91. Fig. 71 is a **Sterlingworth holding-up bar,** which will be found very useful in laying track, since the blow to the spike is transmitted directly to the rail and not to the adjacent ties, as it is when the tie being spiked is held up from the adjacent ties by pinch bars.

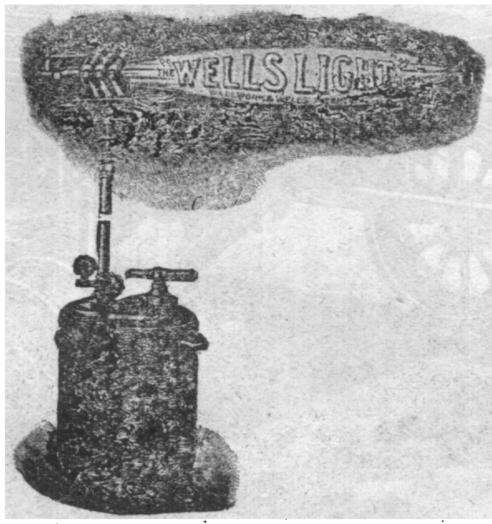


FIG. 70.—PORTABLE LIGHT.

92. A **sand blast** is an appliance that will be found useful wherever ironwork of rolling stock or bridges is to be cleaned for repainting. These sand blasts are a commercial article, and for cleaning metal work can not be equaled by any other method. The **nozzle** of a sand blast is the part that wears out quickest, and it has been found that a small piece of $\frac{3}{4}$-in. pipe pounded flat on one end and threaded at the other, for connection with the hose coupling, is as efficient as the best hardened-steel nozzles on the market.

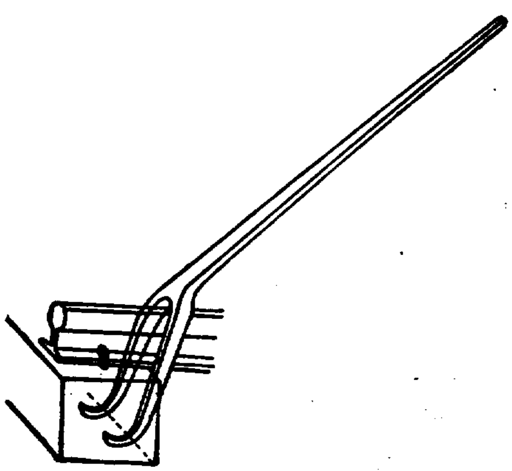


FIG. 71.—HOLDING-UP BAR.

93. With light rails the holes for track bolts can be punched, and a **portable rail punch** will be furnished for this purpose. Rails will be drilled when time and tools permit.

BRIDGES.

94. **Bridges.**—A discussion of the theory of the stresses and strains in bridges will not be considered here. The intention is to describe certain simple types of bridges and to suggest a system based on certain openings and loadings, in accordance with which the chief engineer may prepare, in advance, certain bridges or the material necessary for such bridges. If the work will be mainly reconstruction of an existing line, every effort should be made to obtain a **list of the existing bridges** and a description of each. These lists are kept by all railways. Preparation must then be made to duplicate every bridge on the first 75 or 100 miles of the line. If no such list can be obtained, or if a new line is to be constructed, certain openings shall be decided upon as standard. Knowing the maximum load, either steel or wooden stringers for these openings will be provided by the chief engineer. The

engineer in the field, on coming to an opening where a bridge is required, will plan the bridge so that the openings between abutments, or between bents of piles or trestles, shall be from the lengths previously agreed upon and for which the chief engineer is prepared to send material without delay. This classification can only apply to **single openings,** because with several spans it will be impossible to include anything general about the necessary piers.

Only in exceptional cases will openings over 50 feet be provided for. Larger spans will be subdivided into spans of less than 50 feet by temporary piers wherever possible.

The bridge material provided for the first 75 to 100 miles of the railway will probably not all be used on that part of the line. The stock of material will be increased for the next succeeding section before the end of the first section has been reached by the advancing troops.

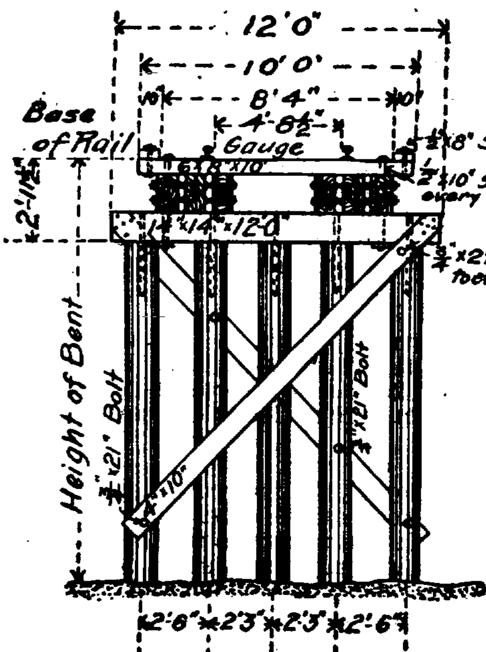
95. In any stream the rate of the current and the amount of drift are important factors in determining the span to be used. The length of time a bridge will be in use is also important, as the river may be at such a stage that one length of span can be used, when if it were at a higher or lower stage, an entirely different one would be necessary.

96. The **strength** of **wooden and steel beams** is shown in the tables under "Bridges," Engineer Field Manual, and also in the various engineers' and manufacturers' handbooks. The loads to be provided for can be ascertained or decided upon beforehand. The locomotive loads are the maximum loads and can easily be found for any standard locomotive.

97. On arriving at a bridge that has been destroyed, the first consideration is to get some sort of a line across to connect with the road on the other side. This can frequently be done by making a **deviation** which will carry the roadbed into the river bottom and up the other bank, necessitating only a very short, low bridge. This work is done by the advance party, and a second party follows and constructs the permanent bridge at the grade of the permanent track. Sharp curves on this diversion line should be avoided, since steep grades will be inevitable, and the combination may cause frequent derailments.

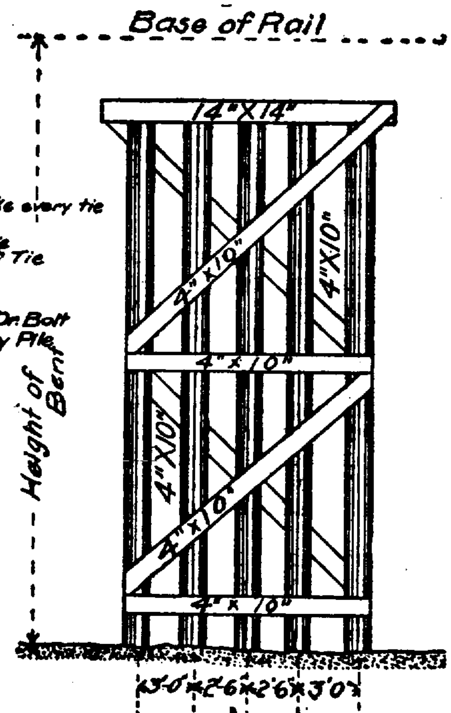
98. **Piers and abutments.**—Before the beams or trusses for the necessary spans can be decided upon, it is necessary to decide upon the location of the piers and abutments. The local conditions as to the banks and the bottom of the stream will, in general, determine the location and kind of abutments and piers that are to be used. In general terms, they will be either of piles, cribs, or trestles. A description of the methods and conditions that govern the use of these three, and their method of construction, is given in the chapter on Bridges.

99. Unless the bottom is very muddy, a crib or trestle bridge can be built quicker than a pile bridge; and on this account, unless a pile bridge is necessary, one of the other two kinds will be used. The question whether **cribwork or trestles** will be built will depend upon the amount and kind of material at hand. Cribs can be built in a shorter time with unskilled labor than can trestles, but the amount of



To 20' in height

FIG. 72.



From 20' to 30' in height

FIG. 73.

NOTE.—No bracing on bents up to 9 ft. high. Double bracing on bents over 18 ft. high and up to 28 ft.

material in cribwork is greatly in excess of that in trestles. Cribwork occupies so much of the waterway that it is more exposed to washouts and accumulation of drift than are trestle or pile bridges.

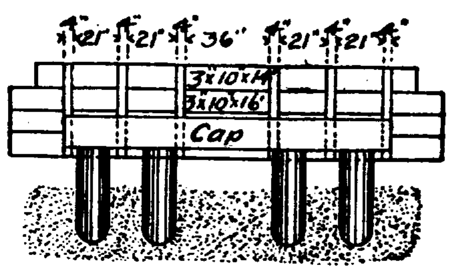


FIG. 74.—ABUTMENT WALL.

100. Up to a height of 18 ft., crib piers can be built more rapidly than trestles if the material is at hand. Above this height, the advantage of the crib over the trestle rapidly decreases; and above 25 ft. the trestle has the advantage. (Experience in South Africa.)

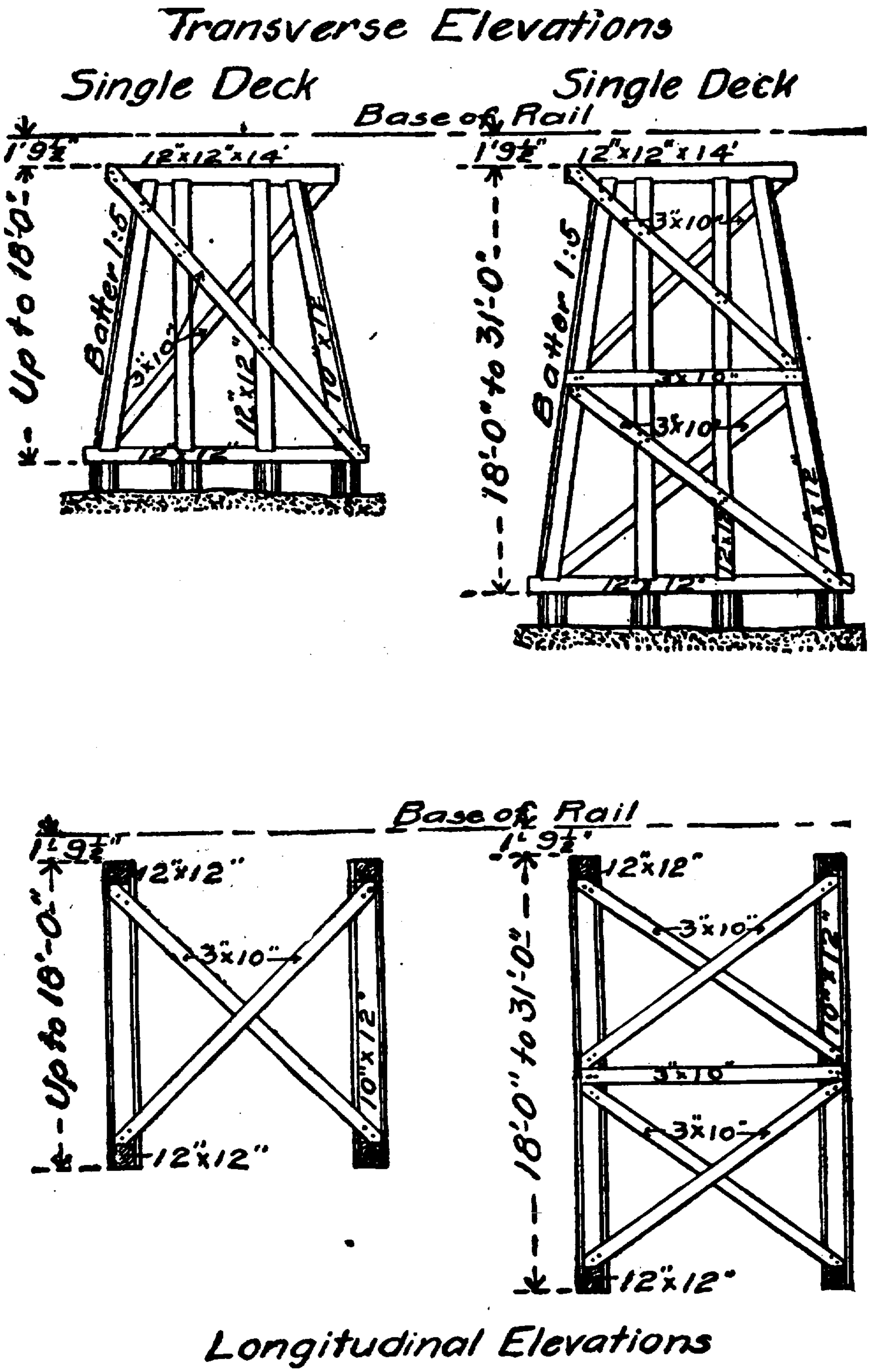

Transverse Elevations
Single Deck
Single Deck
Base of Rail
1'9½"
12"x12"x14'
Up to 18'0"
Batter 1:5
3"x10"
12"x12"
10"x12"
12"x12"
18'0" to 31'0"
3"x10"
Base of Rail
1'9½"
12"x12"
3"x10"
10"x12"
Up to 18'-0"
12"x12"
18'0" to 31'0"
Longitudinal Elevations

FIG. 75.

101. In trestlework it is frequently advisable to fasten the uprights to the caps and mudsills by means of **dogs or side plates,** instead of by **driftbolts,** on account of the difficulty of drawing driftbolts out of the timber in case the trestle is dismantled for future use.

102. On a **rocky bottom,** little difficulty is encountered in the foundations, as the bottom can be leveled off, either by cutting or by the use of concrete in bags. On a sandy bottom, two or three layers of ties make a very good foundation. Care should be taken to prevent any scouring under the foundation of the trestles.

103. **Types of pile bents** are shown in figs, 72, 73, 74. Table XXI gives a complete list of material required for any number of 16-ft. spans of pile bridge. It includes everything except rails and rail fasteners. It may be impracticable to obtain the wooden stringers shown in the table. In such a case steel I beams may be obtainable, and if so, a new table can be made incorporating such changes as the substitution of steel stringers requires.

104. **Beams.**—Knowing standard size of openings and the loading, and having decided upon the location and number of spans necessary, the corresponding floor system can be taken from the material previously prepared, or the superstructure can be ordered from the base storehouse by a very short telegram. Work can be immediately begun on the piers and abutments, and knowing the height of rail and dimensions of ties and stringers, the piers and abutments can frequently be ready for the floor system when it arrives.

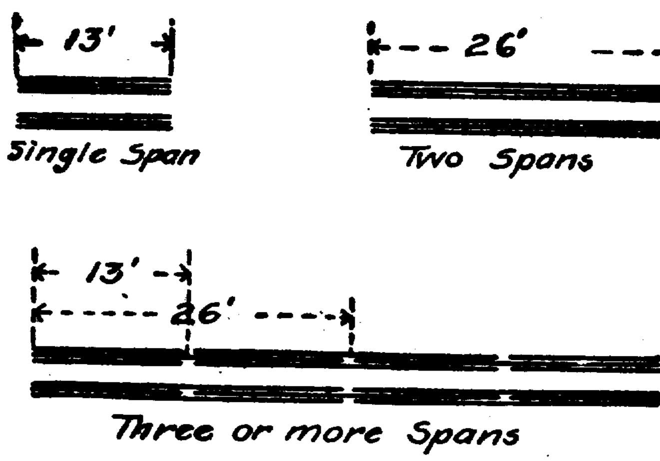


FIG. 76.—ARRANGEMENT OF STRINGERS.

Wherever practicable, the stringers of the floor system should be lapped as shown in fig. 76, but in ordering a **floor system,** care should be taken not to ask impossible things. For instance, to ask for double lengths for a 15-ft. span would require timber 30 ft. in length, which is about the limit of length that can be supplied from the ordinary market; and if a longer span than 15 ft. were contemplated, it would not do to ask for double lengths unless it were known positively that such lengths could readily be obtained.

105. **Trestles.**—Figs. 75 and 77 show the form of construction for trestles of various heights and show the necessary bracings. From these figures and from fig. 78 bills of material for trestle bridges can easily be made up to suit any particular case.

106. The various methods of **erecting the trusses** or beams are fully described in the chapter on bridges. The ends of beams or trusses should be securely fastened to the caps by driftbolts or by some other method that will keep them from sliding sidewise or lengthwise. Adjacent beams should be separated by blocks of wood, or by C. I. spools.

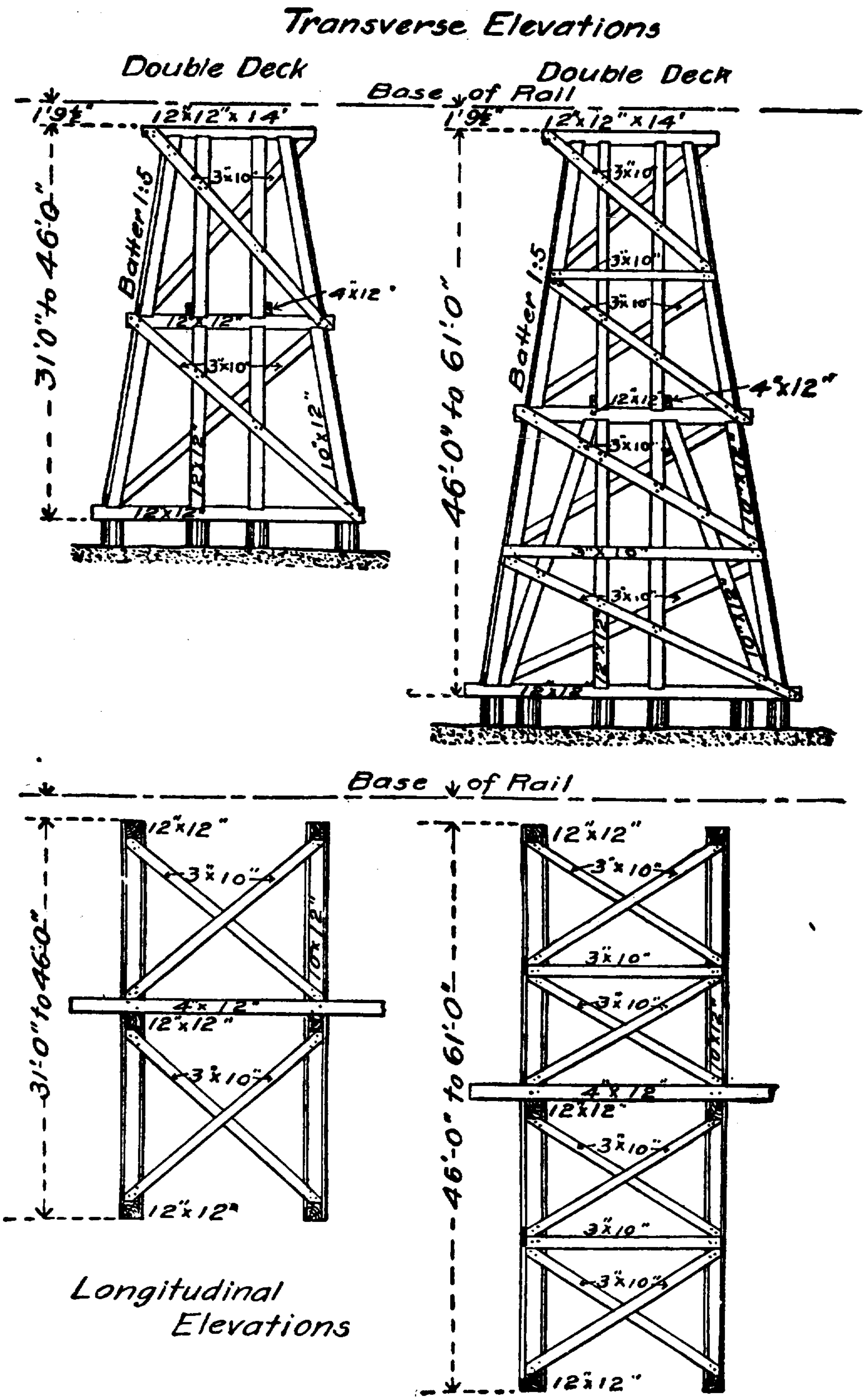

Transverse Elevations
Double Deck
Double Deck
Base of Rail
12"x12"x14'
3"x10"
Batter 1:5
4"x12"
12"x12"
10"x12"
31'0" to 46'0"
46'0" to 61'0"
Base of Rail
12"x12"
3"x10"
4"x12"
Longitudinal Elevations

FIG. 77.

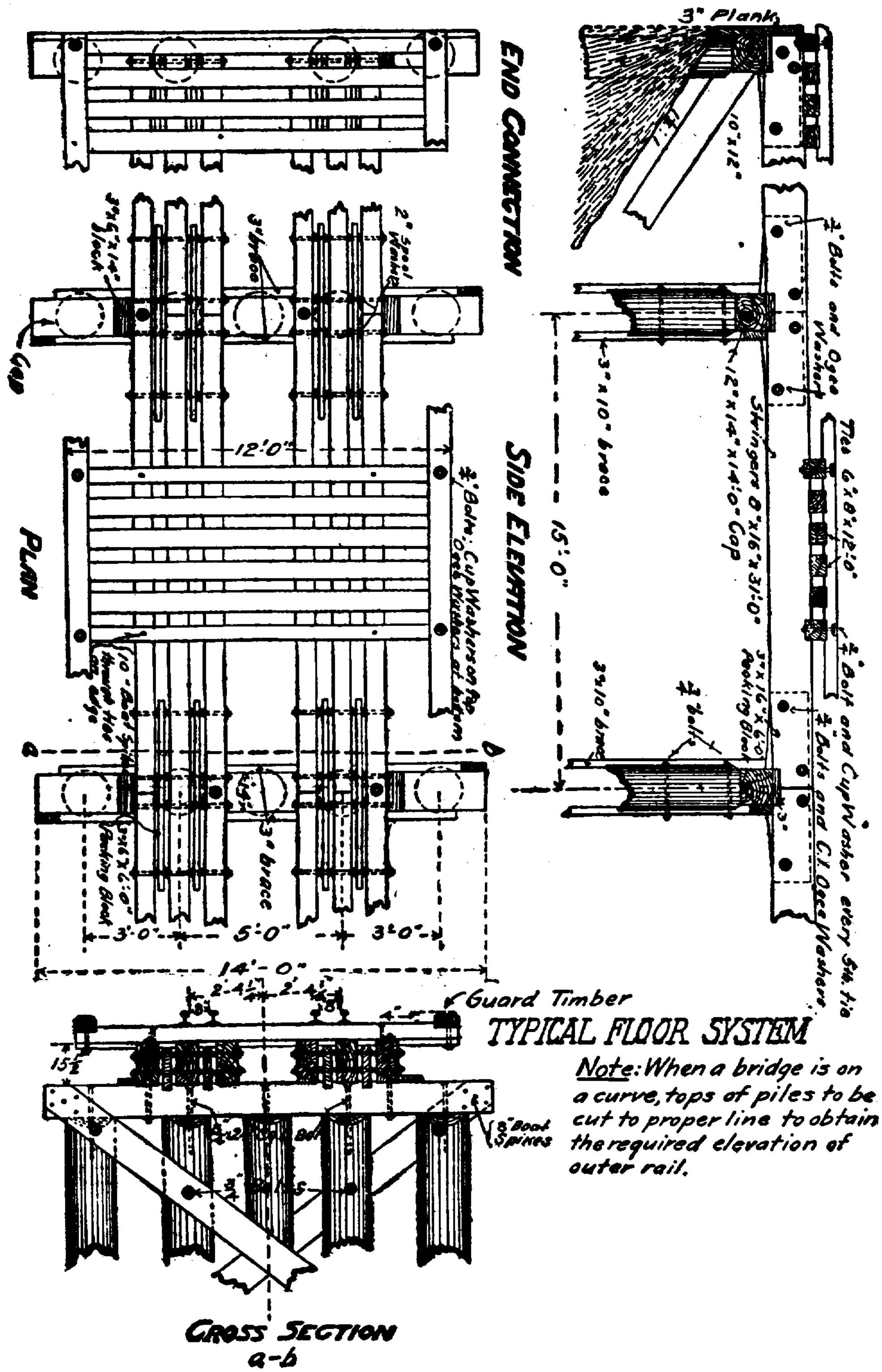


FIG. 78.

107. **Cross bracing.**—Whether trusses or beams are used, some system of floor bracing must be used that will make the bridge rigid under side pressure from wind or other causes, and will prevent lateral movement from vibration due to moving loads.

108. **Floor system.**—The part of a pile or trestle bridge above the caps is known as the floor system. A standard floor system is illustrated in fig. 78, where the various parts are designated by name. The strength is varied by changing the number of stringers.

109. **Creeping.**—The ties of a railway bridge should be spaced from 4 to 6 ins. apart, and about every sixth tie should be fastened to the stringers, either by letting the tie into the stringer or by nailing a block to the stringer that completely fills the space between that tie and the next. This prevents creeping of the track on the bridge. When I beams are used for stringers, the track is prevented from moving sideways by fastening the ties to the flanges with lag bolts. Creeping is prevented by clips that clamp the rail to the flange, or end, of the I beams.

110. **Guard rails** and **guard timbers** are necessary to prevent trains running off the bridges in case of derailment while crossing a bridge. On a single-track bridge, the guard rails extend the full length of the bridge on both sides and are brought together at both ends after leaving the bridge. On a double track bridge, they are brought together at the end from which traffic comes and are left open beyond the other end of the bridge (see fig. 79). Guard rails should be from 8 to 12 ins. inside the main rails. Guard timbers are bolted to the ends of the ties on both sides of the track, the full length of the bridge. They are usually from 4 by 10 to 5 by 8 ins. and lie about 3 ft. outside of the rails.

NOTE.—No guard rails to be used on bridges having a clear span under coping of less than 20 ft.

Guard timbers to be placed at proper distance outside of rails on all bridges except those with solid floor and ballast.

111. **Trusses.**—For spans greater than 50 ft. suitable girders or beams could not practically be carried in stock in the storehouse. Such openings must be spanned by trusses built on the site. As far as practicable, all the materials are framed at the rear and sent to the site ready for erection.

The chief engineer will have on file in his office complete bills of material for trusses of various standard lengths. He will keep on hand a supply of all **standard bridge materials,** and can thus supply the necessary material for any of these trusses.

112. **Cableways.**—In some places an overhead cableway can be used to great advantage in erecting or building a bridge, or in transporting supplies across a stream that vehicles can not cross. There are two classes, the **ordinary cableway** (fig. 80) and the **balanced cable crane** (fig. 81). The first form can be quickly rigged if large trees are close to the bank, and is very convenient when the load does not have to come in to the very foot of the supports. If towers must be used to support the cable, they are difficult to erect and the material is too heavy to carry in a field equipment. A considerably longer span is always necessary than the actual width of the stream, and the load must be pulled uphill over one-half of its journey and is only stable at the lowest point in the catenary. The balanced cable crane, on the other hand, can carry loads farther inshore than its points of support; the stress in the cable is constant whatever the position of the load, and only sufficient force to over-

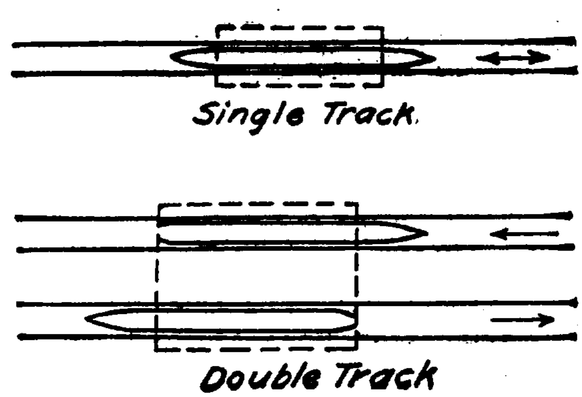


FIG. 79.—GUARD RAILS.

come friction is required to move the load along the cable. The key to the construction of this cableway is that the length of the cable must be such that both counterweights can not rest on the ground at the same time. The automatic rising and falling of the counterweights as the position of the load on the cableway changes keeps the angles of the cable at the load symmetrical with the action line of gravity, and hence the load is stable at any point on the cable.

One end only need oscillate; the other can be rigidly anchored. The counterweights are the only excessively heavy parts of this cableway. They will probably be bags of sand filled on the spot. The amount of material to be transported is comparatively small, and much of it will have other uses.

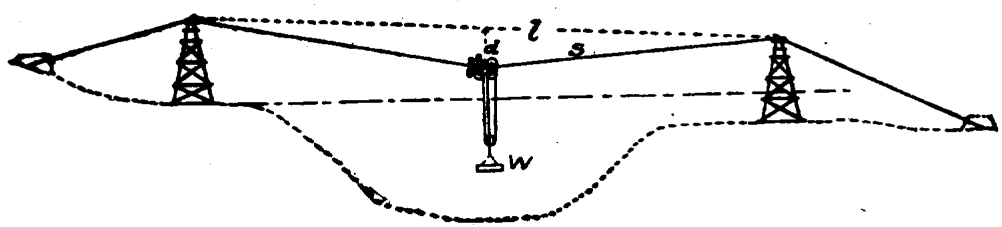


FIG. 80.—ORDINARY CABLEWAY.

For efficient hand operation, the cable of either class must have both ends at approximately the same elevation.

In reconstruction work, the use of cableways will be found to facilitate the erection of bridges very greatly; and in cases where a ferry is not practicable, a cableway may be constructed for the transportation of supplies.

Light cableways with a capacity of about 60 tons per hour for spans up to 400 ft. are commercial articles, and from 25 to 30 tons per hour can be carried over a span of 1,000 ft. on a comparatively light cableway.

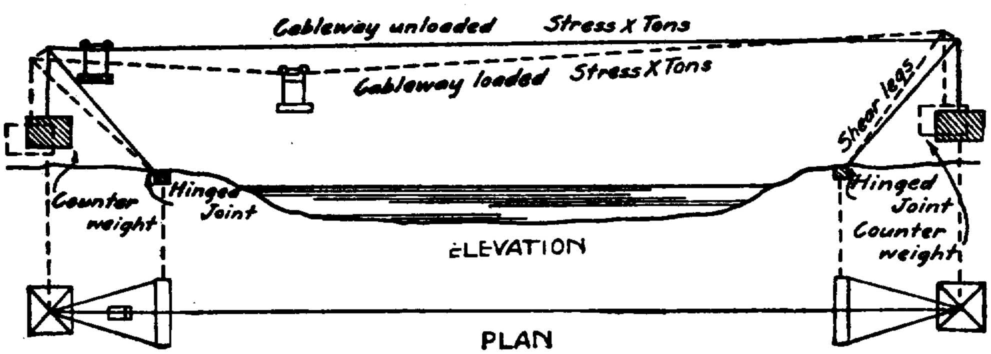


FIG. 81.—BALANCED CABLE CRANE.

TRACK LAYING.

113. Final center line.—As soon as the roadbed is completed, the transit party runs over the line and sets center stakes 100 ft. apart on tangents and 50 ft. apart on curves, and re-marks the center of the track by tacks in the head of the stakes. The road is then ready for the track-laying gang. This center line must be accurate, for bridge and track work will begin simultaneously.

114. Track laying.—The track-laying party now follows, and the plans for all preceding work should be such that the track laying can go on continuously. The **rapidity of track laying** is governed by the rate of supply of material at the working point. This can be accelerated on sidetracks and on double-track work by unloading ties, rails, and other material directly from the cars alongside of the existing track, and work under these conditions is simple and rapid, for the material can be easily distributed.

On **new work,** however, the rails, ties, and all other materials must be either distributed along the line by the **use of wagons** or must be carried on a **train** and the track built ahead of the train; ties, rails, etc., being unloaded and placed in position by laborers.

115. On ground that is fairly level and free from streams the first method, that of distributing material from **wagons,** is the most rapid. The following example gives the working force and distribution of labor used in laying an average of 4.27 miles of track per day of 10 hours during the month of August, 1887, between Minot, N. Dak., and Great Falls, Mont. The force was distributed as follows:

	Men.	*Horses.*
Hauling ties	75	150
Loading ties	28	....
Distributing ties	10	....
Spacing ties	4	....
Lining ties	2	....
Marking and placing joint ties	4	....
Unloading flats and loading iron cars	24	....
Unloading iron cars and placing rails	13	....
Hauling rails	3	6
Spikers	38	....
Nippers	19	....
Strappers	12	....
Distributing spikes	2	....
Lining track	8	....
Total	242	156

Six rail cars were used, and as soon as each car was unloaded at the front it was run back behind the spikers and taken off the track. When the last of the six cars had been unloaded, the other five were again placed on the track and the supply train moved ahead. The best record made was 8.01 miles of track in 11½ hours. This is supposed to be the best day's work of track laying on record.

The ties were unloaded from the construction train, placed in wagons, and hauled to the front, and then thrown into place, lined, and spaced by the first 123 men in the above list. The rails were unloaded from the construction train onto small rail cars, hauled to the front, and unloaded from these cars and placed on the ties by the next 40 men of the table. Rails were spiked to the ties, the bolts put in, and the track lined by the remainder of the crew.

The method just described is the most rapid that can be followed but is more expensive than other methods to be described later and therefore is not generally followed in commercial lines. On a military road, labor is plentiful and cost, often is not a deterrent. Where the adjacent country is rough or swampy the use of wagons becomes impracticable and the track must be built from the roadbed itself.

116. In the second case all the track material is carried **on a train** and distributed ahead of that train. The ties, rails, etc., can be carried **by hand** from the cars to their place on the roadbed, or use can be made of what is commonly called a **track laying machine.**

When the track material is **distributed by hand,** a crew of 3 foremen, 64 men, and 2 teams ought to lay about 1 mile of track in 10 hours under average conditions. The following distribution of the crew is suggested:

Tie carriers	21	Nippers	6
Tie placers	6	Spike distributors	1
Rail placers	8	Bolt distributors	1
Head strappers	2	Water boy	1
Back strappers	4	Teamsters	2
Spikers	12		

This table is based on the use of push cars for both rails and ties and allows but one man to carry a tie. Two men to a tie would probably have to be used.

The **Meru Charjui** section of the **Trans Caspian Railway** was laid by this method in 1885 at the rate of 38.5 miles per month. The **Sibi Railway, in India,** 133 miles long, was laid at the rate of 40 miles per month.

117. **Tools for laying track.**—Allowing for breakage and for changing men from some kinds of work to other kinds at times, the following tools will be needed for a track-laying crew of 64 men:

26 spike hammers.
18 pinch bars.
12 track wrenches.
16 picks.
4 pinch bars 3½ ft. long.
2 water buckets, 4 dippers.
72 track shovels.
3 adzes.
4 chopping axes.
2 hand axes.
4 rail forks
6 rail tongs.
2 ratchet drills and bits.
50 expansion shims, ¼ in.
100 expansion shims, ⅛ in.
200 expansion shims, $\frac{1}{16}$ in.
1 grindstone.
3 sixteen-pound sledges.
3 adz handles (extra).
48 spike hammer handles (extra).
12 pick handles (extra).
4 ax handles (extra).
2 track jacks.
2 tie-spacing poles.
1 drawshave.
4 claw bars.
1 push car.
3 rail cars.
1 hand car.
1 keg 10d. wire nails.
1 keg 20d. wire nails.
1 keg 40d. wire nails.
1 keg 60d. wire nails.
3 oilers.
4 gallons black oil.
4 white lanterns.
2 red lanterns, 2 red flags.
Extra white and red lantern globes.
3 monkey wrenches, 6, 8, and 12 in.
2 nail claw hammers.
1 steel tape 100 ft. long.
1 linen tape 50 ft. long.
6 track gages.
2 crosscut saws.
2 hand saws.
4 water barrels.
2 tie squares.
1 rail curver.
1 rail bender (jim-crow).
2 curving hooks.
2 track levers.
1 tie line, 1,000 ft. long.
Flat, round, quarter-round, eighth-round, and three-cornered files, three or four sizes of each.
4 horses or mules, with harness for hitching double, single, or in tandem.
2 lumber wagons.
2 large tool boxes.
2 thermometers.
1 rail-car clamp gage.
24 track chisels.
3 1-inch ropes for rail cars, ring and hook on each.
1 chalk line.
1 track level
6 cold chisels.
6 switch locks.
4 doz. torpedoes.
1 tool car.
1 brace and 6 bits.
1 2-inch auger.

In case it is intended to turn the crew to surfacing and ballasting, in addition to the above, there would be needed 1 level board, 2 track jacks, and 32 tamping picks where broken or crushed stone ballast is used.

118. **The organization and plant** required for rapid track laying by means of **a track-laying machine** will bear description, and apply not only to new work but also to the repair of breaks where a roadbed has been torn up by the enemy.

The party consists of 1 foreman, 3 subforemen, and from 80 to 100 laborers. The materials are carried on cars that are *pushed* to the railhead by a locomotive. Fig. 82 illustrates the arrangement of such a train, loaded with about 1 mile of railway material. The amount of material in such a train depends directly upon the weight of the rail and the size of the ties. On a standard-gage road a 40-ft. flat will carry about 1,100 ties or 125 to 150 rails (70-lb.). These loads are in excess of the rated carrying capacity of the cars, but the train moves very slowly, and the loads can be safely carried.

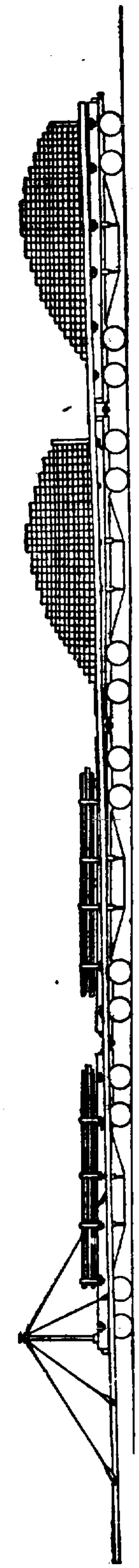


FIG. 82.

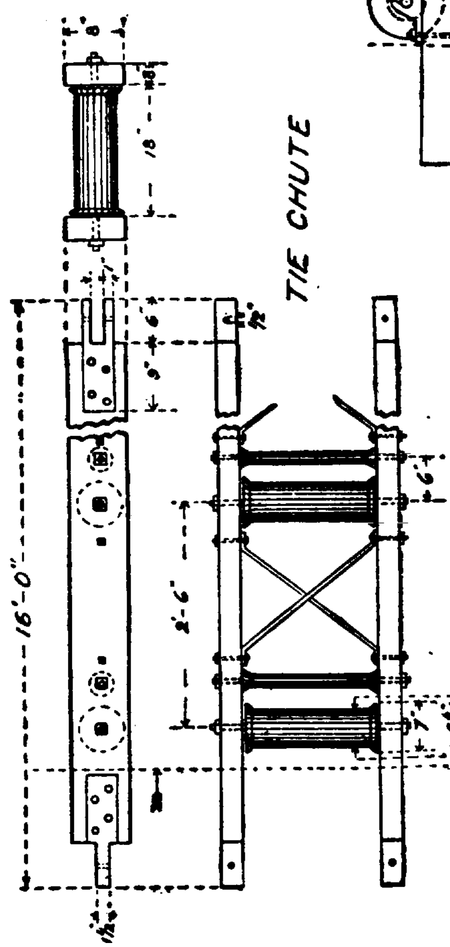


FIG. 83.

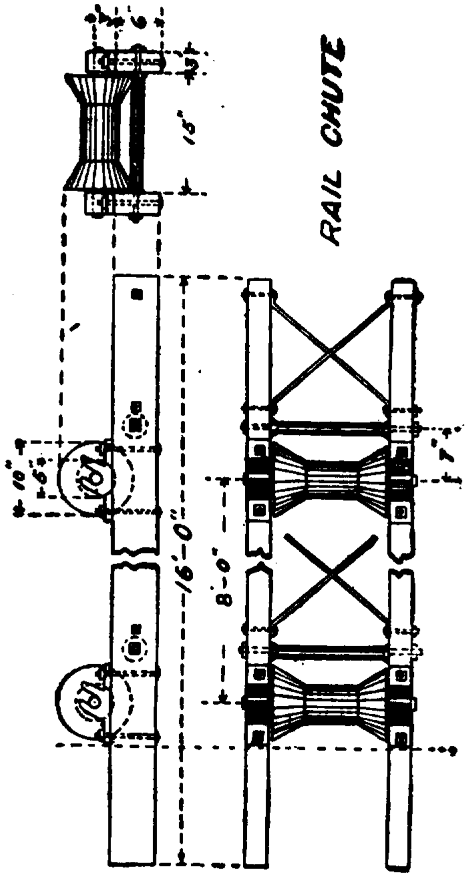


FIG. 84.

119. A train should be made up to carry either a half day's or a whole day's supply of material, in order that no time shall be lost in going to the rear for new material during working hours. The first two cars are loaded with rails and the necessary angle bars, or fishplates, and bolts. The next two cars are loaded with ties. There will be one or two cars for the transportation of the working gang and for storing tools, spikes, and other supplies.

120. The ties and rails are supplied to the front by means of chutes that extend along the sides of the train. The dimensions and details of these chutes are shown in figs. 83, 84. They are supported by iron brackets, shown in figs. 85, 86, which are

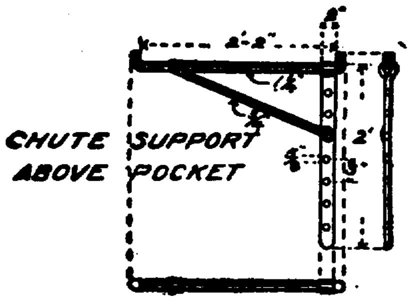


FIG. 85.

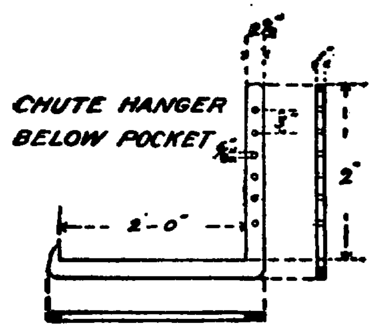


FIG. 86.

set in the pockets along the sides of the flat cars. These brackets are adjustable, and are set at such an elevation as to give the chutes a slope of about 6 ins. in each car length. The ties come down the left-hand side and the rails down the right-hand side of the train. The tie chute extends about 30 ft. in front of the forward car and is supported by guy ropes, as shown in fig. 82. The ties are thrown onto the chute by four men on the front tie cars, and they are pulled along the chute by means of boat hooks (fig. 88). After the ties are in the chute, one man per car

FIG. 87.

can keep them moving to the front. The ties are received at the end of the chute by a gang of nine laborers, who place the ties on the roadbed one rail length in advance of the chute. Two men see to the proper centering and spacing of the ties. For each 30-ft. rail, on a standard-gage road, 18 ties will be used.

121. In the meantime, the necessary fishplates, or angle bars, have been bolted to the forward ends of two rails, and these rails have been dumped into the rail chute. As soon as a rail length of ties has been placed on the ground, the rails are pulled out of the chute and are placed in position on the ties, the rear ends going between the angle bars at the ends of the last rails laid. The rear rail man on each rail takes

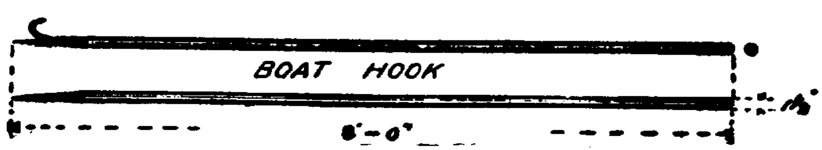


FIG. 88.

a track bolt and nut and wrench from the box on the head of the rail car and loosely bolts up one track bolt at each joint. Meantime the track is temporarily spaced with four **bridles** of the kind shown in fig. 87. These bridles are put in place and

FIG. 89.

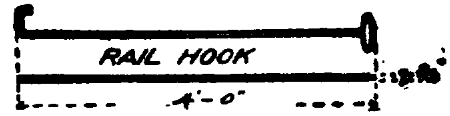


FIG. 90.

fastened by the rail men after depositing the rail on the ties, and are brought up after the construction train passes over them, to be used again.

The train then moves forward one rail length, that is, till the head of the forward car is within a few feet of the railhead. Then the operation is repeated.

122. A **derrick** sometimes is rigged on the forward end of certain track-laying machines, and when the rails reach the end of the rail chute, which in this case extends a half rail length beyond the end of the car, a clamp is fastened to the middle of the rail and the rail is swung by means of the derrick to its place on the ties. The advantage of this machine is that it decreases the number of laborers necessary to handle the rails, and this reduces the number of men working at the immediate head of the train. The tools used by the men on the rail car are shown in figs. 89, 90. These tools facilitate handling the rails and prevent the men from injuring their hands. With a machine like the one described, about 2 miles of track can be laid in a day of 10 hours.

123. The **composition of the party** ahead of the train on this work is about as follows, for 70-lb. rail, standard-gage ties: For handling ties, 18 men (4 on tie cars, 2 moving ties in chute, 2 spacing and centering, 9 carrying, and 1 subforeman); handling rails, 24 men (3 on rail car, 12 rail carriers, 4 clip carriers, 4 spike and angle carriers, and 1 foreman). In addition to these, there is 1 conductor, 1 brakeman, 1 engineman, 1 fireman, and 1 head foreman of the gang, making a total of 47 men.

124. **Behind the train** is a gang that spikes the rails to the ties and tightens all the track bolts. Following this gang is a gang that aligns the track to the stakes previously set. In the rear of these is another gang that surfaces the track.

These last three gangs are in charge of one subforeman, and are made up as follows: Bolting gang, back strappers, 4 men; spiking gang, 4 spacers, 16 strikers, and 8 bar men; aligning gang, 8 men. The number of men in the surfacing gang will depend entirely upon the amount of work to be done in leveling the track, throwing in the earth ballast, and tamping the same.

125. In order to lay track rapidly by this last method, the joints must be opposite each other (square), or practically so; and on a temporary line this is the best method of laying track, as with earth ballast the joints will be pounded down by the traffic, and there is less danger where the low joints are opposite each other than there is with the low joints on one side opposite the middle of the rail on the other.

Rails are usually bought under specifications that 90% of the rails shall be 30 ft. long and the other 10% may vary by 2-ft. lengths from 24 ft. to 30 ft. These short rails can be used on curves, and thus keep the rail joints nearly opposite each other.

126. **Expansion.**—In laying track, allowance must be made for expansion. A 30-ft. rail changes its length 0.252 in. for 100° change in temperature. Knowing the maximum and minimum temperatures of the place, thin plates, called expansion shims, can be made for use when laying steel at the various temperatures. For track laying before 10 a. m., use expansion shim for 10° lower than indicated by thermometer. From 10 a. m. to 4 p. m. use same shim as indicated by thermometer. After 4 p. m. use shim for 10° higher than indicated by thermometer. The thermometer should have the same exposure to the sun that the rail has.

TURNOUTS AND CROSSOVERS.

127. **Turnouts and crossovers.**—A turnout is a curved track by means of which cars are moved from one track to another. The special parts of a turnout are the frog (fig. 9) and the switch (fig. 10), and the guard rails. The term "switch" is frequently applied to the part of a turnout from the point of switch to include the frog. The **switch proper** may be either a stub or a split switch. The latter is the form now generally used. Stub switches are only used on unimportant lines or in yards. In a stub switch, EAD, fig. 91, is a single rail, free to move from A to D, but spiked to ties from E to A. The same is true of the rail BH. The switch rails are fastened together by connecting rods between point and heel. The **headblock** and **switch stand** are at the free end, D, of the switch rails. The arrangement of the switch rails of a split switch is shown in fig. 95.

The point, B, fig. 91, is the **theoretical point of switch,** but is not the actual point on account of the extreme thinness that would be necessary at the end of the switch rail and the great length of switch rail that would be required. The **toe of the switch** is the free end of the switch rail. The **heel of the switch** is the fixed end of the switch rail. The **throw** or **clearance** is the distance D K. For stub switches, this throw is the distance between gage lines at the toe. For split switches it is the distance between the adjacent faces of the switch rail and the main rail.

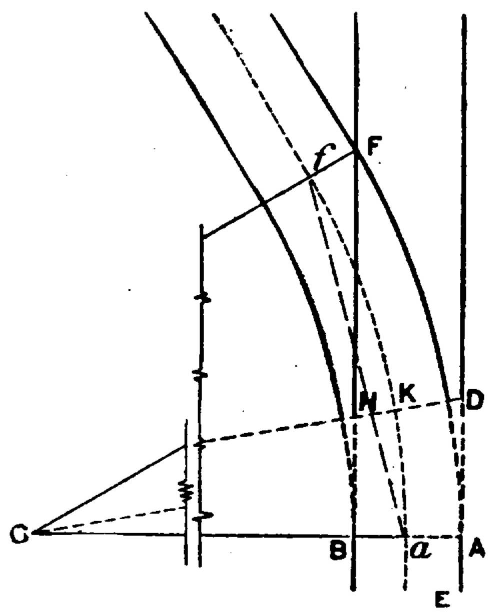


FIG. 91.

Reference to Tables XIV and XV will show that the length of switch rail required for a frog above No. 7 is over 20 ft. Twenty feet is about the greatest length of rail that can safely be left free from the ties, and for each frog number above 6 a certain length of switch rail, called the "point," is usually prescribed on each road. The point of sufficient clearance, H, is fixed, and then the P. C. of the switch falls wherever the arbitrary length of the "point" requires. See columns 5 and 6, table, fig. 97, for the practice on the Chicago and Northwestern Railway.

Frogs are usually designated by number, and this number, n, equals $\frac{1}{2}\cot\frac{1}{2}F$. Sometimes **special frogs** are referred to by the frog angle in degrees and minutes. Tables XIV and XV give all the data necessary to lay out various standard turnouts from a tangent, for the gage, and clearance, indicated at the head of each table. For other gage, or clearance, the engineer can readily construct a similar table to meet his case.