output could not possibly be avoided. As additional heavy punches for coping, slotting, etc., were necessary, it was arranged to purchase machines which are duplicates of those used on the spacing tables. On all the machines used in the shops the interchange of punches, gags and other jigs have been closely considered to prevent delay, or the necessity of large stocks being carried.

The design of the spacing tables is particularly convenient as each of the templates has two lines of gauge points and, therefore, the punching of both pairs of flanges is done on a sill from the same template. From the last movement on the flange punching machine the material is unloaded onto the floor, where a very large space has been reserved to allow of a considerable accumulation of finished centre and side sills, to prevent the possibility of delay on these very important items.

The centre sills when punched on the webs and flanges require to have slots punched in them to accommodate the draft gear and brake pipe. These slots are made on a coping punch so arranged as to require no backward movement of the material; this die is left set up on the machine all the time but is so arranged that small dies can be set up beside the large ones to enable the machine to be used for light punching when not punching slots. One other coping punch is fitted up with dies for making the various mitered cuts and coping the side posts and braces. The coping punch beside the Z bar machine is fitted with a special die for coping the side plate. Three high-speed punches are used for all the various small punching work around the shop, with the exception of the diaphragms which are punched on a horizontal punch.

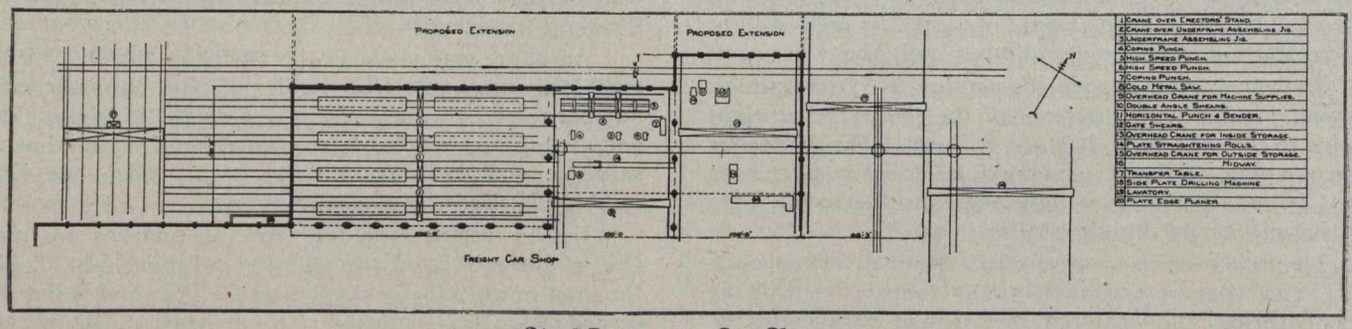
This completes the machine equipment for the steel shop, but it must, of course, be borne in mind that the hot forging, upsetting and bending work are done in the blacksmith shop and material is brought into the steel shop already finished.

The shop is particularly well equipped with air jacks, skids, overhead fixed hoists, travelling hoists on runways and swinging jib cranes. To reduce the labor and the cost of handling and of repairing, ball bearings and roller bearings are used throughout on jibs, hoists, hand travelling cranes and material rollers. Special care has been taken to have definite room allowed for the piling of material outside the shop, for the storage of material around the various machines and the storage and accommodation of the finished material. Specially constructed racks are used throughout the shop. To maintain the orderly handling of the material, painted lines are used to define the boundaries of these piles and mark the passageways, which are always kept clean of material. These boundary lines are repainted at the end of every week, at which time an absolute clean-up is made of any material which would otherwise tend to occumulate.

The Thomas spacing tables are of the semi-automatic type. The movement of the carriage is controlled automatically, while that of the gags for bringing one or more punches into play at each stroke is controlled by hand. The tables are electrically operated, their movement being controlled by two templates $\frac{7}{8}$ in. by 3 in. having a double row of steel pins. They are so arranged that when the trip on the moving portion of the table engages the pin it automatically stops and locks the material to be punched and at the same time, by means of an electric magnet, operates the clutch on the punch. The punch head, after coming down and punching the material, on its return stroke disengages the carriage and the clutch on the punch and automatically starts the movement of the material.

The high-speed punches were designed by John Bertram & Sons. They run at the high speed of 60 strokes per minute and are entirely without gears, being belted from the motor direct to the flywheel of the punch. The clutch is of the six-point type; two punches are fitted in each head, both being controlled by a single gag lever which has three positions, one for each punch and a neutral position.

Assembling.—Special arrangements were made for the storing and handling of material in relation to the assembling to reduce the labor to a minimum. With underframes an important gain was made by the use of clamps instead of assembling bolts, the common practice elsewhere. For an assembling bolt, it is necessary to get a full hole before the bolt can be applied; a wrench is required and the time spent in this way is greatly reduced by using a clamp with a hinged handle. The clamp is applied between the holes to be reamed, and the time lost in removing the bolt from one hole and applying it in the adjacent hole when reaming is entirely avoided.



Steel Passenger Car Shop.

In assembling the underframe a jig is used which accurately locates the centre sills, bolsters and cross bearers. By this method the sills are assembled square, reamed in the same position and then transferred to the underframe riveting jig. This jig consists of a number of cast columns supported on I-beams bolted on a concrete foundation and securely holds the underframe in position while being riveted, so that the underframe is constructed accurately and square in every way. A great deal of time is thus saved in the assembling and the line of the car when finished is very greatly improved. To rivet the underframe on the jig by compression riveters without turning it over, it was necessary to have a special type of riveter designed with a thin nose to permit the top row of rivets to be driven and to allow sufficient clearance for the bottom row, particularly on the bolsters, to be driven without moving the underframe.

The movement of the steel sills from the point of as-

(Continued on page 179.)