

UNION ARCH, WASHINGTON AQUEDUCT.

In its latest edition the American Cyclopædia states, under the head of masonry bridges, that there are comparatively few of any great size in the United States, and instances as perhaps the finest example the High Bridge of the Croton Aqueduct, over the Harlem River, with its eight arches of 80 feet span, and five others of 50 feet span. Probably the majority of well-informed Americans would accept the statement as correct, and few, even among engineers, would hear without some surprise, that by far the largest masonry arch in the world is in this country, and that it forms a part of one of the most important engineering achievements that have been accomplished during recent years—namely, the aqueduct by which the City of Washington is supplied with water.

Unfortunately for its own fame, the work was completed during the most exciting period of the civil war, when the security of the national capital against the assaults of the Confederate army was a matter of infinitely greater popular interest than any improvement of its water supply. Possibly, too, the inadvisability of calling the attention of the enemy to a work of such importance to the beleaguered city may have had something to do with the singular absence of information with regard to it in the popular prints of the time and in later publications. At any rate one will have to search a long time to find more than a casual mention of the work, where one would expect to find the fullest description of it. The splendid masonry arch shown in the accompanying engraving carries the aqueduct over the Cabin John Creek, with a span of 220 feet. The height of the arch is 101 feet, and the width of the structure 20 feet. The arch forms an arc of a circle, having a radius of 134.2852 feet. When the center scaffolding was removed, the arch (unlike all other works of the kind) did not settle, the keystone having been set in winter, and the centre struck in summer.

Two other remarkable structures are included in or form a part of the Washington Aqueduct. From the distributing reservoir the water is conveyed in two thirty-inch pipes. There were two streams to be crossed, College Branch and Rock Creek. Instead of building bridges and laying the pipes on them, the pipes themselves were in each instance cast in the form of an arch and constitute the bridge. The Rock Creek Bridge has a span of 200 feet, with two forty-eight-inch pipes; the College Branch bridge has a span of 120 feet, with two thirty-inch pipes. The arch over Rock Creek is so strong that it is used for a roadway, continuing Pennsylvania avenue to Georgetown.

The other notable masonry arches of the world are the Chester arch across the river Dee, at Chester, England, with a span of 200 feet; the famous centre arch of the new London Bridge over the Thames, with a span of 152 feet; Ponty-Prydd, over the Taff, in Wales, 14 feet; the bridge across the Seine, at Neuilly, France, with five spans each of 128 feet; the nine spans of Waterloo Bridge, London, each 120 feet; and the celebrated marble Rialto bridge in Venice, with a span of 98½ feet.

Washington Aqueduct was begun in 1853, and finished in 1863. The engineer in charge of the work was Gen. Montgomery C. Meigs.—*Scientific American*.

EXPLOSION OF A PORTABLE BOILER.

The case of explosion illustrated and described in the following article, abstracted from the monthly bulletin of the Hartford Steam Boiler Inspection and Insurance Co., was that of a semi-portable fire-boiler, of the locomotive type, and a variety having an oval cross section of body. It is a style much used for small powers, and usually has, as this one originally had, an engine attached, and brackets or legs for supporting it either on timbers or on ordinary flooring. The letters B B, Fig. 1, on the body, and the six unoccupied holes on the barrel, indicate the location of a set of four legs upon which this one was mounted by means of tap bolts. It was, when complete, known as a 6-horse engine, and had perhaps done duty as a well-borer in western Pennsylvania, although its history prior to its present ownership was not obtained. For some time it had been used without its engine, to supply steam for refining or re-distilling mineral oils for special purposes, the pressure required being about 50 pounds to the square inch.

The principal dimensions and general construction are as follows: Length over all, about 8½ feet, including the smoke arch, which was bolted to the barrel and supported the chimney. The body was 46 inches high by 29 inches wide and 36 inches long, the sides, top and bottom of which were formed of a single plate joined at the bottom. The enclosed fire-box was similarly constructed, varying from the regular form of the shell by hav-

ing a flattened arch at the top for fire crown. The dimensions of the fire-box, 25 inches wide, allowed a 2-inch water-space on the sides and bottom, while the height was such as to give a steam-space about 8 inches high above the crown of the furnace. A front plate flanged inward at its periphery and riveted to the main body plate, and flanged outward on the borders of the opening which corresponded in size and form to the cross section of the fire-box, and riveted to its principal plate, formed the front wall of the steam and water chamber of the boiler. The tube plate, which was also the rear wall of the fire box and ash-pit, was a plane plate flanged towards the front, and riveted in the usual manner to the principal fire-plate. There were in this boiler 42 two-inch tubes about 4½ feet long, which were beaded at each end. The body of the boiler shell was completed by a rear plate below the barrel, flanged outward, to fit the interior of the barrel, and inward to fit the interior of the body-plate in accordance with the usual American practice in locomotive boiler construction. The fire-box was completed by bolting a cast-iron plate upon the outward flanged opening in the front plate which served as a door-frame, and to carry the front ends of the grate bars, their rear ends resting on an angle bar which was riveted to the tube plate.

Screw stays, arranged in regular rows on the sides, top and rear below the barrel, at intervals of 6 to 7 inches, passed through the outer and inner plates of the body of the shell and the fire-box, and were headed at both ends to prevent the collapse of the fire-box. No stays were placed in the lower semi-circles that formed the "water bottom."

Upon the barrel near the middle of the length of the boiler was fixed a steam dome 11 inches high and 14 inches diameter, made of flanged wrought-iron plates. The description of this boiler is rather more minute than need be, but its simplicity of construction is something notable for this type, although the variety is in common use in some parts of the country. There are but eight principal parts besides the dome and smoke arch, which make a total of eleven plates of wrought iron, namely, two tube plates, two end plates, (body), two body plates, two barrel plates, two dome plates, and one in the smoke arch. Other forms of boilers, such as the cylinder tubular and the plain or simple cylinder, are much simpler, having no contained fire-box, and mostly in New England practice, no steam dome.

The principal fire plate A, Fig. 1, was something less than ¼ of an inch thick, while some parts of the shell were 5-16 of an inch. At the corner of the patch—the point from which the lines of rupture radiate, Fig. 2—a stay bolt passed through the plate and the patch, and both were here much reduced in thickness.

The safety valve bottom presented an appearance indicated in Fig. 4, the light arc representing about the proportion of the seating that had metallic contact. It was found that the steam-gauge pipe had been plugged with solid matter deposited by the boiler water, in which it was very rich.

When the explosion occurred, the proprietor or superintendent was directing a man who was examining or repairing the small still or superheater, located about 20 feet from the boiler, through which the steam was made to pass. It will be observed that the explosion was caused by the collapse of the furnace; the portion of the left-hand side marked A, folded back upon the tube plate, turning on its vertical seam and buckling so that its upper and lower torn edges are turned towards the front as shown in Fig. 1, which is a cut from a photograph. The boiler, impelled by the reaction of the issuing contents, flew away, slightly ascending and veering some 40 degrees to the right of its extended axial line. It is possible to form a pretty clear idea of its course because it struck and carried away several objects that were in its path through the air before reaching the ground near where it finally rested, about 285 feet away.

The men who were nearest the boiler when it exploded, were blown as by an overpowering gust of wind to a considerable distance and stunned, but not killed; they were out of the track of both water and boiler. It is hardly profitable to speculate on the probable pressure at which the stay bolt in the corner D, of the patch, Fig. 2, gave way, or rather pulled through the patch, for it is deemed enough to know that it was quite sufficient to break this obviously weakest spot in the boiler, and that once broken, an extraordinary and over-powering load fell instantly upon its neighbors, and they gave way in detail.

It is likewise almost certain that there was sufficient force stored in this boiler to do the work which we see it has done, and which nothing else exterior to it did accomplish. Each unit of the water, however small it may be conceived to be, when heated to a high temperature, which was possibly only under a corresponding pressure (barring the Donny theory, etc.), had within its own quota of the gross amount of force