



Fig 9 CENTRING FOR MASONRY

On considering the permanent stability of the tunnel it was thought that if any ground movement should occur such as would bring heavy pressure upon the lining, it would be in the vicinity of the portals, while the timbering would decay most rapidly at the same place. It was therefore determined to put in portals and to build the masonry lining for fifty feet at each end. The masonry section is shown in Fig. 8. It was built of red sandstone, very coarse in structure and well adapted to resist the action of heated gases. The sidewalls were laid in courses, all stones being two feet or more thick, and the bottom courses were extended into the tunnel, so that the ends of the courses might be racked off continuously from base to keystone, and the wall thus left in good condition for bonding on the resumption of work on the lining. The spaces between the plumb posts were filled with spawls in mortar. These walls were built with a small derrick set up without stifflegs or guys, the pin at the top of the post being placed in an auger hole bored in the crown segment of one of the arches; and although the segment was not fastened in any way, the joint and lagging friction proved sufficient to overcome any stresses from the derrick tending to move the segment. The centring for the arch is shown in Fig. 9. The centres rested on a $3'' \times 12''$ wall-plate supported by rough $6'' \times 6''$ posts bearing on a $3'' \times 12''$ frame sill. The frame sill was carried by wedges working against a $3'' \times 12''$ mud-sill; the range of these wedges was large, so that the centres would be considerably lowered when the wedges were struck, and the whole section of centring might then be run ahead on small rollers placed on the mud-sill. With that purpose in view the posts were set far enough away from the side-walls to clear the quarry face projections of the stones, and the first few pieces of lagging were omitted on each side of the centre. The section of centring used was about 25 ft long, the centres being spaced 3 ft, centre to centre; the centres were built of three thicknesses of $1''$ plank breaking joint, and with a minimum depth at joint of 10 inches; the lagging was $2'' \times 4''$ laid on the flat; the consecutive posts were fastened together by irregular diagonal bracing. The masonry arch was 18" deep, the voussoirs measuring $1' - 0\frac{3}{4}''$ on the intrados and the keystone $1' - 3''$; all joints were $\frac{1}{4}''$, and the voids between the masonry and the timbering were packed with dry sandstone, hand laid. By reason of the impracticability of the ordinary methods of handling stone in the confined space between the lagging of the centres and the timbering of the tunnel, special methods had to be resorted to. The method employed was to leave an opening in the crown lagging of