carried high on adjoining poles to a point where anchorage can be obtained.



CROSS ARMS.

Cross arms shall be given one coat of approved preservative or two coats of paint before pins are installed.

Cross arms shall be located on the face of poles as shown in standard drawing or as shall be directed by general line foreman.

Gains shall be cut of the exact width of the cross arm and to a depth of one-half inch and so that the cross shall fit tightly.

All cross arms shall be held to pole by a through bolt driven from back of pole toward and through arm, having a washer on each end.

High-tension cross arms shall be fastened to poles with a 3/4 inch through bolt and all feeder, telephone and signal arms shall be fastened to pole with a 5/8 inch through bolt, using a two inch square galvanized iron washer under the head and nut of all through bolts.

All cross arms shall be drawn up pole by use of a hand line and shall not be carried up pole by linemen in his arm or belt. All cross arms shall be equipped with proper braces and pins applied on ground before raising.

The same method shall be pursued in double arming poles as in putting on the single arm and double arm shall be installed in the same manner as hereinbefore instructed.

Cross arms must be squared with a line stretched from center of top of pole to center of pole at a point six feet from butt and all cross arms on same pole must be parallel to each other and parallel with trolley bracket if trolley bracket is used.

The lowest feeder, telephone or signal cross arm, carry-

ing conductors of electrical current less than 700 volts, shall have its center not less than thirty-one feet above the top of the rail of any foreign railroad track or street railway over which the conductors carried on the cross arm shall cross. The lowest cross arm carrying wires of a voltage over 700 volts shall have its center not less than thirty-six feet above the top of the rail of any foreign company's track over which it shall cross.

CROSS ARM BRACES.

All ten feet high-tension cross arms shall have a 1 1/2 inch by 1 1/2 inch by 3-16 inch sheridized angle iron brace seventy-two inches center to center of holes with an eighteen inch drop.

All seven foot high-tension cross arms shall have a 1 1/2 inch by 1 1/2 inch by 3-16 inch sheridized angle iron brace sixty inches center to center of holes with eighteen inch drop.

All telephone, feeder and signal cross arms shall have two flat sheridized strap braces 1 1/4 inch by 1/4 inch by 26 inches center to center of holes.

In some instances at the discretion of the general line foreman a single 1 1/4 inch by 1/4 inch by 26 inch sheridized iron brace may be used when the stability of the line is found not to require two braces.

Two 1/2 inch galvanized machine bolts shall be used to fasten brace to high-tension cross arm and a 3/8 inch galvanized carriage bolt shall be used to fasten strap iron braces to cross arms. Galvanized washers are to be used under head of bolt.

No washers shall be used on carriage bolts used for brace bolts.

The head of the brace bolt on the high-tension cross arm shall be put on the top of the cross arm, this to avoid the dropping out of the bolt should the nut work off.

Braces are to be placed opposite the pole side of cross arms or on the outer face of arms.

All cross arm braces are to be fastened to the pole with 1/2 inch by 4 inch galvanized lag screws.

PINS.

Pin shanks shall be dipped in an approved preservative or paint and while wet firmly seated in hole.

All pins shall be fastened in cross arms at the store yard before cross arms are distributed. All wooden pins shall be fastened into cross arm by an eight penny nail driven downward through the arm into shank of pin, the head of the nail to be kept clear of arm so as to permit easy withdrawing of nail. All iron pins shall be provided with washer to protect cross arms.

PROTECTION.

At steam railroad crossings and at crossings of aerial conductors special protective devices should be employed and constructed according to design approved by Engineer Maintenance of Way.

No telephone, feeder or signal wire or other form of conductor carrying electric current less than seven hundred volts, except trolley wire, shall cross the track of a foreign company under a minimum vertical clearance of thirty feet and shall be above the wires of a foreign company five feet.

No conductor carrying electric current of over seven hundred volts, except trolley wires, shall cross the tracks of a foreign company, under a minimum vertical clearance of thirty-five feet, and shall be above the wires of a foreign company eight feet.

Metal trolley troughs, for the prevention of the trolley leaving the wire, made of either No. 16 gauge galvanized sheet iron or No. 8 gauge galvanized woven wire together with proper attachments should be placed over all railroad crossings extending forty feet each side of the foreign railroad crossing.

HIGH-TENSION LINE.

No. 2 gauge B. S. standard hard drawn bare copper wire shall be used on all transmission line work.

Pins used in the construction of all transmission lines shall be high grade locust pins, thirteen inches over all with a six inch shank, 1 1/2 inches in diameter and 1 1/4 inches in diameter at head of pin. Pins shall be fastened in cross arm by means of an eight penny nail driven downward into shank of pin, the head of the nail to be kept clear of arms so as to permit of easy withdrawal.

Transmission line cross arms should be 4 1/2 inches in thickness and 5 3/4 inches in depth and the holes shall be so spaced in cross arms that the phases are at least thirty-six inches apart.

All transmission line cross arms shall be braced by 1 1/4 inch by 1 1/4 inch by 3-16 inch galvanized angle iron braces.

All transmission line insulators shall be of porcelain and shall be rejected if not capable of standing the following tests:

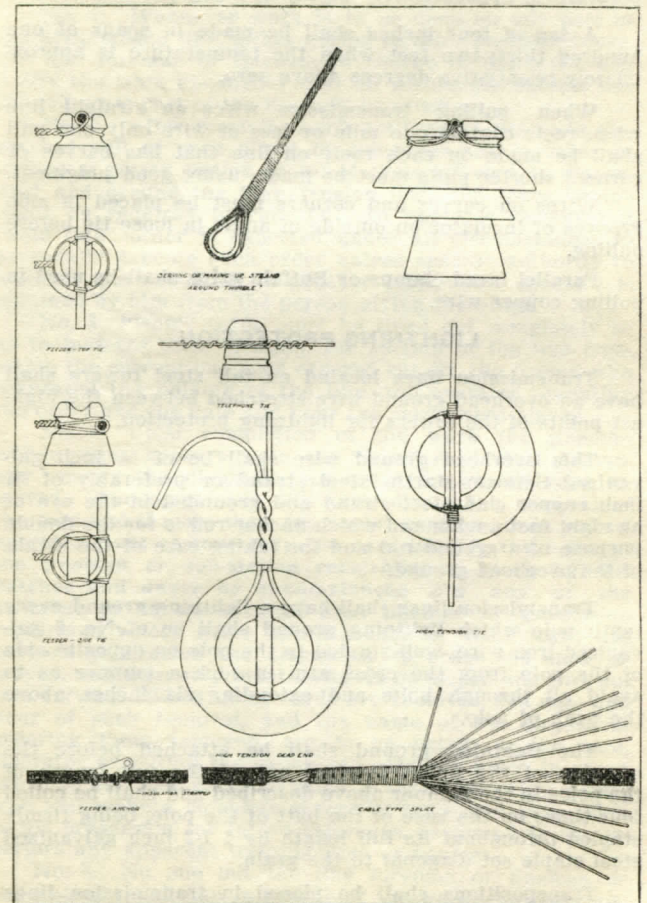
Insulators for high-tension service shall be subjected to a flash-over test for five minutes, that is a continuous flash over the insulators for a period of five minutes, which is deemed equivalent to twenty years service. An insulator that has stood a five minute flash-over test and has a standard weight test of twice the working voltage will not be apt to puncture as a surge would flash over

the insulator into the cross arm before puncturing the head.

All wire shall be tied to the insulator with No. 6 gauge B. S. standard soft drawn copper wire forty inches in length.

All splices in transmission wire shall be effected by the means of copper connecting sleeves.

The method used to tie transmission wire to the insulators shall be as follows:



The tie is placed staple-wise in side groove of insulator, given two complete turns around line wire, brought back on opposite side of insulator and given four complete turns around line wire and cut off close to line wire.

A sag of seven inches shall be made in every one hundred foot span and a sag of nine inches shall be made in every one hundred thirty-two foot span when the temperature is approximately eighty-five degrees above zero.

A sag of four inches shall be made in spans of one hundred thirty-two feet when the temperature is approximately twenty-five degrees above zero.

When pulling transmission wires on straight line when reels contain one mile or less of wire only one pull shall be made on each reel; on line that has curves or corners shorter pulls must be made, using good judgment.

Wires on curves and corners must be placed in side grooves of insulator on outside of angle in loose tie before pulling.

Parallel faced clamps or Buffalo grips shall be used in pulling copper wire.

LIGHTNING PROTECTION.

Transmission lines located on tall steel towers shall have an overhead ground wire stretched between the high-points of the towers for lightning protection.

This overhead ground wire shall be of 3/8 inch galvanized Seimans-Martin steel strand or preferably of 3/8 inch copper clad steel strand and grounded in the eye of an eight foot anchor rod which anchor rod is for the double purpose of a ground rod and for taking care of the strain of the overhead ground.

Transmission lines shall have a lightning ground every tenth pole which lightning ground shall be of No. 6 galvanized iron wire, well stapled to the pole on opposite side of the pole from the cross arm in such a manner as to avoid all through bolts and extending six inches above the peak of pole.

The lightning ground shall be attached before the erection of the pole. It shall extend the full length of the poles in the manner above described and shall be coiled four times on the base of the butt of the pole, being firmly stapled throughout its full length by 1 1/2 inch galvanized steel staple set diagonal to the grain.

Transpositions shall be placed in transmission lines at points indicated by the Engineer Maintenance of Way.

RULES FOR THE SAFETY OF EMPLOYEES IN CONNECTION WITH THE RECONSTRUCTION AND REPAIR OF HIGH TENSION TRANSMISSION LINES AND ALTERNATING CURRENT APPARATUS.

No. 1. Whenever work is to be done on any part of the high-tension line, either during or after business hours, the line foreman or lineman in charge of the work will notify the train dispatcher that he wishes the current cut off and what part of the line will be affected.

No. 2. After receiving such notification the train dispatcher will at once direct by telephone the operator in charge of power station or sub-stations affected, to disconnect and ground the high tension line, and place "hold" cards as required in rule 14. An operator receiving a "hold line" order is expected under all circumstances to personally execute such order unless specific authority to delegate the execution to another responsible operator is obtained by him from the person giving the order.

No. 3. "Hold" cards must be filled out completely so as to indicate their location, the section of the line from which the current has been ordered cut off, the person who requested the holding of the line, the operator executing the order and the date and hour the cards were placed.

No. 4. Upon completion of the work the lineman whose name appears upon the "hold" card must personally notify the dispatcher to order the "hold" card removed. The dispatcher will then direct the removal of the card and if more than one "hold" card has been placed, operator must remove only the card bearing the name of the lineman or sub-station repairman as given by dispatcher and under no circumstances are any of the switches to be closed until each lineman or sub-station repairman whose name appears upon a "hold" card has personally directed the dispatcher to order the card removed, and then only must switches be closed and line put into service. When these cards are removed, the date and hour of such removal, and the name of the dispatcher ordering them removed, are to be noted on the card. Operator executing the order will sign his name in space provided and then send the same to the electrical engineer, who will make a complete record of same and keep them in his possession for future reference, reporting to his superiors any apparent irregularities or neglect.

No. 5. No one but the line foreman or lineman or sub-station repairman in charge of the work, the train dis-

patcher, the ranking operator at power station and sub-station operators will give or receive any instructions relative to cutting the high tension current out or in.

No. 6. The train dispatcher in giving an order to the operator at power station or sub-station to cut current off from certain high-tension line or lines, will state the name of the lineman requesting the line held and what section of the line is wanted. The operator will write this as received, plainly and without abbreviation on the "hold" card provided, and when he has finished writing the order he will repeat it to the train dispatcher and give his name. If correct, the dispatcher will give his name and the time, which name and time shall be promptly written on the "hold" card.

No. 7. The train dispatcher must keep before him a copy of the "hold" card on which must be recorded the name of the lineman or linemen, if more than one requested the line be held, the station holding the line and the names of the operators receiving the orders and the time of each order.

No. 8. When a lineman desires to work on a section of the high tension line or any high tension apparatus which is already being held for another lineman at some other point, he will notify the dispatcher, who will immediately order additional "hold" cards filled out and placed on control switches in stations affected, as per rules Nos. 1, 2, and 3. In removing this additional "hold" card, instructions in rule No. 4 must be followed.

No. 9. In case of one phase of high tension switches only opening at either power house or sub-station, it may be replaced immediately without getting into communication with any one.

No. 10. In case two or more phases of high tension switches in power station or intermediate sub-stations opening automatically on the high tension line from no apparent cause, notify train dispatcher immediately and wait five minutes, then the station operator shall call the dispatcher again and be advised by the dispatcher as to what to do about closing the switches, time shall be allowed the operators in sub-stations affected to get their stations clear of the line as required in rule 13. After a lapse of five minutes the switches can again be closed, provided the station operators have the train dispatcher's permission to do so, and the sub-station start up as soon as they get the power. If the station operator cannot get dispatcher over telephone he will wait an additional five minutes before closing his switches and at the expiration of ten minutes he will close his switches and place his station in operation. If, however, the switches again open automatically before and after the sub-stations are put

back on the line the train dispatcher will immediately notify the line foreman and will proceed forthwith to make such tests between stations as are necessary to ascertain the location of the trouble. In these tests the line foreman or lineman will work in conjunction with the train dispatcher and the operators in power station and sub-stations.

No. 11. When the section of line in trouble is located all sub-stations, if any, between the trouble and the power station, will again start up and remain on the line.

No. 12. When linemen arrive at trouble they must, before making any repairs, request dispatcher to order "hold" cards placed as required in rule No. 3 and under no circumstances should they assume that the line is dead. It must be understood that the line is held only for the man whose name appears on the "hold" card.

No. 13. In case of an interruption in the high tension current, sub-station operators will immediately open the alternating current and direct current rotary converter switches, then notify the train dispatcher that the station is clear of the line; remain close to the telephone so as to answer promptly when called, and prepare to assist in making such tests or repairs as may be necessary. During the time an attempt is being made to put high tension on the line, sub-station operators will watch high tension wiring on inside of station to be able to determine if trouble is inside. He should also inspect outside wires where they enter the building.

No. 14. When dispatcher orders "hold" cards placed, as required in rule No. 3, operators must disconnect the apparatus from the line as follows:

Power Stations.

The high tension oil switch on out going lines is to be opened and blocked and the air brake switches in tower opened and then a ground connection put on the line side of each of the outgoing wires of the line affected.

Terminal Sub-Stations.

In terminal sub-stations open the rotary A. C. and D. C. switches so as to shut down all machines. Then open high tension oil switch and air brake switches and place ground connection on each wire on the line side of the high tension air brake switches.

Intermediate Sub-Stations.

The intermediate sub-stations, if the interruption is on the incoming line, then the rules governing terminal sub-stations will apply, with the addition that all the switches controlling the outgoing high tension line should also be open.

If the interruption is on the outgoing line then the oil

switch and air brake switches are to be opened and a ground connection put on each wire on the line side of the air brake switches. No ground connections are to be made without first opening the controlling high tension switches. As soon as the operators in the stations on each end of the section of the high tension line on which "hold" cards were ordered placed have properly disconnected the line called for, and grounded same, they will advise the train dispatcher accordingly, the train dispatcher will then notify the linemen.

No. 15. Before touching any conductor of the high tension line, the linemen will make a careful inspection to see that there is no condition existing which may endanger him in his work. Then, before getting closer than three feet, throw a chain over circuits each side of the place where work is to be done and be certain that the chain is in perfect contact with all phases and chain grounded. The chains should have at least 20 feet of paraffin rope at each end.

No. 16. Great care must be exercised in all cases, particularly when two or more crews of men are working on the same line or apparatus at the same time.

No. 17. Line foreman or lineman should always, so far as possible, be on the telephone line when dispatcher orders "hold" cards placed or removed, as required in above rules. They should listen to the conversation between train dispatcher and operators and know that the rules are being carried out to the letter and any infractions should immediately be reported to their immediate superior officer. In all cases of doubt the lineman will consult the operator of power station or sub-station and in case of further doubt will consult his immediate superior.

No. 18. Employees in telephoning to operators should be brief and accurate.

No. 19. After each serious interruption to service a thorough investigation will be made into the cause and conduct of each employee in restoring service.

No. 20. Cases may arise where the strict enforcement of the above rules will seriously impede the progress of the work on hand. In such cases linemen may make such temporary modifications of these rules as will expedite the work without materially increasing the hazard to workmen or system. When communication cannot be had with dispatcher the operator will follow out instructions from lineman or sub-station repair man in same manner as when instructions are given by dispatcher. Operator will then get the dispatcher as soon as he can and repeat the instructions given by lineman or sub-station repairman.

No. 21. No employee shall touch or expose person

by dangerous proximity either with or without rubber gloves to any switch, current or potential transformer, cable, wire, bus bar or any other apparatus or conductor on which a potential of higher than 650 volts exists, until he has positively ascertained that such apparatus or conductor is disconnected from all sources of such potential. All such high tension apparatus and conductors of every kind, even if properly insulated, must always be considered and treated as bare high tension conductors and dangerous.

No. 22. If cars cannot be operated linemen are authorized to hire whatever conveyance is necessary to ployees are instructed to use commercial telephone or telephone lines are out of commission linemen and other employees are instructed to use commercial telephone or telegraph lines for the purpose of restoring service.

No. 23. It is of importance that in cases of serious delays your superior officers be kept posted as to general conditions by any method by which they can be reached.

No. 24. The term "hold" card used in the above instructions signifies a card which is to be placed by the operator after the opening up and grounding or short circuiting the line as previously described. The display of this card is an assurance to all parties interested that the current is cut off from the section or apparatus indicated.

(COPY OF "HOLD" CARD.)

Station Date 191...

(Power or sub.)

Hold line between and for

(Name of lineman or repairman)

Signed Dispr. Time..... A. M.

(Operator receiving order)

P. M.

HOLD

REMOVED: A. M.

Date 191... Time..... P. M.

Dispatcher ordering card removed

Signed

(Operator removing card.)

OVERHEAD LINE CROSSINGS.

Wherever the overhead lines of this Company shall be constructed across the overhead lines of another Company the construction employed by this Company shall be of the best and strongest materials obtainable and shall generally conform to the following rules, except when the Engineer Maintenance of Way shall otherwise order.

These rules shall apply particularly to the construction of high tension power and transmission lines above other transmission lines or telephone or telegraph lines, and are to cover a certain minimum standard of construction for this Company's overhead lines in crossing over the overhead lines of other companies.

The wires of this Company shall have a vertical clearance above the wires of the company crossed of not less than eight feet, taking into consideration the maximum sag under the most unfavorable conditions of temperature and loading, except, trolley contact wires; and the supports for the overhead conductors shall have a side clearance unless physical conditions or municipal requirements prevent, of not less than twelve feet from the nearest structure of the company crossed.

In crossing the railroad tracks of another company the side clearance shall not be less than twelve feet from the nearest track rail, except that at sidings, a clearance of not less than eight feet may be allowed. At loading sidings or team tracks sufficient space shall be left for a drive-way.

Poles, or towers, shall preferably be located outside the foreign railroad company's property, except in unusual cases or to secure a shorter crossing span.

Steel towers shall be of the design and construction approved by the Engineer Maintenance of Way.

Concrete poles shall be constructed of Portland cement and of the best aggregates obtainable, preferably clean, sharp sand and crushed trap-rock, free from clay, loam or other impurities.

The metal reinforcements for concrete poles shall be a mild steel such as fills the specifications for structural steel of the American Railway Engineering and Maintenance of Way Association.

The mixture shall be such as to give a concrete without appreciable voids and having a compressive strength of not less than 2,000 pounds per square inch when tested in eight inch cubes at 28 days.

Wooden poles shall be of selected timber, reasonably straight, peeled, free from defects which would decrease their strength or durability; not less than eight inches minimum diameter at the top, and of such strength as not to break under the maximum load conditions of any

or all of the conductors in the adjacent spans each side if the central crossing span should break.

The Engineer Maintenance of Way shall supply approved drawings for the construction of all concrete poles.

Poles thirty feet and under shall be set five feet six inches deep in earth and five feet deep in rock.

For poles longer than thirty feet, the settings herein just before specified shall be increased six inches for each additional five feet in total length, up to, and including an eight foot setting.

When poles are located in swampy ground, the sides of banks, or locations subject to wash-outs, the settings herebefore specified shall be increased, or settings shall be protected by stone, concrete, timber cribbing or rip-rap.

Where guys can be placed, the total strength of the guyed structure shall be sufficient to sustain the maximum stress.

No guy shall be less than three-eighths inch nominal diameter, double galvanized stranded steel of a tensile strength not less than 4,500 pounds.

All wooden crossing poles, supporting four or more No. 6 B. & S. gauge wires or their equivalent in section, shall be head-guyed away from the foreign company's property and shall be sufficiently guyed at other points to take strain, due to change in alignment or change in mechanical tension.

Guys attached to wooden poles or to wood stubs and having in their vicinity potentials exceeding 500 volts, but not exceeding 9,000 volts, whether carried on the guy poles or otherwise, shall be provided with at least one strain insulator which shall be of a breaking strength not less than that of the guy in which it is placed. This insulator shall be placed not less than eight feet vertically above the ground line.

Every guy which passes over or under any electric wires other than those carried upon the guyed pole shall be so placed and maintained as to provide at all times a clearance of not less than two feet between the guy and such electric wires.

Guys to the ground shall connect to a galvanized anchor rod, extending at least one foot above the ground level.

Cross arms shall be double on the crossing poles or towers.

The cross arms and their attachments shall have sufficient strength to provide against breaking in the case of the breaking of any or all of the wires in the span adjacent to the crossing span.

Cross arms shall be four and one-half inches in thickness and five and three-quarters inches in depth for all

be obtained with the above materials galvanized or copper steel strand may be used.

All conductors used in a crossing larger than a 4-0 B. & S. gauge wire, shall be bare-stranded wire.

No. 2 standard copper wire shall have a minimum sag of four inches in every 100 feet or span when temperature is approximately 85 degrees above zero.

A minimum sag of three inches shall be made in spans of 100 feet when the temperature is approximately 25 degrees above zero.

Lightning protection wires supported above the crossing conductors shall not be less than No. 4 B. & S. gauge copper or copper clad wire. Three-eighths inch nominal diameter, or larger steel strand, double galvanized and having a breaking strength of not less than 4,500 pounds may be used. When such wires are installed on any other than a thoroughly grounded steel structure they shall be permanently connected to the ground at each of the crossing poles, or towers, with a copper wire, preferably of No. 1-0 B. & S. gauge, but not less than No. 4 B. & S. gauge or equivalent in section. The course of this ground connection shall be as straight as possible.

All lightning ground wires shall be wrapped around and thoroughly soldered to a one inch by eight foot galvanized iron pipe and the ground wire shall be protected by a one inch moulding strip for a distance of eight feet above the surface of the ground.

Where wooden or concrete poles are used instead of steel towers for the overhead line crossing, the crossing poles shall be spaced not more than one hundred feet apart and they shall be head guyed away from the point of crossing. The next two poles on either side of the crossing poles shall be set approximately one hundred and thirty-two feet from the crossing poles.

The head guys on crossing poles shall extend to next adjacent pole and be attached to same at a height of six feet above the ground surface.

The poles next to and on each side of the crossing poles shall be both head and back guyed to butts of adjacent poles on line, at a height of six feet from ground surface.

Crossing poles shall be side guyed when possible. Anchors for side guys being placed from the pole a distance equal to one-half the height of the pole.

All guys at crossings shall be made of not less than three-eighths inch galvanized steel strand and shall be insulated by wood or porcelain strain insulators equal to the line potential and with an ultimate strength not less than one and one-half times the breaking strength of the guy.

The conductors shall be of not less than No. 2 B. & S. gauge hard drawn stranded wire. The conductors shall be carried on line insulators which insulators shall be double on the crossing poles or tower and the poles on each side of the crossing poles or towers.

Suspension strain insulators shall be attached to eye bolts through both arms on each crossing pole and on the two line sides of crossing poles. The conductors shall be attached to strain insulators on both line sides of pole by means of three bolts clamps and a short piece of strand wire of the same diameter and material as the conductors.

The ground wire shall be of 1-0 copper B. & S. gauge and shall be grounded to each pin, this may be done by running a plate across on top of the cross arm and grounding pins to the plates.

FOREIGN COMPANY'S OVERHEAD LINE CROSSINGS.

The following specifications define the minimum requirements and describe the type of construction desired by this Company in the erection and maintenance of electric transmission, lightning and power lines of other companies at points where such lines cross the tracks, right of way or property of this Company.

The Company installing a crossing under ground, over head or beneath a bridge, shall, on the completion of the work, promptly replace and restore the property and site to its original condition, and shall remove all plant and rubbish incident to the construction of the crossing.

Wires, or cables, shall be carried in some suitable form of vitrified earthen ware, treated fibre, creosoted pump stock, or iron pipe conduit of a size sufficient to permit the wires, or cables, to be readily drawn in and shall terminate in man holes, pole boxes, or terminals located, if possible, outside of this Company's property.

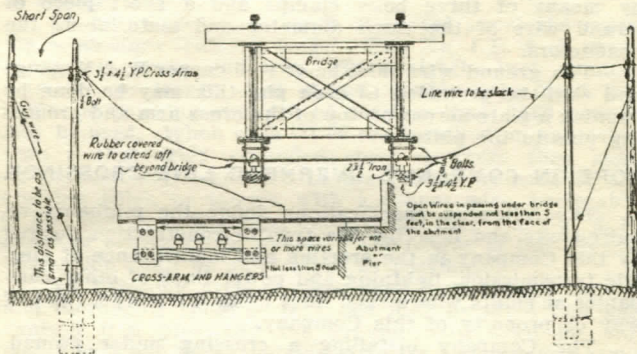
The top of the conduit shall be located at a depth of not less than four feet below the base of the rail nor less than two feet six inches below the surface of the ground at the lowest point of the crossing of this Company's property, wherever possible. Conduits shall be laid with a uniform slope of not less than one-eighth inch to the foot to drain away from this Company's property.

Conduit shall be laid on a footing of concrete not less than three inches thick and the sides shall be protected by concrete not less than three inches thick. Over the top shall be laid a covering of concrete not less than three inches.

Wires, or cables, may be supported beneath bridges in a grounded iron or lead pipe conduit, supported at suit-

able intervals, and extending three feet beyond the bridge structure.

Conductors carrying a potential in excess of five thousand volts constant potential or 10,000 volts constant current shall not be installed beneath steel bridges in open construction, unless the clearance between any portion of the bridge structure and the wires or cables shall not be less than eight feet.



Where wires or cables pass beneath bridges and are attached thereto, the construction of the supports adjacent to the bridge shall conform to that portion of these specifications following relating to overhead crossing construction and to the rules our Company observes in crossing overhead of foreign company.

Wires, or cables, supported in open construction or in cables shall be supported not less than five feet in the clear from the face of the abutment.

The minimum clearance between wires or cables and any portion of the bridge shall generally be one foot, but in no case less than six inches.

The separation of conductors at the bridge attachments shall not be less than nine inches.

Spans attached to and supported beneath bridges shall not exceed fifty feet between supports.

Insulators shall conform generally to the same specifications of the insulators used by this Company.

The attachment of conductors to insulators shall conform generally to the method used by this Company under similar conditions.

The pins shall be of locust or steel, and these shall be used according to the method this Company uses them under the same conditions.

Pin supports shall not be less than three and one-half inches in section and shall be supported by a method approved by the Engineer Maintenance of Way of this Company.

The pin supports attached to the bridge shall be plainly marked by a sign reading "Dangerous, do not touch," and the name or initial of the owning company.

For overhead crossings the poles, or towers, shall preferably be located outside this Company's property, except in unusual cases or to secure a shorter span.

Long crossing spans shall be avoided and wherever possible shall not exceed 100 feet in length.

Wherever practicable, the adjoining spans shall be of a length not in excess of one and one-half times the length of the crossing span and it is desirable that all spans be approximately the same length.

It is desirable that the crossing span be at approximately right angles to this Company's tracks, but it is more important that the crossing and adjoining poles or towers be located in a straight line, when this may be done without installing an unusually long crossing span.

The poles, or towers, shall be located as far as possible from inflammable material or structures.

The wires, or cables, shall cross over the telegraph, telephone and similar wires wherever practicable and in crossing wires of this Company carrying a lower potential than the wires of the foreign Company, the foreign company should construct their line above this Company's lower potential wires. If the wires of this Company are conductors of a higher potential than the line crossing us, it is permissible to allow them to go below our higher potential lines, provided there is no interference and that the proper clearances prescribed by the state law can be obtained.

Cradles, or overhead bridges, shall not be used beneath the crossing wires or cables; but, in cases where the crossing wires or cables cross beneath this Company's telephone or low potential conductors, a protection of adequate strength and proper design may be required between the two sets of crossing wires or cables.

The side clearance of overhead structure crossing this Company's right of way shall not be less than twelve feet from the nearest rail, except that at sidings a clearance of seven feet may be allowed.

At loading sidings sufficient space shall be left for a drive-way.

The desired verticle clearance above the top of rail under the most favorable conditions of temperature and loading is thirty-five feet, but in no case shall this clearance be less than thirty feet, except trolley contact wires

which may be supported at a height of not less than twenty-three feet.

The clearance between the crossing wires, or cables and any existing wires, under the most unfavorable conditions of temperature and loading, shall preferably be eight feet.

The material and workmanship used in constructing crossings by this Company over foreign companies shall be the standard by which the material and workmanship of other companies shall be gauged except as herein before stated.

FEEDER.

All feeder shall be of bare copper wire or cable, except for such distances in cities and towns where triple braid insulated wire or cable shall be strung.

All feeder wire shall be of at least 4-0 B. & S. gauge. Care shall be taken in unreeling wire to keep the same out of wind and free from kinks or sharp bends.

One-half mile of feeder shall be drawn up and tied in at one time, allowing seventeen inches sag in a hundred and thirty-two feet span where the temperature is approximately eighty-five degrees above zero and a sag of ten inches when the temperature is approximately twenty-five degrees above zero.

Two three-shieve five inch shell blocks, together with three bolt clamps or Buffalo grips, must be used in pulling feed wire; no Haven clamps shall be used.

For splicing feed wire a six inch four-naught splicing sleeve shall be used, similar to Electric Railway Equipment Co.'s Cat. No. 6328. The ends of the wire shall be inserted in sleeve from opposite ends meeting exactly in center, the nuts shall then be placed on ends of sleeve and tightened with wrench, solder shall be poured in hole provided in sleeve. Wire shall be well cleaned before splicing. Sufficient time must be given solder to cool before placing strain on splice.

Cable or strand wire splices shall be made up or wrapped cable type splices and soldered so as to be mechanically and electrically equal to the cable itself.

Wrapped cable type splice shall be made by stripping the ends to be spliced for twenty-four inches, unlaying and brightening eighteen inches of these bare ends, cutting out the core strand of each and passing the wires of one end between those of the other and laying parallel with main cable.

The wires of one strand either side of middle of splice are then close served over main portion and rest of wires of that end; a second pair of strands is similarly served on, and so on, until the last pair of strands serve simply on

the main portion. The splice shall then be sweated full of solder and smoothly taped to equivalent of original insulation if cable is insulated. (See page 127.)

To splice solid feeder when regular splicing sleeve is not available, clean ends to be soldered, placing them side by side and wrap with cleaned annealed copper wire, leaving about two inches on each side of wrapping, apply soldering paste or stearine and solder with hot pot of metal. Bend ends at right angles with main wire and cut off with bolt cutters.

Feeder shall be insulated on saddle type porcelain insulators having a working voltage of 6,600 volts.

Feeder line shall generally be strung on top groove insulators on locust pins in lower cross arm on track side of arm.

The feed wire shall be placed in the top groove of the insulator.

Malleable iron side brackets with a curved back and three lag slots in the back shall be used for the support of a single feed wire.

All malleable iron brackets shall be fastened to the pole with three 1/2 inch by 4 inch galvanized cone pointed lag screws.

Where two feeder wires are constructed on the same pole, they shall be supported by cross arms.

A No. 6 B. & S. gauge soft drawn copper wire eighteen inches long shall be used in the following manner for tying feed wire to insulator. The tie wire shall be placed staple-wise in side groove of insulator, the ends shall then be given two complete turns around feed wire, brought back on opposite side of insulator and twisted together. The ends shall be cut off close to the twist. (See page 127.)

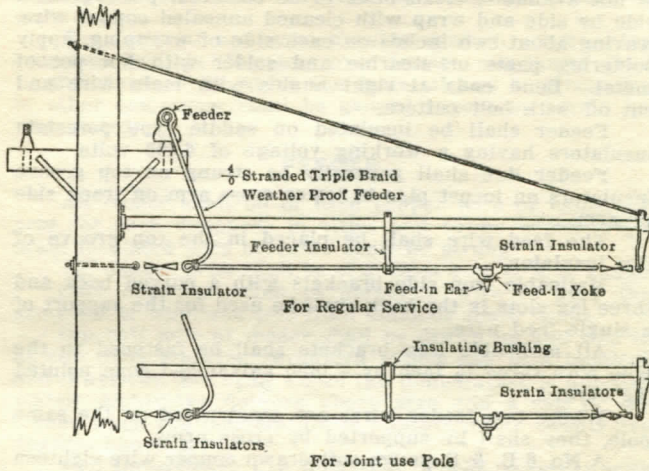
On turning corners at an angle less than twenty degrees, feeder line shall be double armed at corners and feeder tied in side groove of insulators on outside of corner angle.

An turning corners at a greater angle than twenty degrees, all strains shall be taken off of insulators and cross arms by snubbing feeder to pole on each side with double three-eighth inch strand wire, insulated with 1 1/2 inch by 11 inch wood break strain insulators, feeder line being slack between snubs.

In bracket construction on all corners and dead ends strain shall be taken off of brackets and insulators by dead-ending in wood strain insulators fastened to pole with three-eighths inch galvanized steel strand.

Feeder lines shall be tapped to trolley four times in each mile, the taps being placed approximately one-fourth mile apart. On straight line suspension the taps from the feeder to the trolley should in all possible cases be

of short pieces of old trolley, preferably wire of the same dimensions as the trolley and should form the suspension span in place of the strand wire span, connected to trolley by a Syracuse feed in yoke.



With bracket support the feeder connection shall run from feeder, to which it shall be well soldered to nine inch wood strain attached to span eye-bolt in pole, thence replacing the usual steel strand through insulated intermediate casting to nine inch wood strain or a clevis conical strain insulator attached to end casting of bracket.

With span support, the feeder connection shall run from feeder to nine inch wood strain attached to span eye-bolt in pole, thence, replacing the usual steel strand, to close tie in nine inch wood strain thirty inches beyond trolley farthest from feeder. Span shall be completed by three-eighths inch galvanized seven-wire steel strand, close tied in the strain and in the eye-bolt and shall have sag equal to sag in other spans.

One end of the wire serving as feeder tap shall be thoroughly cleaned and straightened and placed in parallel contact with feeder for six inches by use of a No. 10 soft drawn well cleaned copper wire being wrapped close and soldered around feeder and tap.

Where long spans, long heavy grades, or other conditions cause unusually heavy strains, feeders shall be anchored by mechanical clamps of approved type, secured to eye-bolt in cross arm through a nine inch wood break

strain. Covered feeder shall be bared so clamp takes direct hold on the metal.

If very heavy pull is to be anticipated, take guy from cross arm to next pole.

Section insulators shall be installed at a span suspended from hanger. Section switch-box shall be bolted to back of pole, using bolts of proper length, each with washer under head and nut, latter being inside box, which shall rest on cross arm carrying feeder sectionalized. The feeder shall be dead-ended in strains attached to eye-bolt at proper point in feeder cross arm and shall then enter box. If feeder drops from dead-end point it shall be carried lower than bushings in box, and then up to prevent drip from entering.

At all points where feeder tap connections are made a lightning arrester shall be placed connected to the feeder line to take care of lightning discharges.

The arrester shall be supported on the pole by use of two 1/4 inch by 3 inch lag screws fastened through the strap attachments at top and bottom of arrester box. The line side of arrester shall be tapped to feeder by being securely wrapped around feeder and soldered. The ground side of arrester shall be attached to No. 6 weatherproof wire by means of lug and set screw in arrester box and shall be extended in the most direct line to its attachment to the ground rod. No loops or coils shall be made in ground wire as it is the desire to conduct the discharge to the ground in the most direct manner.

The ground wire shall be attached only to the ground rod except when paving or rock renders it impossible to get a ground rod down to moisture, then the ground wire shall be attached to the rail by means of a coppered channel pin inserted in the web of the rail. The ground rod shall be a piece of one inch galvanized iron pipe eight feet long, driven into the ground so that not more than twelve inches of this pipe is above the surface. The ground wire shall be bared and scraped clean and given six close wraps around the pipe and well soldered. The rail attachments shall likewise be made to the pipe and well soldered.

A test of the Garton-Daniels arrester shall be made by taking a dry wooden coated lead pencil and passing the graphite point through the air gaps of the lightning arrester. If it draws and breaks an arc and the plunger in the relay coil acts, the lightning arrester is then in perfect condition and the job considered finished.

Similar test of lightning arresters shall be made at least every four months.

On catenary construction feeder taps shall be connected to trolley by means of an eight inch Detroit feeder

clamp. The feeder connection shall be made in the manner hereinbefore described, using at least a 3-0 solid tap wire.

The feeder tap shall be placed one foot ahead or back of mast arm being left free in center and shall in no instance go above or come in contact with catenary cable.

TROLLEY.

A nine foot flexible pole bracket or mast arm, with a 7-16 inch by 10 feet 6 inches over-support rod and no lower brace, of one and one-half inch "C" tubing shall be used for direct line suspension, except when in special cases longer ones are needed, as on the outside of a curve, then the length shall be determined by the conditions.

Suspension wire of three-eighths inch galvanized steel strand shall be made up and attached to end casting of bracket and entire bracket assembled on ground before being raised to position on pole.

The over-support rod of trolley shall enter the pole three feet six inches above center of bracket tubing and a beveled washer shall be used to protect pole from over-support rod nut.

The eye bolt shall be installed at level of trolley wire, the pole casting shall be a distance above center of eye-bolt equal to distance center to center between span eye and arm socket of end casting.

Pole casting shall be attached by two 1/2 inch by 4 inch galvanized lag screws.

Pole brackets shall be erected so that the arm has an upward rake from the horizontal of one inch in four feet of length, the intermediate casting shall be clamped on arm so that trolley wire comes midway between it and end casting; and the steel strands shall be close tied in to eye-bolt and into end casting. On steel poles, strain insulators shall be cut into strand on either side of hanger and between end and intermediate castings to give double insulation.

On steel poles eye for strand, socket for arm and pole attachment for over-support rod shall be carried by special fittings, clamped to pole.

On curves a galvanized double curve pullover shall be used properly insulated by two conical strain insulators where bracket arm construction is followed, in span wire construction pullovers shall be insulated by wood break strains, placed thirty inches each side of trolley wire.

On curves of over thirty minutes and under two degrees, single curve pullovers attached to trolley ears eight feet each side of mast arm and guyed to suspension span eye bolt with 1/4 inch galvanized steel strand and insulated with one 1 1/4 inch by 9 in wood break strain

or porcelain strains shall be used to secure uniformity of curve and eliminate sharp angles or corners in trolley wire.

On curves of over two degrees a brail or parallel of three-eighths inch galvanized steel strand shall be strung around curve on poles, through eye-bolts, and single curve pullovers properly insulated from brail by use of one 1 1/4 inch by 9 inch wood break strain or porcelain strains and spaced so as to secure uniform curvature of trolley wire shall be attached to trolley and brail with one-quarter inch messenger. All brails shall be securely anchored to the butt of the adjacent pole at each end of curve. All poles on curves shall be guyed.

Spans shall consist of seven-wire three-eighths inch galvanized strand, and in case of steel poles, shall have strain insulator cut in, not less than five feet from pole; where pole carries high-tension circuits a strain insulator shall be used of suitable strength and creeping surface. Where foreign line crosses close to the span, two strain insulators shall be used, one at either side of foreign line to insure that if latter falls, it shall be on a dead section.

Where span wire construction is used, eye-bolts shall be placed at the proper height and span wire drawn as tight as possible by hand so as not to exceed one foot sag in twenty feet of span and made up in eye-bolts using 1 1/4 inch by 9 inch wood break strain or porcelain strain insulators on each side of trolley, placing the insulators sixty inches each side of trolley wire.

In case of two or more tracks; strand between pullovers shall have temporary tie at one end until final dressing.

On span wire suspension all poles shall be anchored on fills and curves.

Wood break or porcelain strain insulators shall in no instance be placed in proximity to trolley as the trolley pole is liable to leave the wire and break the wood strain.

After this the slack shall be pulled and the cars attached. Parallel faced clamps of approved type shall be used; chains, cam come-alongs or other short grip devices shall not be employed. Extreme care being taken that no winds or kinks are left in the wire.

All trolley shall be erected eighteen feet above the top of the rail except at railroad crossings, where the trolley wire shall clear the top of the rail twenty-three feet. The suspension strand wire shall be stretched tight so that no perceptible sag is in it after trolley wire is hung. Trolley wire shall be strung tight with not to exceed five inches of sag between spans when temperature is approximately eight-five degrees above zero.

Trolley wire shall be run out by mounting the reel on an arbor on which it can freely turn, and leading wire to an anchor or to trolley already installed. Tension may be

maintained by a brake or rim on side of reel, but under no circumstances shall braking be done against the copper. Or the trolley wire may be unreel and laid in center of track and pulled to the span by means of a rope and attached to it in a loose piece of scrap tie wire or rope.

A fifteen inch bronze or extruded metal clinch ear shall be used for all trolley.

To place clinch ears, put the ear on the trolley, clinch one end and tap the other end in place and clinch, then tilt ear and trolley to an angle of forty-five degrees and clinch from center each way. A Stilson wrench, hammer and a block of steel 2 inch by 2 inch by 6 inches in length shall be used in clinching ears.

After the car is applied the hanger shall be screwed into it and the hanger placed on suspension wire by use of hanger wrench and the trolley properly lined.

A round top galvanized lock trolley hanger properly insulated with the lower end of the stud fitted with a circular metal washer shall be used on trolley on tangent track.

When the rails of track are at the same level, the trolley shall be suspended directly over center of track and shall be so located by use of a plumb bob and gauge, except in a curve where no elevation is given to the rails of the track.

When rails of track are elevated as on a curve, the elevation shall be determined by use of a level board and the trolley thrown toward the inner or low rail of track according to the following rules:

For trolley eighteen feet above the top of rails multiply the superelevation by 3.78.

When trolley is twenty feet above top of rail multiply the superelevation by 4.21.

When trolley is twenty-two feet above top of rail, multiply superelevation by 4.63.

To determine the point on suspension wire from which to measure the throw, use a plumb bob suspended directly over the center of the track.

On seventy-five foot radius curves where no elevation is given the track, the trolley wire shall be placed six inches off the center of the track toward the inner rail; on sixty foot radius curves, the trolley shall be placed seven and one-half inches off the center of the track toward the inner rail; on fifty foot radius curves the trolley shall be placed nine inches off the center of track toward the inner rail.

The trolley wire on main track at all sidings must extend at least two pole lengths beyond switch point. No trolley frogs shall be used on main line except at turn-outs in streets or special cases designated by Engineer Maintenance of Way.

In bracket construction, trolley wire guys shall be installed at the ends of curves and on long curves and tangents at equal intervals as nearly as possible, but not to exceed fifteen hundred feet.

Trolley wire guys shall be seven-wire steel strand attached to strain plate supported at a bracket by double pullover with proper insulation and led both ways to next adjacent poles. Each guy shall have a strain insulator cut in it five feet from strain plate and shall be secured to proper pole by a two-turn wrap at height of bracket arm. Where practicable, the strain of these guys shall be taken by anchor guys in the line of the pull; if this is impracticable, high guys shall be used. Great care must be taken to insure equal pull on the guys and especially to insure that the strain plate is not twisted out of line, the ties should not be made up permanently until the final dressing of the overhead.

All trolley frogs shall have flexible approaches and shall be made with a bridging piece to prevent the trolley pole from catching in the "V" of the frog.

Trolley frogs shall be located eighteen feet ahead of the point of the track frog and insulated guys attached, four ways to poles.

Trolley in city streets shall be anchored in four ways to poles by means of a malleable iron strain plate, placed one-quarter mile apart, properly insulated from poles.

A six inch wood runner section insulator, 37 inches long, malleable iron body with renewable bronze approaches shall be used wherever necessary in city construction and wood underrun section insulators with two wood strains to sustain the pull of trolley wire shall be placed at each sub-station to enable the current being cut off from a section of the trolley.

All catenary trolley brackets shall be placed on pole so as to allow the trolley to be eighteen feet two inches above top of rail when trolley is finally strung and completed.

Brackets shall be equipped with all fixtures on the ground before being raised to position on pole. The position of the brackets on the pole shall be at an upward inclination from the horizontal of one inch to four feet.

Two five-eighths inch by four inch galvanized cone pointed lag screws shall be used to support the trolley bracket on the pole and the upper support rod shall enter the pole at a point three feet six inches above the bracket and protect the pole by a bevel washer.

In span construction, the span wire shall be installed so that when the weight of the messenger, hangers and trolley is put on it there will be a sag of about one foot

for each twenty feet of span. All fills shall have span construction and such curves as the Engineer Maintenance of Way shall designate shall have span construction.

All spans shall be insulated by use of nine inch by one inch wood strains and the back guys on the poles shall be insulated for full line potential.

On span construction all spans shall be attached to the poles with three-fourths inch galvanized eye-bolts, poles to be protected from eye-bolts by two inch square galvanized washers.

On catenary construction, tangent track, trolley shall be steadied every sixth pole and at every pole on curve. The steady shall be made up of a double curve pullover, three-eighths inch galvanized strand and insulated from pole by the use of one and one-fourth by nine inches wood strains placed sixty inches from pullover. The ends of span wire shall be made up in eye-bolts attached to the poles. The use of wood or metal steady strains is condemned.

All catenary for operation with wheel collector shall be either three point or five point construction.

The trolley and the messenger wire shall both be run out at once and hung over the brackets, except at curves where the trolley wire should be supported below the bracket arms. The trolley wire should then be pulled up tight and temporarily anchored while resting on the bracket arm.

The trolley can be pulled with three men to about the right tension by the use of a pair of three sheave blocks and a luff or purchase with a pair of two sheave blocks.

For catenary suspension, seven strand, seven-sixteenths inch extra galvanized Seimans-Martin steel messenger shall be used and shall be strung to allow a nine inch sag after taking weight of trolley and hangers on one hundred thirty-two feet spans, and on one hundred feet spans a sag of seven inches shall be allowed. These sags are for an approximate temperature of eighty-five degrees Fahrenheit. Catenary messenger on curves must be placed in side groove of insulator opposite strain.

Both messenger and trolley wires shall be anchored every one-half mile on tangent track, and at the ends of tangent track approaching a curve. Sufficient slack shall be left in the curves to allow the trolley and messenger wires to be pulled over to their position above the track.

In span construction, after the poles are guyed and the spans in place, the messenger and trolley wires shall be run out and hung temporarily to the span wires by hooks. The tension on the trolley and messenger wires and the installation of hangers shall then proceed as in bracket construction.

To locate hangers on three point catenary work, the distance between poles shall be divided into three equal parts.

The center hanger shall be located in the exact center of the span between the poles and the hangers on each side of the center hanger shall be located from the center hanger one-third the total length of the span between the poles.

To locate hangers on five point catenary work, divide the distance between the poles into five equal portions, place the center hanger in the exact center of the span between the two poles and the two hangers on each side of the center hanger one-fifth the length of the span from each other.

The instructions for the location of the hangers shall be rigidly adhered to. When screw ears are used the screws shall be drawn as tightly as possible, and to more deeply seat them, a hammer and weight shall then be used as in clinching an ear, applying the blows on the jaws of the ear, care being taken not to rivet screws. The screws shall then again be tightened and slightly upset to prevent backing out.

On curve construction pulloff hangers shall be used to secure the proper curvature of trolley and messenger wires.

On curves of over two degrees a back bone or parallel of three-eighths inch galvanized steel strand shall be constructed on poles around the outside of curves and pulloff hangers shall be bridled to the backbone. Bridles or spiders shall be properly insulated from the backbone by the use of one, one and one-fourth by nine inch wood strain. Pull-off hangers shall be so located and spaced so as to secure uniform curvature of trolley wire. All bridles or spiders shall be of one-fourth inch galvanized messenger.

The construction of the backbone or rail for catenary work shall be typical of the construction designated for direct line suspension.

A twenty inch Cleveland trolley splice without a boss shall be used for splicing grooved and round trolley wire. A twelve inch extruded metal riveted splicer shall be used for splicing figure eight trolley wire. To splice trolley, place three bolt clamps six feet from ends of trolley, put on a pair of three sheave blocks and luffing or purchasing with a pair of two sheave blocks, pulling trolley to proper tension and place splice on wire, being sure winds are out of wire and clinch splice well on the trolley. In any case the free ends of the wire shall be bent sharply back at outlet and cut off, forming a hook with end one inch long.

To splice catenary messenger, place blocks in same manner and put on four one-half inch Crosby guy clamps

one inch apart, making strands up each side of clamps.

At the end of single sidings no pole shall be set so that it can be broken by a car pushed off the end of the siding, either two poles must be set on each side of the track and the trolley dead-ended in guys from both poles or the one pole to which the trolley is dead-ended moved to one side of the track a distance of eight feet from the center line of track.

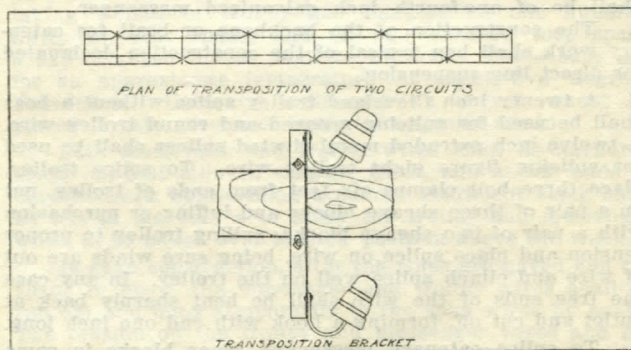
TELEPHONES.

All telephone line wire shall be of not less than No. 10 B. & S. gauge hard drawn bare copper, except through trees where permission cannot be obtained to trim, or at a crossing of high voltage wires, where triple braid weather proof No. 10 B. & S. gauge H. D. copper wire shall be used.

In stringing telephone circuit care must be taken to keep the wire free from kinks or sharp bends. Should the wire become kinked or badly bent it must be cut out and spliced, thus avoiding trouble later on.

Both wires of a telephone circuit must be strung at one time by use of two payout reels and transpositions must be thrown into circuit while stringing by means of changing reels from one standard to the other, when stringing from car, or if pulling wire from stationary reels by changing sides with ends of wire always throwing the left wire over the right wire and spaced as described following:

Transpositions in telephone lines are necessary to overcome cross talk from other telephone lines on the same lead or parallel leads, and to overcome induction of current.



Where poles carry two circuits the transpositions must be alternately thrown, thus making a transposition on each second pole.

Transpositions shall be thrown every fourth pole, thus leaving the circuit straight on three poles between transpositions.

Transpositions must be tied in on transposition brackets. The use of double grooved or two piece insulators for transpositions is condemned.

Double groove porcelain pony insulators shall be used on one-half inch steel Western Union pins for telephone construction. Cross arms for telephone circuits shall be three and one-fourth inches by four and one-fourth inches by four feet Washington fir.

All telephone wire shall have a sag of seven inches in a span of one hundred thirty-two feet when the temperature is approximately eighty-five degrees above zero and four inches when temperature is approximately twenty-five degrees above zero.

No other than Buffalo grips or grips of similar style must be used to pull telephone wire. Not more than one-half mile of wire shall be pulled at one time.

When telephone wires are to be strung above feeder or other power lines, care must be taken to keep same from coming in contact with ground or other conductors and when tied in shall have a clearance of not less than thirty-six inches from feeder or wires of less voltage and shall clear wires of greater voltage not less than ten feet.

Telephone wires shall be tied to insulator by placing the line wire in side groove of insulator, placing tie wire staplewise in groove of insulator with one end above and one end below the line wire, closing the ends past each other, not crossing them and giving each end five complete turns around line wire with turns spaced one-half inch apart. (See page 127.)

On curves telephone wires shall be tied on outside of curve and in lower groove of insulator. Dead ends shall be made by use of half sleeves given two complete turns.

Splices in telephone wires shall be made by entering wires into opposite ends of self-welding joints or sleeves and twisting joint or sleeve three and one-half turns.

All joints in drops, lines, and all wire in instruments, switchboards and extension bells must be tight at point of connection as one loose connection will make the entire line noisy.

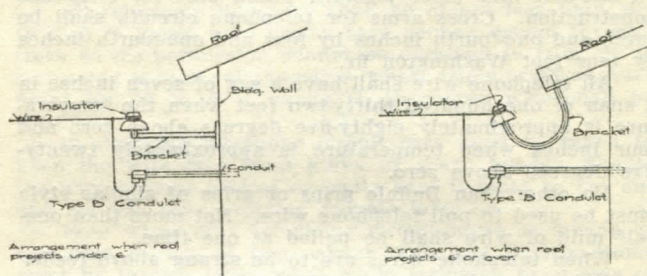
Weather proof copper wire No. 14 B. & S. gauge shall be used for all telephone drops.

All drops must be dead-ended to glass or porcelain knobs or insulated brackets placed on building and if

possible shall be continued to switch, or arrester, the joints shall be well cleaned, soldered and taped. All drops must be soldered to line wires.

All telephones permanently tapped to line, shall be protected by use of an arrester similar to Western Electric No. 58 with a good ground.

All telephones at sidings shall have a cutout switch placed above the booth or box door so that by placing a block on the door the switch will be opened when door is closed.



Where duplex wire is used for drop wires on and into buildings, an insulated double pointed tack shall be used to fasten wire; both wires must not be put under the same tack or staple as the staple may cut the insulation and short the line. In running duplex into one hole, the hole entering the building shall be bored from the outside on an upward angle and a drip loop shall be made by forming a "U" shape in wire at point of entrance to prevent water running into tube of hole. Arrester grounds must be put through separate holes or tubes and not with line wires.

LOCATING INSTRUMENT AND LINE TROUBLE.

When notified of trouble on telephone line the foreman shall see that linemen sent on the trouble is equipped with a telephone test set and instructed as to the probable location of the trouble.

All linemen on telephone trouble shall carefully inspect all the telephones and line wires in the field of trouble.

If the bell of an instrument will not ring the protector should be examined for an open fuse. If protector is found in a satisfactory condition, the instrument should be examined for a broken wire. If, after a thorough search, a broken wire is not found, the break may be in the ringer coils.

If bell receives and transmits rings feebly the most

common trouble is a resistance cross or poor connection in box.

If when ringing a party the ring comes in strong to the party being rung and the ring is weak or will not ring at the instrument being tested, an examination should be made for bad armature adjustment, weak ringer magnet or open ringer coils.

If, when a party, the ring comes in weak to the party being rung and the ring is strong at the instrument transmitting the ring, an examination should be made for partially shorted armature, loose connection on generator or weak magnets on generator.

If bell rings frequently or continually, a cross with other wires or a one side ground is the probable cause. If it is found that the telephone of the party called does not ring and the bells of the instrument used in making the call rings, a test for an open line or burned out protector should be made.

If rings are received and transmitted but cannot talk or hear, the receiver cord should be examined, the batteries tested, the receiver hook examined to see that it comes up to place and a search should be made for loose connections.

A hurried test of the complete talking circuit in a telephone may be made by opening the disconnect switch, shorting telephone end of switch, placing receiver to ear and blowing breath in transmitter. If it can be heard plainly in receiver it is proof that the batteries, transmitter, induction coil and receiver are O. K. If it cannot be heard, any of these may be defective.

It sometimes occurs that conversation may be heard without removing receiver from hook or the switch board operator can hear cars, vehicles or other objects as they pass the telephone. When above occurs, the trouble is caused by switch hook spring contactors being bent out of place.

If line is noisy and rings grounded an examination of the protector at the switch board should first be made for dirty or burned carbons, if protector is O. K. the protectors of telephones permanently connected to line together with telephones should be examined if trouble is not found in protectors or telephones the line should be examined for a cross with other lines, trees or other conductors. If the trouble is still not located the line should be opened and tested in sections until located.

RULES FOR LINEMEN IN WIRING BUILDINGS, ETC.

General.

All wiring installation to be standard open work or grounded conduit and to conform to the rules of the

National Electrical Code.

All new buildings or complete rewiring of old buildings to be in conduit.

All electrical supplies and fittings to be on the approved list of electrical fittings.

Sockets.

1. Use only weather-proof sockets with No. 14 stranded rubber-covered wire on outside installations or damp inside installations.

2. Use only vapor-tight sockets on No. 14 stranded wire in oil houses and other places where there are inflammable gases or fine dusts.

3. Be sure that brass shell sockets are properly bushed.

Cord.

1. Use only reinforced cord on all extensions and long drops.

Open Wiring.

1. Use No. 4½ split knobs.

2. Use not less than No. 8 wire where spans are from truss to truss or other places where supports are more than 4½ feet apart and in such cases keep 6 inch separation.

3. See that joints are soldered and double-taped with rubber and Manson tape.

4. Avoid concealed knob and tube work as much as possible, but, if necessary, keep separations 1 inch by 5 inches and use flexible loom on each wire to a distance of 1 inch outside of the opening and back as far as the last knob.

5. Do not lose proper spacing at switches, cut-outs, etc.

250 Volts or Under.

1. Use not less than No. 14 rubber-covered wire with 2½ inch separation and supported every 4½ feet.

550 Volt.

1. Use not less than No. 14 rubber-covered wire with 4 inch separation and supported at least every 4½ feet.

2. Use not less than No. 14 wire on drop lights.

Conduit Work.

1. All conduit work to be continuous and grounded with proper bushings and lock-nuts at outlet boxes, etc.

2. All A. C. wires to be run in the same pipe.

3. Be sure to ream ends of conduit.

4. Have not more than four bends from outlet to outlet.

5. Use double braid rubber-covered wire.

Wire Sizes.

1. Be sure to see that wires are of proper carrying capacity for load, as per table.

Allowable Carrying Capacities of Copper Wire for Interior Conductors.

B. & S. G.	Table A	Table B	Circular Mils
	Rubber Insulation Amperes	Other Insulations Amperes	
18	3	5	1,624
16	6	10	2,583
14	15	20	4,107
12	20	25	6,530
10	25	30	10,380
8	35	50	16,510
6	50	70	26,250
5	55	80	33,100
4	70	90	41,740
3	80	100	52,630
2	90	125	66,370
1	100	150	83,690
0	125	200	105,500
00	150	225	133,100
000	175	275	167,800
0000	225	325	211,600

2. If no drops are used on a circuit and No. 14 wire or heavier is used throughout, 1,320 watts are permissible on any circuit; otherwise, 660 watts.

Switches.

1. Have switches of proper carrying capacity.

2. Have all switches readily accessible and installed in most convenient location.

3. Blades of switch should be dead when open, except on main service switch.

4. Knife switches to open with gravity.

5. Switches at oil houses and similar places to be on outside of building.

Cut-Outs.

1. Use not over 10 ampere fuses on branch circuits of 110 volt; 5 ampere on 220 volt; 3 ampere on 550 volt.

2. Install cut-outs where wires change size.

3. Use inclosed cut-outs in cabinets.

4. Have door of cabinet mounted to drop shut by gravity.

Motors.

1. Ground all motor frames.

2. See that feeders are provided for 25 per cent overload.

- 3. Provide separate switch, cut-out, etc., for each motor.
- 4. Have switches, etc., in sight of motor and readily accessible.
- 5. See that all rheostats are mounted on noncombustible bases or brick walls and away from gases.
- 6. Use lugs for wires of size No. 8 and over if stranded.

Heaters.

- 1. Office heaters to be equipped with double pole switch, cut-out and lamp in multiple.
- 2. Use flame-proof wire from switch to heater.
- 3. Heaters should be mounted with at least 4 inch air space between current-carrying parts and inflammable material with 6 inch clearance overhead.

Mains.

- 1. Be sure to see that mains are proper size to take care of all contemplated loads.
- 2. Provide drip loops at entrance to buildings.
- 3. See that service switch and cut-out are readily accessible, unless under unusual circumstances switch should not be over 7 feet from floor.
- 4. Switch to open by gravity and to be protected by fuses; switch and cut-outs in turn to protect meters.

Arc Lamps—Constant Potential.

- 1. Have separate switch for each light or series.
- 2. Equip all lamps with globes.
- 3. Do not use arcs around inflammable gases or dusts.
- 4. Hang all arcs from insulated base by other than current-carrying wires.
- 5. All portable connected wire, if any, to be stranded.

Generators, Etc.

- 1. Ground frames.
- 2. Provide platform of wood or transite at all high potential machines and switch boards.
- 3. Circuit breakers, switches and fuses should be properly provided (no fuses on A. C. generators and their excitors).
- 4. Keep proper spacing for feeders.
- 5. Use lead-covered cable or iron conduit where protection from moisture is necessary.

Switch Boards.

- 1. To have at least 18 inch clearance behind and to be accessible on all sides.
- 2. Use transite or asbestos board sheets on openings at trenches.
- 3. Use flame-proof wire on backs where wiring is crowded.

Lightning Arresters.

- 1. Must be attached to every overhead circuit.
- 2. Provide permanent ground of not less than No. 6 copper wire.
- 3. Install arresters inside of cut-out switches at car-barn.

Transformers.

- 1. Ground cases.
- 2. Make provision to drain oil outside of building.
- 3. Where practical, put in separate compartment.

Cars.

- 1. All new car wiring to be grounded conduit with threaded outlet boxes or double lock nuts.
- 2. Old wiring to conform to code standards throughout.

SIGNALS, CROSSING BELLS, INTERLOCKING AND TRACK CIRCUITS.

DEFINITIONS.

Block—A length of track of defined limits, the use of which by trains is controlled by block signals.

Block Station—A place from which block signals are operated.

Fixed Signal—A signal of fixed location, indicating a condition affecting the movement of a train.

Block Signal—A fixed signal controlling the use of a block.

Home Block Signal—A fixed signal at the entrance of a block to control trains in entering and using said block

Distant Block Signal—A fixed signal used in connection and with a home (and advance) block signal, to regulate the approach thereto.

Advance Block Signal—A fixed signal used in connection with a home block signal to sub-divide the block in advance.

Block System—A series of consecutive blocks.

Manual Block system—A block system in which the signals are operated manually.

Controlled Manual Block System—A block system in which the signals are operated manually and so constructed as to require the co-operation of the signal men at both ends of the block to display a clear or a caution block signal.

Automatic Block System—A block system in which the signals are operated by electric, pneumatic or other agency actuated by a train or by certain conditions affecting the use of a block.

Absolute Block System—One in which only one train at a time is permitted to occupy the block.

Arm Sweep—The segment of a circle defining the limits of movement of the arm.

Arm—A movable arm pivoted to the signal mast, the positions of which give the indications.

Blade—That part of the arm which, by its form and positions, gives the day signal indications.

Bracket Mast—A mast mounted on a bracket post.

Bracket Post—An arrangement of main post with cross beam, upon which is placed one or two masts for carrying signal arms, the arrangement of masts determining which track or tracks the signals govern.

Bridge Mast—A mast mounted on a signal or other overhead bridge.

Chain Wheel—A device used for changing the direction of a wire line.

Compensator—A device placed in a pipe or wire line for automatically maintaining a constant length of line under changes of temperature.

Crank—A device used for changing the direction of a pipe line.

Crank Stand—A frame in which cranks are supported.

Cross Locking—A variable shaped block or bar running cross-wise of the interlocking machine, actuated by the movements of the locking dog and by means of which connection is effected between the levers.

Detector Bar—A bar placed at a switch alongside of and normally below the top of rail operated in connection with a facing point lock, derailing device or crossing switch, or so that its operation and consequently that of the lock will be prevented by the presence of any of the wheels of the train.

Electric Slot—An appliance of automatically disengaging the signal arm connection from its actuating lever, returning signal arm to "stop."

Foundation—A fixed support, usually set in the ground, for carriers, cranks, compensators, wheels, signals and other like devices.

Interlocking Machine—The primary operating or controlling mechanism of an interlocking plant, placed in the interlocking station and in which the interlocking feature is effected.

Interlocking Plant—An arrangement of switch, lock and signal appliances so interconnected or interlocked that one movement must succeed another in a predetermined order.

Interlocking Signals—The fixed signals of an interlocking plant.

Interlocking Station—A place from which an interlocking plant is operated.

Jaw—A device attached to pipe line for connecting same with machine, crank, compensator or any other device designated for pipe operation.

Leadout—A combination of cranks, wheels, rocking shafts, pipes and wire, etc., inside and outside of interlocking station by which connections are made between machine and pipe runs.

Lever—That part of an interlocking machine whose movement effects the operation of its function.

Locking—A combination of locking dogs and cross-locking or locking dogs and tappets by means of which interconnection is effected between the levers and the order of movement determined.

Locking Bar—A bar running lengthwise in the interlocking machine to which the locking dogs are attached.

Locking Dog—A variously shaped block attached to locking bar and through which the interlocking is accomplished.

Mast—The upright to which the signals are directly attached.

Operated Unit—A switch, signal, lock or other device in signalling operated by a lever or other operating means.

Permissive Block System—One in which two or more trains may occupy a block at the same time.

Pipe Carrier—A frame with roller support for the pipe line.

Pipe Run—An assemblage of pipe lines of an interlocking plant with their carriers and foundations in a common course.

Rocking Shaft—A rotating shaft with arms, used for changing the line of motion from one plane to another, perpendicular to the axis of the shaft; also used at slip switches for operating several detector bars and locks.

Route—A course or way taken by a train in passing from one point to another, especially a customary or predetermined course or any one of several possible combinations of turnouts or crossovers by which a train may travel between two places.

Screw Jaw—A threaded jaw used for the purpose of adjustment.

Semaphore Signal—A device consisting of a movable arm attached to a mast, the indications being given by the position of the arm.

Semaphore Spectacle—That part of a signal which holds the colored glasses and to which the blade may be attached.

Tappet—(a) (In machine with vertical locking.) A bar operated directly or indirectly by the lever or lever

latch, which actuates or drives the locking bars and is locked by them. (b) (In machine with horizontal locking.) A pivot or swing dog attached to the locking bar and actuated or locked by the cross-locking.

Wire Carrier—A frame with roller support for the wire line.

Wire Run—An assemblage of wire lines of an interlocking plant with their carriers and foundations in a common course.

ORGANIZATION OF SIGNAL DIVISION OF MAINTENANCE DEPARTMENT.

The supervisor of interlocking and signals shall report to and receive orders from the superintendent of overhead lines and signals. He has charge of all mechanical and electrical interlocking and signal construction and maintenance forces and will perform such other general duties in the erection of signals as may be assigned to him.

Inspectors of interlocking and signals shall report to and receive orders from the supervisor of interlocking and signals. They have immediate charge of maintenance forces assigned to them.

Interlocking and signal construction foremen shall report to and receive orders from the supervisor of interlocking and signals. They have immediate charge of construction forces assigned to them.

Assistant interlocking and signal foremen shall report to and receive orders from the construction foremen.

Fitters, blacksmiths, interlockers, carpenters, wiremen, assistant wiremen and helpers shall report to and receive orders from the interlocking and signal construction foremen or assistants.

Repairmen shall report to and receive orders from inspectors.

Interlocking and signal maintainers shall report to and receive orders from the inspector.

Batteryman shall report to and receive orders from interlocking and signal maintainers.

GENERAL RULES OF THE SIGNAL DIVISION.

Employees whose duties are prescribed by these rules must provide themselves with a copy.

Employees must be conversant with and obey the rules and special instructions. If in doubt as to their meaning, they must apply to proper authority for an explanation.

Employees must pass the required examination.

All employees above the class of lampmen must be familiar with the rules of the transportation department.

Employees must render every assistance in their power in carrying out the rules and special instructions.

Any violation of the rules or special instructions must be recorded.

The use of intoxicants by employees while on duty is prohibited. Their habitual use or the frequenting of places where they are sold is sufficient cause for dismissal.

In case of danger to the Company's property, employees must unite to protect it.

For positions above that of laborer, any person who cannot read and write English, or who does not possess a knowledge of the rudiments of arithmetic shall not be employed.

Minors shall not be employed in signal maintenance.

A person dismissed from any department of the service shall not be employed in this department without the consent of the head of the department from which he was dismissed.

RULES FOR INSPECTORS OF INTERLOCKING AND SIGNALS.

Inspectors of interlocking and signals will be held responsible for the proper maintenance of all mechanical and electrical work on their divisions in so far as it relates to interlocking and signals.

They will call on interlocking and signal construction foremen for assistance when necessary and will have charge of such men as are assigned to them for maintenance work, but will not have authority over construction men when same are making extraordinary repairs.

They will notify supervisor at once on changing residence.

They will call for orders at headquarter's station and dispatcher's office, morning and evening.

They will make no promotions nor changes in rate of pay without written approval of supervisor.

They will be especially careful that their men cooperate with the employees of this and all other departments.

They will report promptly and accurately any fault of operation, construction, or maintenance and any disregard of signals coming to their personal knowledge.

They will make careful inspection of all sections, examining everything connected with signals, bells, etc.

They will inspect store rooms, battery houses, and all places where material is stored and see that they are neat and clean, and that only material necessary for the efficient working of signals is kept on hand, properly cared for, and not wasted or used unnecessarily.

They will make written report of result of said inspections, keeping original and sending duplicate to supervisor daily.

They will instruct maintenance and battery men to remedy any defect in their work and if on next inspection their instructions have not been complied with they will notify supervisor.

They will know that the rules for maintenance, battery men and repair men are properly understood and obeyed.

They will consult with foremen in recommending promotion in the following line:

- Helpers.
- Assistant Fitters.
- Assistant Wiremen.
- Fitters.
- Wiremen.
- Carpenters.
- Blacksmiths.
- Interlockers.
- Maintainers.
- Repairmen.
- Assistant Foremen.
- Foremen.

Promotion to be based on faithful and efficient service and successful examination.

RULES FOR INTERLOCKING AND SIGNAL CONSTRUCTION FOREMEN.

They will be held responsible for the proper condition of all work assigned to them.

They will call for orders at headquarter's station and dispatcher's office, morning and evening.

They will make no promotions or changes in the rate of pay without written approval of supervisor.

They may suspend men for cause.

They will be especially careful that their men cooperate with the employees of this and all other departments.

They will, when installing new work, use only standard specifications and plans approved by Engineer Maintenance of Way and will make no changes in such plans without permission of supervisor.

When employing new men, they will promptly forward the service blank properly filled in to the Engineer Maintenance of Way (Laborers excepted.)

They will report promptly and accurately any fault of operation, construction or maintenance and any disregard of signals coming to their personal knowledge.

They will report "tools and material on hand" on

proper form, quarterly, and whenever transferred, and will report progress of work daily to supervisor.

They will, at the end of each month, report to the supervisor amount of new material used (each plant or block location to be reported separately), and of all new material used, and all excess material on hand when work is completed.

They will, in case switches or signals are out of service, notify the dispatchers and superintendent of transportation by wire when repairs are completed, unless repairmen or maintainer has done so.

They will keep their home address in writing at the headquarter's office.

They will, in sleet and snow storms, place their forces at important interlockings to assist and relieve repairmen and maintainers and co-operate with track division forces.

They will, when bonding new rail, or doing other work where signals are in work, have a competent man in charge whenever possible, who will be responsible for any failures resulting from such changes.

RULES FOR INTERLOCKING AND SIGNAL MAINTAINERS.

They will be held responsible for the proper care and maintenance of all interlocking, mechanical and electrical signal devices, batteries and lamps on their sections, and will make all repairs which do not require the construction force.

They will report daily to the inspector of interlocking and signals on proper form, stating location and nature of work done.

They will forward, not later than Saturday A. M., to the supervisor, a full and correct report, on proper form, of all failures for the preceding week, whether covered by card or not, returning card on day received.

Note—Any omission to report signals failing to go to danger properly will be cause for severe discipline.

They will notify inspector at once on changing residence and will not change residence from headquarter's town without proper permission.

They will report at headquarter's station and dispatcher's office for orders each morning and advise dispatcher where they may be found during the day, report before going off duty at night, and keep their house address in writing at said dispatcher's office.

They will not leave sections without permission of inspector, except in case of sickness, when they must immediately notify him or the nearest construction or overhead foreman.

They will be on duty at night during severe snow and sleet storms, unless they know that competent substitutes are provided. They will cover trouble promptly at night whenever called upon.

They will ride over their sections at night at least once a month and report condition of lights to inspector.

They will make inspection of all signals from train as early as possible each morning, and, whenever possible, will make a second like inspection late in the afternoon.

They will, in case of accident, make inspection of switches, signals, etc., and report the result of their examination to the inspector and supervisor and be sure that they are working properly before allowing trains to pass. In case of accident at any road crossing protected by bells, they will make immediate inspection and report of same to inspector and supervisor.

They will not fasten slots so as to give clear indication, but must make repairs promptly.

They will, on finding or hearing of a signal failing to go to danger properly, make immediate inspection; fasten this signal at danger and leave it in that position until repaired, sending special report at once to supervisor and Engineer Maintenance of Way.

They will assist each other on small repairs whenever possible and call on battery men and lampmen for assistance when necessary, taking care not to interfere with their work and in case of serious trouble will notify division inspector.

They will co-operate with employees of this and all other departments.

They will keep all scrap in section scrap heaps and all other material in a safe place and all apparatus in their charge neat and clean.

They will never give hand signals except to stop trains in emergency.

They will be responsible for tools furnished them and will replace any which may be lost.

They will be supplied with correct plans and will make no change in locking or wiring at any time, and no change in instruments, except to replace defective ones, without written order from supervisor, and will report any defects in locking to him by telephone.

They will order all lampmen supplies except oil and waste.

They will, at interlocking stations, see that each tower is provided with the requisite number of fire extinguishers and also necessary tools for emergency use.

They will call at interlocking stations frequently, being especially careful to keep all appliances in good order at such points.

They will see that lampmen will properly perform their duties.

They will, in making repairs, give precedence: First, to signals failing to go to danger properly; second, to crossing bells failing to ring; third, to slotted signals at interlockings; fourth, to block signals, failing at danger, and fifth, to indicators, etc.

They will keep all pipe carriers, crank, compensator and wheel foundations rigid, leveled and in perfect line and top of all crossleads three-fourths of an inch below base line of lowest rail.

They will keep all signals when indicating stop or caution at right angles to post and balance levers on stop, and so adjusted that they will stand at an angle of 60 degrees above horizontal when clear. They will renew or paint arms when necessary.

They will take especial care to keep motor brushes and commutators bright and clean, smoothing the latter down when necessary with sand paper, then wiping brushes carefully, applying a small quantity of hydrol and wiping off commutator after giving it a few revolutions.

Note—Never use emery paper on commutator.

Motors should be cleaned and oiled every 400 movements, cleaning with a piece of waste or soft cloth, moistened with a light oil or gasoline and the commutator should not be sand papered off more than three or four times during the year. Inspection to be made at least every eight days.

Motor brakes should be tested and adjusted on each inspection of motors.

They will oil all signal bearings and switch instruments, examine all semaphore arms, castings and glasses, tighten all bolts and clean number plates once a month.

They will, on finding or hearing of a signal failing to go to danger properly, make an immediate inspection. They will first open circuit and set signal to danger, then turn up number plate and leave signal at danger until repaired, sending special report at once to the supervisor and Engineer Maintenance of Way.

They will not turn up number plates when working at signals, except in case of failure, and as soon as trouble is remedied will turn them down.

Maintainers must keep all bonding in signal sections in good repair. Voltage on track must be kept as low as conditions will permit. Voltage readings should be made of each section once every three months or oftener if necessary. Impedance bonds will be frequently inspected.

They must prevent failures by keeping apparatus in proper repair, and all working parts in proper adjustment;

both ends of crossovers must be equally tight and no switch or derail must be over one-eighth inch open, when locked. No excuses will be taken for loose locks on switch points.

Note—Inspection will be made by inserting gauge between switch point and stock rail—switch to be thrown so that gauge will hold switch point one-eighth inch from stock rail, then switch lock to be tried.

All switches must be tested for main line. These gauges will be furnished by supervisor upon application.

They will examine all switches while in operation at each inspection.

They will adjust detector bars to lie below top of rail when lever is normal or reverse.

They will keep all bolts, nuts, set screws and lag screws tight; cotters in place and properly spread, and will renew any pins or studs in connection if worn more than one thirty-second of an inch, taking up all lost motion in pipe lines and other connections, as much as possible, and bushing and re-drilling such parts as become worn.

They will make complete general inspection of connections, switches and signals once a month, reporting condition of same to supervisor with recommendations for improvements and added safeguards if any are necessary.

Relays shall be tested monthly and maintained in proper adjustment.

They must oil and test weekly all shunt and switch appliances. Air buffers shall be cleaned with gasoline and oiled every four months.

They will know that all tools at each interlocking station are in their assigned places and report shortages, if any.

They must examine the condition of all lightning arresters and grounds and be sure they are in perfect working condition.

All high tension or primary circuits shall be inspected monthly and all broken insulators removed and the circuits kept free from trees or grounds.

The batteries of Cook Railway Crossing Signals shall be filled with soft water weekly.

Track instruments or contactor boxes on the Cook signal shall be tested and adjusted weekly. Track contactor boxes on the Cook signal should be adjusted to open one-fourth inch and when closed should move contacts only enough to make contact.

Relay carbons shall be trimmed as soon as they are seen to be arcing.

Unit shall be oiled and cleaned every five hundred movements.

The maintainers shall clean and oil the mechanism of a Hoeschen crossing bell every one thousand movements.

The lightning arrester on a Hoeschen bell shall be cleaned after each electrical storm.

Trolley trip or trolley contractor signals shall have the trip or contactor inspected and cleaned every month.

The directional relays shall be tested and adjusted weekly on all trolley contact signals.

They will inspect batteries frequently and see that they are kept in good order; instruct battery men as to amount of battery necessary and time for renewals, and make requisitions on supervisor the 10th of each month for all the material required on their section.

They will see that material is safely kept in places provided for the purpose and not wasted, returning all old zinc, copper, etc., from batteries to the general store-keeper quarterly, forwarding all such material in closed boxes or barrels and sending bill of lading promptly to supervisor. They will weigh material before it is shipped and report weight with bill of lading.

They will, during sleet and snow storms, co-operate with track division forces to keep plants working.

Good maintenance demands thorough inspection and good judgment. No hard and fast rules can cover all conditions or be equal to those gained by daily contact with the apparatus.

Maintenance anticipates, prevents trouble and is thus distinguished from repairing. Do not wait for trouble to develop.

Below are given a list of the most important points to be considered in the maintenance of Union Switch and Signal Company's Signals; experience will suggest other points requiring particular attention.

Frequency of inspection should be proportional to frequency of operation. The highest efficiency can be obtained from the apparatus only by frequent and intelligent inspection.

STYLE "B" SIGNALS.

Slot Magnets—In order to insure the release of the armature when the slot coils are de-energized, an air gap must be maintained between that armature and the magnet cores. Brass core pins are used for this purpose and care must be taken that these pins do not wear or become shortened so as to reduce the air gap. The armature should seat evenly on all the core pins when the magnet is energized. See that no oil, grease or dirt accumulates on the armature or poles of the slot magnets.

Mechanism—The semaphore spectacle should rest on

the adjustable stop provided in the bearing for this purpose and when in this position the rod should be so adjusted that the forks of the slot arm points to the center of the lower sprocket.

The purpose of the buffer or dash pot is to cushion the shock of the semaphore arm when returning by gravity to the stop position. The required amount of cushioning can be obtained by adjusting the screw in the air vent; care must be taken not to close the vent entirely. The signal should be operated several times after making such an adjustment to insure that the right amount of cushioning has been secured. Lubricate the buffer cylinder about once a month by unscrewing the plug containing the vent and squirting a little oil into the cylinder. Wipe clean the outside of the cylinder before the plug is removed and special care must be taken to see that no dirt or grit enters.

Inspect and clean the signals frequently and carefully, especially the moveable parts of the mechanism. See that they do not get tight from lack of lubrication or gummed from the use of unsuitable oil. When repairing or replacing any of the moving parts of the mechanism see that they work freely before again putting the signal in service. See that they do not cause other parts to bind. Carelessness may result in a dangerous condition.

Oil the bearings once a month. Use oil sparingly and wipe off any surplus. A good, light, non-freezing, lubricating oil is suitable for the mechanism; it should be free from acid or alkali, else rusting will result.

Keep all circuit controllers and contact surfaces clean and bright.

Look carefully after cotter pins, lock washers, binding posts, nuts and screws to see that they are in place and not working loose.

Examine wire connections on binding posts to be sure that the wires are not broken and see that all such connections to moving parts have proper freedom so as not to make sharp bends which might catch on other parts of the mechanism.

Motor Brakes—The brake should stop the motor when the chain rollers are in the vertical position. If the rollers travel beyond this position, increase the brake tension by means of the adjusting screw; if the leather brake disc becomes hard, soften it with a drop or two of oil. Rub this oil into the leather and wipe the brake wheels clean so that the oil will not form a lubricant.

SOLENOID DWARF SIGNALS.

Test the snap circuit controller at intervals to see that there is proper tension in the springs and freedom of drum movement.

The points mentioned in connection with inspection and oiling of style "B" signals apply in large measure to Solenoid Dwarf Signals as well.

RELAYS.

Remove for test relays that are suspected of working improperly. When a relay is turned partly over all the contacts should make simultaneously, and when energized with the normal operating current, shown on the label, there should be about one thirty-second inch (1-32 inch) slide in the contact points. The springs of the contact fingers may in some instances age and cause the contacts to get out of alignment. Exercise great care in readjusting these springs. Bend them to a position beyond that necessary for adjustment and gradually bring back into alignment.

When the contact become glazed and develop a high resistance they need cleaning. This can best be done with a fine Swiss file, using it very lightly. Wipe off the carbon dust when finished. Bring all contacts into alignment in the same manner.

The armature should move freely in the trunnions and have about one sixty-fourth inch (1-64 inch) end play. With D. C. relays it is necessary to maintain an air gap between the armature and the magnet cores. Brass core pins are needed for this purpose, and care must be taken that they do not wear or become shortened so as to reduce the air gap. The armature should rest against all the core pins when the magnet is energized. Efforts to adjust a relay should not be made without proper tools.

Relays constitute a vital factor in any signal system. They necessarily consist of a delicate mechanism which should not be tampered with. Adjustments and repairs should be made only with the utmost care by a person of experience. If there is no such person in the employ of the railway, relays should be returned to the manufacturer for repairs and adjustments.

Unbalancing—With alternating current track relays, unbalancing of the track circuit above a certain amount is liable to cause the relays to open or prevent them from picking up. Unbalancing may be caused by a defective power bond which is equivalent to a broken rail. It is usually indicated by excessive heating of the relay and track transformer and even by the blowing of the fuse in the relay connections to the track. Unbalancing, if of long duration, is liable to cause warping of the relay frame owing to the excessive heat. Inspect the power return where there is any indication of unbalancing.

FITTERS, INTERLOCKERS, BLACKSMITHS AND HELPERS.

They will, when acting as extra or temporary maintainers, make all reports in the name of regular maintainers, if covering section for less than a week, otherwise they will report to division foreman or inspector, as if they were regular maintainers.

They will be responsible for tools furnished them and will replace any which may be lost.

WIREMEN, ASSISTANT WIREMEN AND HELPERS.

They will, when acting as extra or temporary maintainers or battery men, report all trouble to the regular maintainer, if covering the section for less than a week; otherwise, they will report to the inspector as if they were regular maintainers.

They will be responsible for tools furnished them and will replace any which may be lost, and will take them home at night.

TRACK RETURN BONDING.

All rails shall be connected by a bond to permit the passage of electric current, except insulated joints at the ends of block signal circuits.

Bonds shall be applied either by compression or brazing; preferably attached to web of rail and protected by the rail joint.

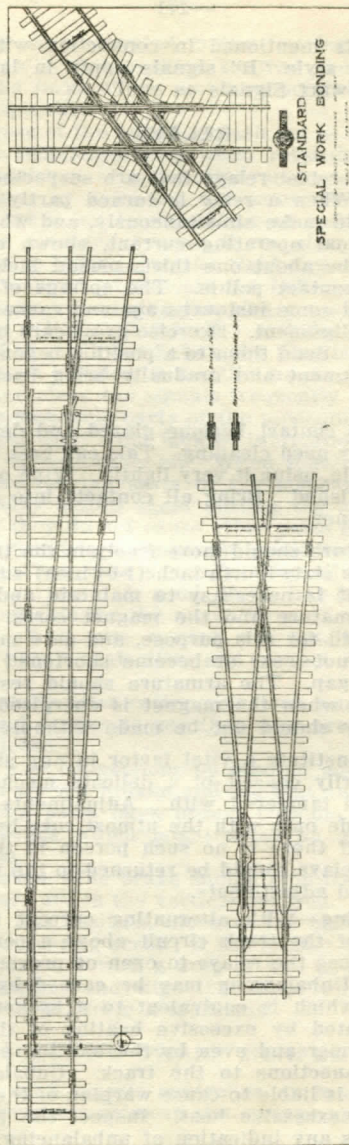
All bonds shall be of 4-0 capacity copper strand or ribbon copper.

All jumper and cross bonds shall be preferably of soft drawn copper strand, composed of nineteen wires and the bond terminals shall be carefully soldered on this strand, or if brazed terminals, the brass bond clips shall be mechanically fastened in a good and workmanlike manner.

All jumper and cross bonds shall be stapled to ties and cross bonds shall be stapled along center of side of tie so same will be protected and concealed by the ballast.

Jumper bonds shall be applied beyond first joint at each end of all special worn fixtures.

The location of cross bonds will be designated by the superintendent of overhead lines, it being desired to locate them so that they will come exactly under trolley feed-in taps, where such taps occur, cross bonds should be located about one-fourth mile apart; except in block signal systems using track circuits for operation of signals, here the cross bond shall be discontinued. Cross bonds shall



Bonding Special Work.

also be located not farther than fifty feet ahead and behind all track turn-outs.

Where compressed terminal bonds are to be used, the holes in the rails shall be drilled or reamed out of the bright metal and the bond terminal pressed therein with an approved compressor exactly centered over the terminal. Under no circumstances shall oil or grease be used in drilling or reaming the holes for bonding the rails. Nothing but clean water and plenty of it shall be used for this purpose. The holes to be drilled or reamed for compressed bonds shall not exceed seven-eighths inch in diameter.

The compressed bond terminal shall be brightly polished by use of fine emery cloth before bond is compressed in rail.

When applying compressed bonds in holes that have been previously bored, the holes shall be reamed out by the use of a reamer or shall be carefully cleaned out and brightened by the use of a three-fourths inch rat-tailed file. All rust must be removed from the bond hole before bond is applied, as rust, oil, etc., has a very low conductivity.

The bolts on all joints where bonds are applied shall be thoroughly tightened and the joint tamped solidly to surface. Wherever possible, the joint shall be brought to surface before the bond is applied and discipline will be assessed for bonds applied on loose or low joints.

All exposed bonds shall be thoroughly coated with a heavy coat of asphaltum or a Sarco product. Exposed bonds applied without this coat and in contact with the ground surface are subject to very rapid corrosion.

Bonds shall be tested by an approved instrument and all faulty ones found shall be replaced by new ones.

ELECTRIC WELDED OR BRAZED BONDING.

Use and Care of Grinder.

Keep Motor clean, commutator bright and see that brushes make good contact with commutator.

Lubricate bearings with a little plain vaseline about once a week (if too much vaseline is used it is liable to be thrown over field and commutator when running.)

Before replacing armature in motor, after lubricating the bearings, see that the casing and brush holders are free from all dirt or grease. This can be cleaned by using waste or rag, preferably the latter.

To start motor hang pole on trolley wire and place ground plate on rail, turn on snap switch on the grinder and move Rheostat handle to right one point which starts motor, then move handle up to about the third point or

half way, which is the usual position for running when the line voltage is about five hundred.

Grind the rail until it is thoroughly clean and bright where weld is to be made.

When rail is rusty, which is usually the case on new work, it should be ground lightly where copper contact leg rests on it, otherwise it will be very hard to get good contact.

Use vitrified wheel on old or new rail, but when grinding off solder use the Norton wheel or a little oil or grease on the vitrified wheel will prevent the solder sticking to it.

Welding Clamps.

The welding clamps are made so that welding may be done on the head or the web of the rail by raising or lowering the electrodes with the small hand wheels above the electrodes. The clamp may be moved in or out, as needed, by turning the upper side hand wheel.

For curve bonding, any radius can be obtained by turning the small tangent screw.

Keep contacts clean between cable terminals and copper contact legs by occasional sand papering and between carbon electrodes and copper legs by sand papering clean every time an electrode is bolted on. Keep screws and moving parts well oiled to insure their easy working.

Electric Welding the Rail Bond.

Lower clamps so that the inside copper electrode rests on head of rail, apply a thin coat of welding compound (mixed to stiff paste with water) to bond terminal; place bond against rail with top of bond one-eighth of an inch below top of rail, screw carbon electrode tightly against bond terminal; see that controller handle is thrown over to left against stop in off position; close line switch, which starts rotary and after it is up to speed (without moving controller handle) throw in switch under controller and move controller handle to right four or five points, when carbon will begin to heat. Care must be taken that bond is pressed closely to rail so there is no arcing between rail and bond terminal. If it does not commence to heat at once, press loose end of bond against rail. If this does not start heat immediately look to contact between rail and copper electrode. When you see that it is heating properly move controller handle slowly to right and as the brass cap on bond terminal begins to melt apply a little welding compound. Run in some welding brass between the bond terminal and the rail. This brass can best be melted by holding a strip of it against the incandescent carbon. As the brass melts, work it over between the terminal and the rail. Only a small amount of this brass should be added at a time, as a large amount will only

hide the terminal and prevent seeing the development of the weld. Use about one and one-half inches of strip brass. As the heating progresses it will be necessary to tighten the welding screw, this should be kept tight against the terminal until the brass cap is entirely melted. The screw may then be loosened a trifle to allow the additional brass to run down between the terminal and the rail. Care must be taken that the bond does not arc as this will burn the bond, if the bond gets to arcing the current switch must be pulled immediately and the hand wheel tightened and the current switch again put in, as in starting.

Do not try to turn on the circuit too rapidly as time is necessary to heat the rail sufficiently from the carbon through the copper and molten brass.

A slight softening of the copper will be indicated to the operator by a loosening of the tension on the hand wheel. Tighten on the hand wheel slightly and break the circuit immediately by opening switch under controller. Care must be taken that the bond is not pressed too tightly at this stage or it will make the terminal too flat to carry four naught capacity. The weld is made. According to varying conditions the weld should be completed in from two to three minutes.

A perfect weld is made when the heat has melted all the brass and the rail and bond terminal has become sufficiently hot to weld readily under pressure produced by the hand wheel on clamp. The molten brass is expelled from the contact surface by this pressure. Bring controller handle back to starting point. Loosen welding screw until carbon is free from the bond; raise clamp about one-half inch from rail by means of raising cam on top of clamp and move car to other end of bond. Proceed again as before.

When through welding at one joint raise clamp as high as it will go and see that it is securely fastened before moving car to next joint.

Clamped Electrode.

When bonding on head of rail the welding end of carbon should project from iron clamp about three-eighths of an inch. When bonding on web of rail the carbon should project an inch or more as needed. Bolts should be tried frequently to see if they are tight, as the heating and cooling has a tendency to loosen them and push the carbon back into the holder.

Keep end of carbon smooth with file so that it makes contact with all of bond terminal.

By reason of the protection of the heated end of the carbon they do not burn away unnecessarily and each six inch carbon will install about one hundred four-naught bonds.

Care of Rotary.

Keep commutator bright. When it is black and dirty, hold a piece of fine sandpaper (never use emery cloth) on it while running until you get it thoroughly clean.

Wash carbon brushes and holders when dirty in gasoline. See that carbon brushes make good contact with commutator.

Use compressed air, when available, for blowing out armature and field coils.

Examine the oil occasionally and if it shows any signs of grit or dirt, draw it off and replace with fresh oil. The oil rings should be examined occasionally to make sure that they revolve and carry up oil.

Do not use reversing switch on rotary to operate car and do not reverse it from one position to the other while the armature is in motion.

When rotary leaves the factory the brushes are set at the proper point of commutation. If they should spark any, shift them backward or forward until sparking ceases.

Sparking may also be caused by brushes not fitted into the circumference of the commutator. They may not have sufficient pressure on commutator; they may be burned on their ends; they may be wedged in brush holder; commutator may be rough (if so it should be smoothed off with fine sandpaper); dirt may have collected under brushes, etc., all of which causes may be remedied by intelligent methods of caring for the machine. An open circuit or loose connection in the armature, causing a bright spark which will appear to run completely around the commutator may be recognized by scarring of the commutator at the point of open circuit. It should be immediately repaired.

Switches.

The double pole switch on side of transformer is the line-switch and should be used for starting and stopping rotary.

The switches on top of transformer are connected to primary coils and are to be used in welding with varying line voltage, according to diagram in frame on front of transformer.

The double pole switch in front of car under controller is in the A. C. primary circuit, between the collector rings and the transformer, and is to be used only when welding.

The double pole, double throw switch on rotary is for reversing direction of rotation of rotary so that car can be run in either direction.

This switch must not be opened while armature is revolving.

Clutch.

The rotary converter is provided with a clutch so that it can be used as a motor for the propulsion of the car through a chain drive. This clutch is in two parts (male and female). The female part is keyed to armature shaft and rotates with armature. The male part is on a loose sleeve to which driving sprocket is attached with armature shaft running through. A lever is attached to male part, which, when raised, throws the two clutch parts together and starts car. When running any distance the two clutch parts should be bolted together which prevents any wear. A grease cup on end of armature shaft is filled with graphite grease to lubricate loose sleeve of male clutch so that it will not stick or freeze to armature shaft when you are bonding. A turn or two on the screw will force enough grease through to lubricate it thoroughly.

Circuit Breakers.

The circuit breaker should never be used to start or stop the rotary. It should be examined occasionally to see that it works freely and is free from burrs that might cause it to stick. A few drops of oil occasionally on the contacts will do much to insure proper operation.

Keep breaker set at sixty on the calibrated scale.

Driving Chains.

Oil the driving chains and when necessary adjust the length by turning the stud screw on the rotary base. Before turning stud screws loosen the four floor bolts of rotary frame. After adjusting, tighten these floor bolts. Do not adjust chain too tightly. A little slack in the chain is needed.

Keep chains clean and as free from sand as possible.

Oiling.

Before starting out to the work, oil axle bearings and trolley wheel and see that there is plenty of oil in rotary bearings.

The axle bearings are oiled through one-eighth inch iron pipe, which projects through car floor over each bearing. A wire should be run through these pipes occasionally to clear out any dirt which may have collected in them.

The screw jack bearings are also oiled through tubes and should be cleaned out same as axle bearing tubes.

Use a good grade of machinery oil such as Atlantic Red.

Wipe up surplus oil and keep the car clean of oil and dust.

Rheostats.

If one or more grids of rheostats get broken, temporary repairs can be made by jumping around broken section with a piece of wire.

Grids for repairs can be furnished by the Company. Give number of the car when ordering.

Running the Car to and From Work.

See that welding clamps are securely fastened up.

The operator controls the car from the raised seat and uses the line switch on side of transformer for starting and stopping car, except when using the clutch for short runs.

Do not start car unless controller handle is at extreme left against stop.

If car does not run fast enough, move controller handle to right three or four points.

To make short runs throw in the driving clutch by raising lever.

Both clutch parts (male and female) together when making long runs.

Run around curves and take switches slowly.

The car is too light to run at high speed even on straight track.

General.

Oil and clean all parts of the car and grinder thoroughly each day before starting work. If any trouble develops, which can be traced to failure to keep equipment in proper condition, discipline will be assessed.

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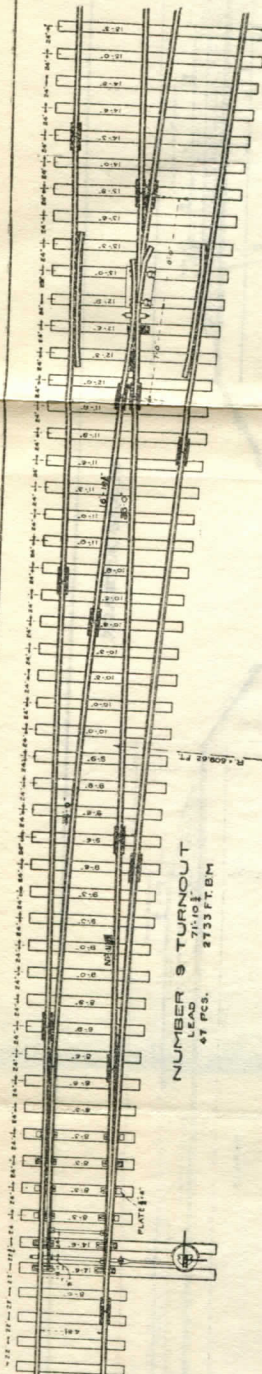
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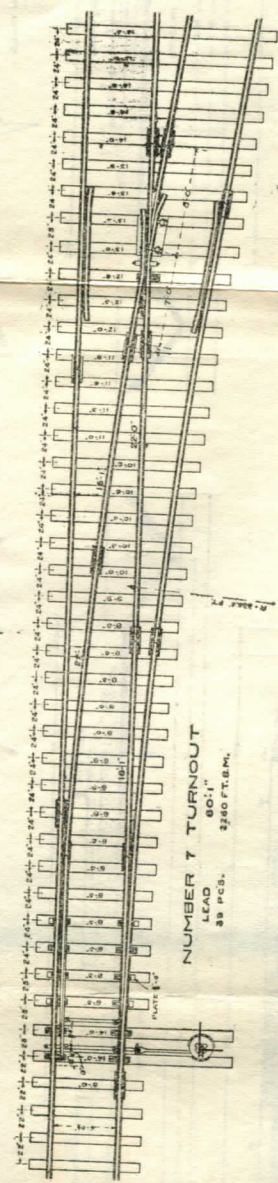
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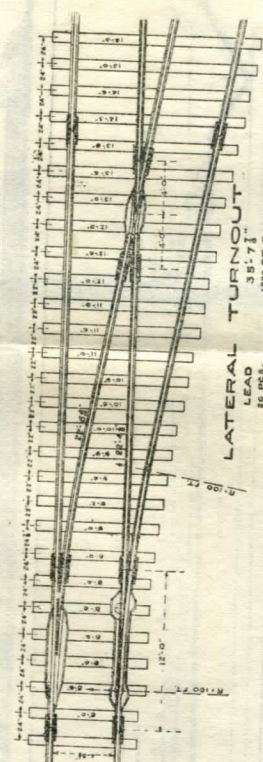
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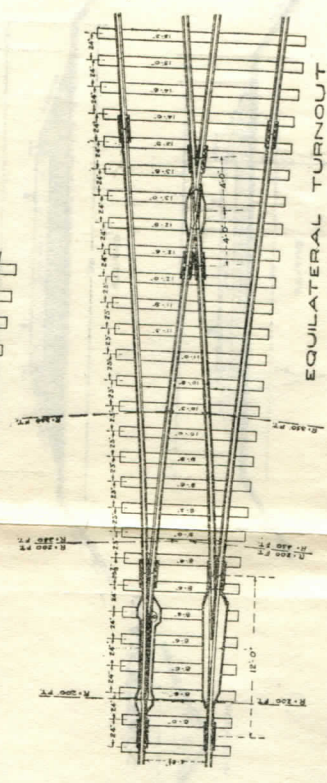
NUMBER 9 TURNOUT
LEAD 71'-10 1/2"
41 PCS. 2753FTBM



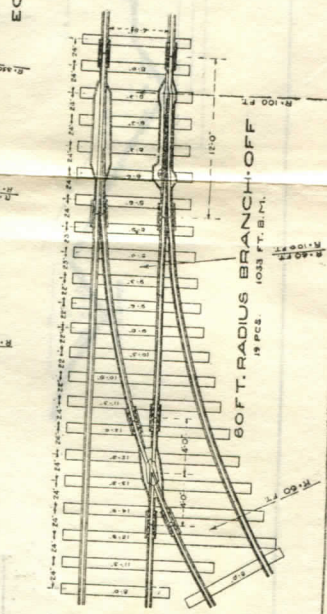
NUMBER 7 TURNOUT
LEAD 80'-1"
39 PCS. 2260 FT.B.M.



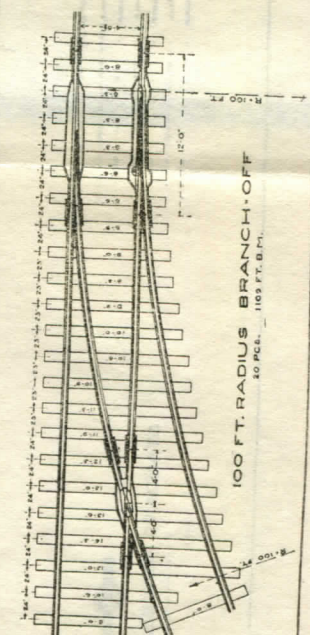
LATERAL TURNOUT
LEAD 351'-7 1/2"
56 PCS. 1228 FT.D.M.



EQUILATERAL TURNOUT
26 PCS. 1831 FT. B.M.



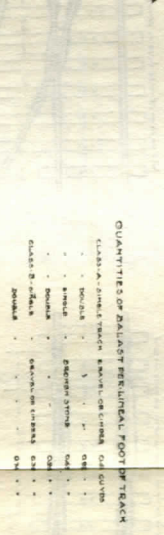
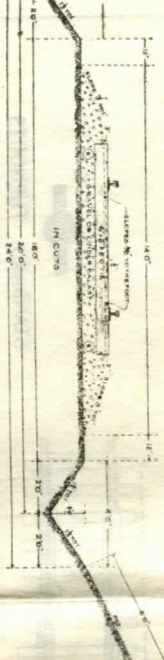
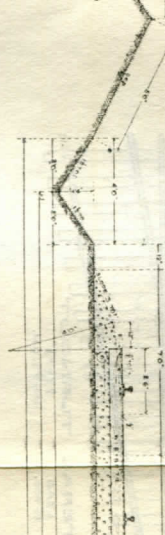
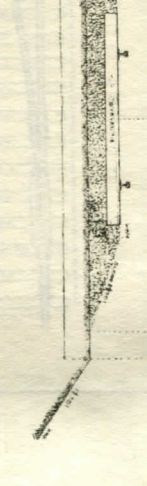
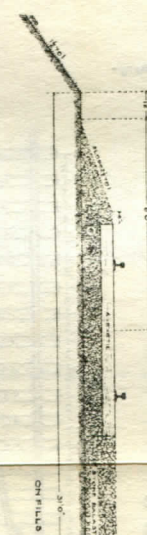
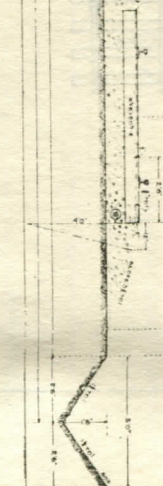
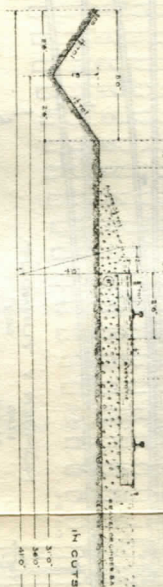
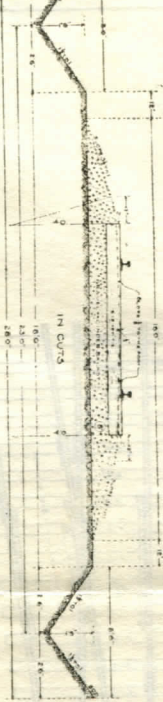
60 FT. RADIUS BRANCH-OFF
19 PCS. 1023 FT. B.M.



100 FT. RADIUS BRANCH-OFF
50 PCS. 1169 FT. B.M.

STANDARD TURNOUTS
OFFICE OF ENGINEERS OF PORTLAND AND SEASIDE
SCALE 1/4" = 1'-0"

CLASS 6 X TRACK



CLASS 6 TRACK

QUANTITIES OF BALLAST REQUIRED PER LINEAL FOOT OF TRACK

CLASS 6 TRACK

CLASS	ON HILLS	IN CUTS
CLASS 6 TRACK	1.00	1.00
CLASS 6 X TRACK	1.00	1.00
CLASS 6 Y TRACK	1.00	1.00
CLASS 6 Z TRACK	1.00	1.00
CLASS 6 AA TRACK	1.00	1.00
CLASS 6 AB TRACK	1.00	1.00
CLASS 6 AC TRACK	1.00	1.00
CLASS 6 AD TRACK	1.00	1.00
CLASS 6 AE TRACK	1.00	1.00
CLASS 6 AF TRACK	1.00	1.00
CLASS 6 AG TRACK	1.00	1.00
CLASS 6 AH TRACK	1.00	1.00
CLASS 6 AI TRACK	1.00	1.00
CLASS 6 AJ TRACK	1.00	1.00
CLASS 6 AK TRACK	1.00	1.00
CLASS 6 AL TRACK	1.00	1.00
CLASS 6 AM TRACK	1.00	1.00
CLASS 6 AN TRACK	1.00	1.00
CLASS 6 AO TRACK	1.00	1.00
CLASS 6 AP TRACK	1.00	1.00
CLASS 6 AQ TRACK	1.00	1.00
CLASS 6 AR TRACK	1.00	1.00
CLASS 6 AS TRACK	1.00	1.00
CLASS 6 AT TRACK	1.00	1.00
CLASS 6 AU TRACK	1.00	1.00
CLASS 6 AV TRACK	1.00	1.00
CLASS 6 AW TRACK	1.00	1.00
CLASS 6 AX TRACK	1.00	1.00
CLASS 6 AY TRACK	1.00	1.00
CLASS 6 AZ TRACK	1.00	1.00

STANDARD ROADBED SECTIONS

