at the point of intersection. The angle at each rail crossing can be computed in the shop. Where two roads must cross and no crossing is at hand, one track can be raised a sufficient amount to allow a movable section of rail to be put into place across the other track. When the cars have passed, the section is taken out, opening the lower track to cars.

Crossings for vehicles are made by nailing planks to the ties or to blocks laid in the bed of the track. To keep such crossings clean and thereby prevent cars from jumping off the track, it is a good plan to lay a rail on its side along the inside of each rail of the track, the head of such rail to lie against the web of the track rail.

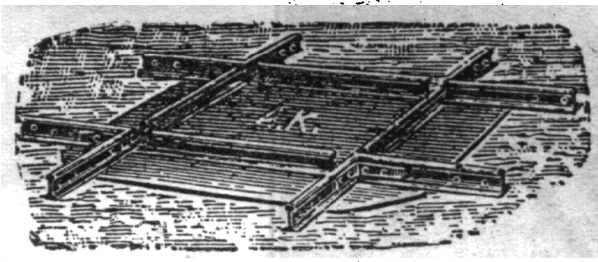

FIG. 18.—CROSSING.

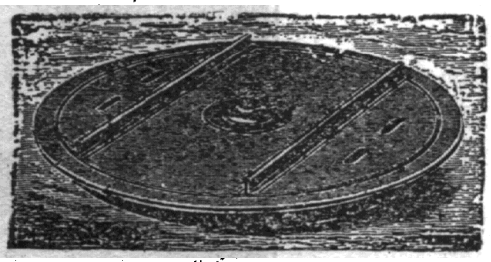

FIG. 19.—TURNTABLE.

26. **Turntables.**—For sharp turns, and for turning cars and locomotives, turntables are necessary. The commonest kind used with portable track is shown in fig. 19. These are furnished ready-made by the railway-equipment firms. (For a complete turntable see par. 168, fig. 119.)

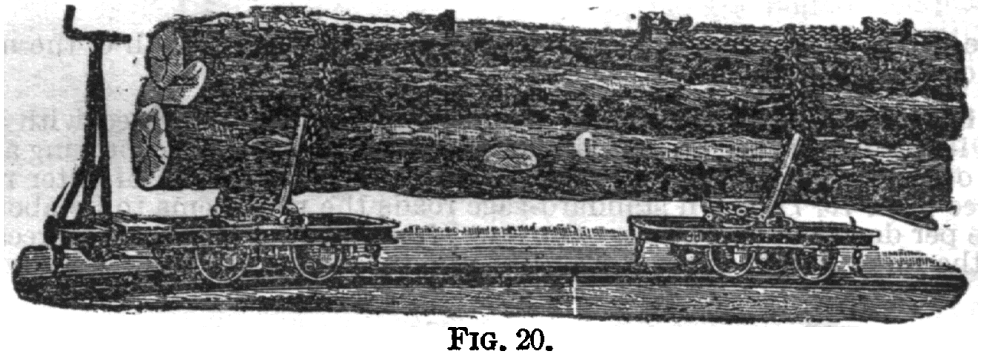

FIG. 20.

27. **Cars.**—Commercial types of narrow-gage cars are made entirely of steel, entirely of wood, or of the two combined. For certain uses the all-steel cars are very good, but for work in the field, cars with wooden bodies have been found to be much easier to repair, and a break of any sort does not throw the car out of use for a long time.

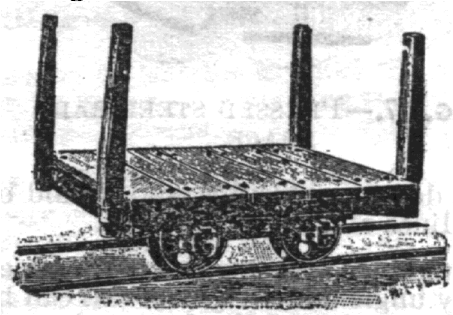

FIG. 21.

All cars should have the **coupling bars** the same height above the rail. They should have **rings** or **hooks** on each corner, by means of which they can be moved by animals walking on the *side* of the track. As far as possible all parts should be interchangeable.

Fig. 21 is a small **platform car,** with steel frame, platform of steel, of wood, or of wood lined with steel, for hand power, capacity from 2 to 3 tons, 18 to 36 in. gage, size of platform about 3 by 5 ft. to 5 by 8 ft. Other sizes made to order.

Fig. 22 shows a **flat car,** capacity from 10 to 12 tons, 12 to 20 ft. long, 3.5 to 5 ft. wide, and from 18 in. to 36 in. gage.

Fig. 23 shows a similar car with wooden end walls. The stake pockets allow sides to be put on which convert this car into a **gondola.**

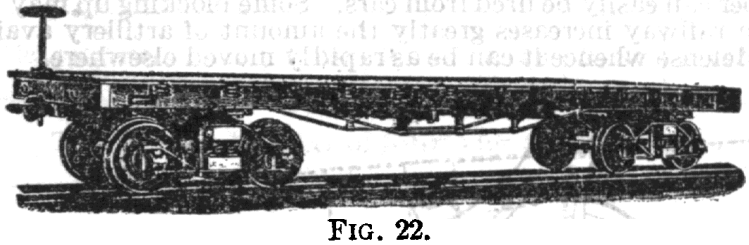

FIG. 22.

28. By constructing a wooden top frame, trucks similar to those in fig. 20 can be utilized in pairs for **transporting siege guns** and other heavy armament.

The track is floored over for a sufficient distance to allow the gun to be run across the railway and moved so as to lie longitudinally along the track. By means of

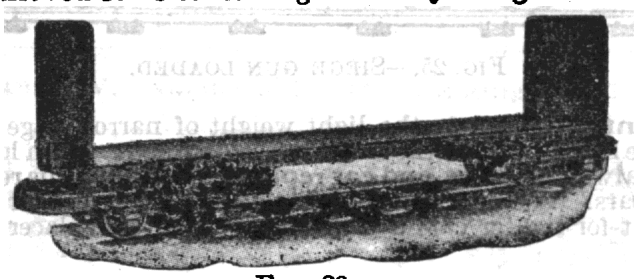

FIG. 23.

ropes, the gun and its limber are run up special ramps (outside of the rails) until they are higher than the body of the car; the wheels are then chocked and the car run under the gun. The necessary blocking is put on the car and chocks are removed, whereupon the gun and limber roll down the ramps and the gun settles on the block-

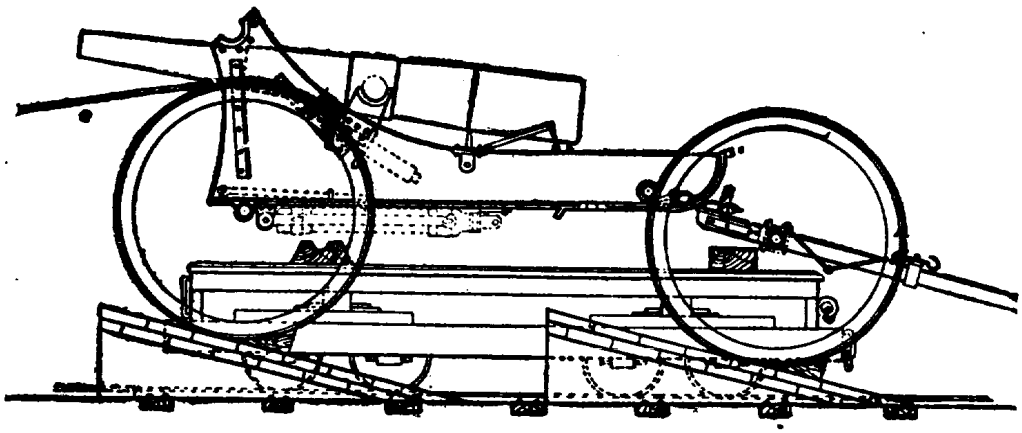

FIG. 24.—LOADING A SIEGE GUN ON TRUCK.

ing. The limber is then released and the gun is ready for movement. The gun is unloaded with similar appliances. One limber is sent on the first car to be used in unloading the guns when they arrive.

The method of mounting the armament on such a truck is illustrated in figs. 24 and 25.

29. The possibilities of combat railways for both offense and defense are very great and have never been fully utilized. Guns up to 6 in. caliber and howitzers of larger caliber can easily be fired from cars. Some blocking up may be necessary. Such use of a railway increases greatly the amount of artillery available in any sector of the defense whence it can be as rapidly moved elsewhere.

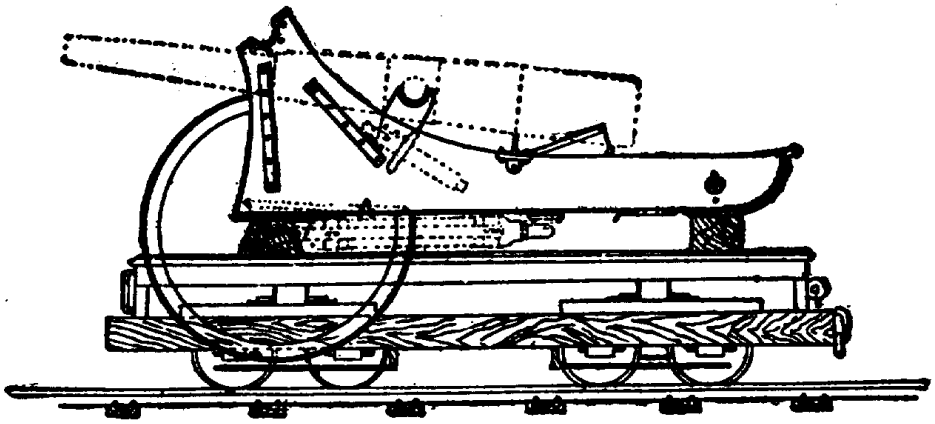

FIG. 25.—SIEGE GUN LOADED.

30. **Derailments.**—Owing to the light weight of narrow-gage cars, an empty car can easily be lifted back on the track if it is derailed. With loaded cars, however, this is not always the case, and car replacers facilitate this replacing without unloading the cars. The one shown in Fig. 26 is a good one for heavy cars and locomotives, but for lighter cars a considerably lighter replacer would be more convenient.

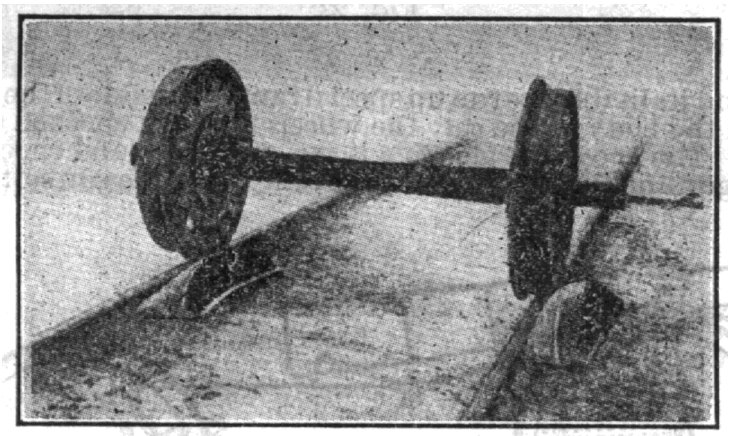

FIG. 26.—BUDA LIGHT-WEIGHT REPLACER.

31. In estimating for materials for combat or other railways the following rules and tables will facilitate work:

The number of long tons of rail per mile of single track is found by multiplying the weight per yard by $\frac{11}{7}$. Thus, for 35 lbs. per yard, $\frac{11}{7} \times 35 = 55$, the number of long tons per mile.

TABLE II.—Number of **crossties** for **1 mile of track.**

Distance c. to c.....ft..	1.5	1.75	2.0	2.25	2.5	2.75	3.0
Number of ties required.....	3,520	3,018	2,640	2,346	2,112	1,920	1,760

TABLE III.—Number of **joints** for **1 mile of track.**

Length of rail.	Number of joints.	Number of bars and bolts for each joint.
30 ft.....	352	16 to 65 lb. rails have 2 angle bars and 4 bolts.
Standard practice (90% 30 ft., 10% short).	357.5	70 to 100 lb. rails have 2 angle bars and 6 bolts.
24 ft.....	440	
15 ft.....	704	

TABLE IV.—Number of **joints** to the **long ton of rails.**

Weight of rail per yard.	Based on 30-ft. lengths.	Based on standard practice, 90% 30 ft., 10% shorts.	Based on 24-ft. lengths.	Based on 15-ft. lengths.	Weight of rail per yard.	Based on 30-ft. lengths.	Based on standard practice, 90% 30 ft., 10% shorts.	Based on 24-ft. lengths.	Based on 15-ft. lengths.
Lbs.					*Lbs.*				
100	2.24	2.27	2.80	.....	50	4.48	4.55	5.60	8.96
90	2.49	2.53	3.11	.....	40	5.60	5.69	7.00	11.20
80	2.80	2.84	3.50	.....	30	7.47	7.58	9.33	14.94
70	3.20	3.25	4.00	.....	20	11.20	11.37	14.00	22.40
60	3.73	3.79	4.67	7.46	16	14.00	14.22	17.50	28.00

TABLE V.—Table for 1 mile, single track.

Rail weight per yard.	Weight of splice bars (358 prs. per mi.).	Bolts and nuts.			Spikes (10,560 per mi.).		Weight of total accessories.	Weight of rail.
		Size.	Number.	Weight.	Size	Weight.		
Lbs.	*Lbs.*	*Ins.*		*Lbs.*	*Ins.*	*Lbs.*	*Lbs.*	*Long tons.*
100	29,642	¾ x 4½	2,148	1,953	6 x ⅝	7,040	38,635	157.14
95	27,208	¾ x 4½	2,148	1,953	5½ x 9/16	5,867	35,028	149.29
90	24,701	¾ x 4¼	2,148	1,867	5½ x 9/16	5,867	32,435	141.43
85	22,911	¾ x 4¼	2,148	1,867	5½ x 9/16	5,867	30,645	133.57
80	21,480	¾ x 4	2,148	1,790	5½ x 9/16	5,867	29,137	125.71
75	20,227	¾ x 4	2,148	1,790	5½ x 9/16	5,867	27,884	117.86
70	19,153	¾ x 3¾	2,148	1,753	5½ x 9/16	5,867	26,773	110.00
65	12,744	¾ x 3¾	1,432	1,169	5½ x 9/16	5,867	19,780	102.14
60	11,706	¾ x 3¾	1,432	1,169	5½ x 9/16	5,867	18,742	94.29
55	10,346	¾ x 3½	1,432	1,146	5½ x 9/16	5,867	17,359	86.43
50	8,628	¾ x 3¼	1,432	1,123	5½ x 9/16	5,867	15,618	78.57
45	5,942	¾ x 3	1,432	1,073	5 x ½	4,182	11,197	70.71
40	4,905	¾ x 3	1,432	1,073	5 x ½	4,182	10,160	62.86
35	4,368	⅝ x 2½	1,432	610	4 x 7/16	2,708	7,686	55.00
30	2,399	⅝ x 2½	1,432	610	4 x 7/16	2,708	5,717	47.14
25	2,041	⅝ x 2¼	1,432	582	4 x 7/16	2,708	5,331	39.29
20	1,611	⅝ x 2¼	1,432	582	3½ x ⅜	1,689	3,882	31.43
16	1,325	⅝ x 2	1,432	546	3½ x ⅜	1,689	3,560	25.14

Above table is based on standard practice for length of rails, viz, 90% to be 30 ft. and balance of 10% to be not less than 24 ft., varying by 2 ft. Ties 2 ft. c. to c.

Above number of splice bars, bolts and nuts, and spikes allow for no excess.

TABLE VI.—Accessories required for 10 tons of rails.

Rail weight per yard.	Splice bars or fish plates.		Bolts and nuts.			Spikes.			Weight of total accessories.
	No. pairs.	Weight.	Size.	Number.	Weight.	Size.	Number.	Weight.	
Lbs.		*Lbs.*	*Ins.*		*Lbs.*	*Ins.*		*Lbs.*	*Lbs.*
100	23	1,904	¾ x 4½	138	126	6 x ⅝	672	448	2,478
95	24	1,824	¾ x 4½	144	131	5½ x 9/16	708	393	2,348
90	25	1,725	¾ x 4¼	150	130	5½ x 9/16	746	414	2,269
85	27	1,728	¾ x 4¼	162	141	5½ x 9/16	790	440	2,309
80	28	1,680	¾ x 4	168	140	5½ x 9/16	840	467	2,287
75	30	1,695	¾ x 4	180	150	5½ x 9/16	896	498	2,343
70	33	1,766	¾ x 3¾	198	162	5½ x 9/16	960	533	2,461
65	35	1,246	¾ x 3¾	140	114	5½ x 9/16	1,034	574	1,934
60	38	1,243	¾ x 3¾	152	124	5½ x 9/16	1,120	622	1,989
55	41	1,185	¾ x 3½	164	131	5½ x 9/16	1,222	680	1,996
50	46	1,109	¾ x 3¼	184	144	5½ x 9/16	1,344	747	2,000
45	51	847	¾ x 3	204	153	5 x ½	1,494	591	1,591
40	57	781	¾ x 3	228	171	5 x ½	1,680	665	1,617
35	65	793	⅝ x 2½	260	111	4 x 7/16	1,920	492	1,396
30	76	509	⅝ x 2½	304	129	4 x 7/16	2,240	574	1,212
25	91	519	⅝ x 2¼	364	148	4 x 7/16	2,688	689	1,356
20	114	513	⅝ x 2¼	456	185	3½ x ⅜	3,360	538	1,236
16	142	525	⅝ x 2	568	216	3½ x ⅜	4,200	672	1,413

Above table is based on standard practice for length of rails, viz, 90% to be 30 ft. and balance of 10% to be not less than 24 ft., varying by 2 ft. Ties 2 ft. c. to c. Above number of splice bars, bolts and nuts, and spikes allow for no excess.

TABLE VII.—Table of steel spikes.

Size in inches.	Average number per keg of 200 lbs.	Number required and weight per mile, single track.			Rail weight per yard.
		Based on ties 2 ft. c. to c. (10,560 per mi.).	Based on ties 2 ft. 6 ins. c. to c. (8,448 per mi.).	Based on ties 3 ft. c. to c. (7,040 per mi.).	
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
6 x ⅝ P. R. R	300	7,040	5,632	4,693	75 to 100
5½ x 9/16	360	5,867	4,693	3,911	45 to 80
5 x ½	505	4,182	3,345	2,788	30 to 50
4 x 7/16	780	2,708	2,166	1,805	20 to 35
3½ x ⅜	1,250	1,689	1,352	1,126	16 to 25
2½ x ⅜	1,342	1,575	1,260	1,050	12 to 16

Above numbers allow for no excess.