couplings consisting of sleeves made of the same material and rubber rings. The apparatus used to couple two lengths of pipe together is shown in Fig. 2. In constructing the line the sleeve was placed over the end of the length of pipe to be laid, and one rubber ring was placed over the same end a distance equal to the length of the sleeve back from the end of the pipe. The other rubber ring was placed at the end of the same pipe. It was found that extreme care had to be taken to see that the horizontal axes of the two lengths lay in the same line or the rings would not roll properly into position. The claws of the coupling rig were placed over the sleeve, and the clamp was secured tightly to the sides of the fixed length of pipe. When pull was applied to the claws the sleeve was drawn toward the joint, the rubber rings rolling under the beveled edge of the sleeve and compressing as they

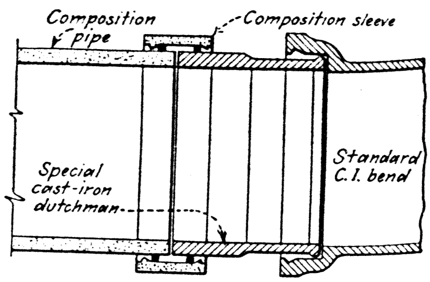

Fig. 4—When the composition pipe was to be connected to cast-iron fittings or valves, a special cast-iron dutchman was used to make the transition.

reached their final position. By removing the claws and reversing the procedure the couplings could be pushed into place instead of being pulled. This method was required in laying the last section of the line.

A modification of the jointing apparatus was used when joining full lengths of pipe. Instead of the A-frame a 1-in. plate, 3 in. wide, was placed over the end of the free section, the sleeve and rubber ring being placed over the length already laid. Full-length rods, 15 ft. long and 1 in. in diameter, threaded at the end, were passed through holes drilled in the plate. Claws were fastened to the free end of the rods and engaged the sleeve. When a turnscrew on the plate end of the rod was operated, the coupling was pulled into place. Special cast-iron dutchmen were used to connect the composition pipe to bends, gate valves and other cast-iron fittings.

The labor cost of laying and jointing this pipe was found to be higher than is usual for cast-iron pipe in this vicinity. The men, however, were not familiar with this type of joint, and it is thought that if more of the pipe is laid in the future, the cost can be substantially reduced. One disadvantage lies in the size of the bell holes required and the extra width of the trench that is necessary because of the jointing equipment. Little difficulty was encountered in familiarizing the laborers with the use of this type of pipe.

After the laying had been completed a hydrostatic test of 150 lb. per sq.in. was applied. This is double the p sure that the pipe would be norn subjected to, and no leakage observed.

Rapid Progress Being Made on Vancouver Water Tunnel

DRIVEN and half lined, the tunnel under the First Narrows at the entrance of the harbor at Vancouver, B. C., being built by the Greater Vancouver Water District, is scheduled for completion by June, 1933, after a rapid period of construction. This pressure tunnel will replace the present system of submerged mains, bringing the district's water supply from sources north of the city. Two shafts, 400 ft. deep and 3,104 ft., of 7½-ft.-diameter tunnel, are the principal features of the development, which will connect with existing facilities at either end. Capacity of the tunnel is designed for the ultimate supply from Capilano Creek of 200 m.g.d. (Imperial).

The water supply for Vancouver is obtained from two mountain streams, Capilano Creek and Seymour River, north and across the harbor from the city. Since the completion of the original water-supply system in 1880, water has been taken across the inlet at either of the two narrows in submerged cast-iron pipe lines. The method of laying one of these submerged lines is described in detail in *Engineering News-Record*, Sept. 2, 1926, p. 366. The supply from Capilano Creek is piped under the First Narrows, which is the main harbor entrance. During 1931 the port of Vancouver handled a greater tonnage of shipping than any other harbor in Canada, and the occasional breaking of the mains near the shore connections by the grounding of ships and other problems involved in maintaining this part of the water-supply system made the continuance of this submerged crossing no longer justifiable for a large and rapidly growing city.

With the formation of the Greater Vancouver Water District in 1926, investigations were immediately undertaken to find a suitable location for a pressure tunnel under the narrows. The south or city end of the proposed crossing was fairly definitely established by the location of the line into the city and could not be changed more than a few hundred feet. Rock underlining the narrows was found to consist of sandstone and shale for the south half of the channel width, with the northern half overlain with a glacial deposit of boulders and gravel varying from zero depth at mid-channel to about 300 ft. one-half mile to the north. Conditions for the tunnel location had to satisfy navigation requirements, which included a proposal for future widening by dr ing of the glacial deposits and the f ing of solid foundation for the lan and sealing of a caisson which w permit the north shaft to be sunk to proposed tunnel level. The invest tions disclosed a small area of s foundation at the north end about ft. below high-water level in a posi suitable for both the shaft and tu terminal.

The south shaft was sunk thro boulder clay hardpan for a depth of ft., and the remainder of its 400-ft. de was in sandstone. The north shaft sunk through sand and gravel for 110-ft. depth to rock and then in sa stone and shale. The tunnel was dri in sandstone, conglomerate and sh and was timbered only in the sh formation for a length of about 1,100

The upper 160 ft. of shafts will lined with 1⅛ in. of steel plates and inner concrete lining 4 in. thick. T remaining depth of shafts and the t nel are being lined with steel-cylind reinforced-concrete pipe to provide strength and watertightness. The pi consists of steel cylinders 14 ft. lo $\frac{3}{32}$ in. thick and surrounded by one, t or three rows of ⅝-in. spiral reinforci rods, depending upon the rock conditi The reinforced-steel cylinder is lined a plant with 2 in. of concre centrifugally placed, and after placi in the tunnel the sections are electrical welded to form a continuous pipe. T concrete is then pneumatically deposit around the reinforcing bars, complete filling the space between the pipe a the rock. In addition to this backfilli pressure, grouting is carried on outsi the pipe, and the joint spaces on the i side are filled and finished smooth. A reinforced-concrete pipe in the shaf has been placed, and more than 1,700 f of the tunnel has been lined.

The contract was awarded in Jul 1931, the south shaft was completed b November, and the north shaft, requir ing the deep caisson operation, was com pleted May 10, 1932. The tunnel wa holed through on May 21, 1932, havin been driven almost entirely from th south end. Work was scheduled fo completion by June 1, 1933. The projec is being carried out by the Greater Vancouver Water District under the direction of E. A. Cleveland, chief commissioner. The contract is held by Northern Construction Co. and J. W. Stewart, Ltd., Vancouver.