until after her arrival in Carlisle Bay, where she was completely cleared, and with her hatches closed, and *her whole hold exposed to the concentrated heat of many stoves, that fever ceased.*"

ON A PACKING FOR PISTONS OF STEAM ENGINES AND PUMPS.*

By Mr. George M. Miller, of Dublin.

This packing consists of two rings, pressed outwards against the cylinder by the pressure of the steam as it acts on the alternate faces of the piston, without the use of any springs. This construction of piston is used by the writer in the locomotive engines on the Great Southern and Western Railway of Ireland. The piston is of cast iron, 2 inches in thickness and 15 inches diameter. Two square grooves are turned in the edge of the piston, $\frac{5}{8}$ in. in width and $\frac{5}{8}$ in. apart, and a corresponding steel ring is fitted into each groove, the rings being divided at one part with a plain butt joint, and sprung over the piston into their places. Two small holes, $\frac{1}{4}$ in. diameter, open from each face of the piston to the bottom of the nearest groove, whereby the steam is admitted behind the packing ring and presses it out against the cylinder so long as the steam is acting upon that face of the piston. The alternate action of the two rings is continued as long as the steam is acting on the piston, one of them being always pressed steam-tight against the cylinder.

Another form of the piston has been used in cases where the piston is desired to be flush on both faces or to fit a cylinder with flat covers; in this a circular flat head forged upon the piston rod is fitted between the turned faces of the two halves of a cast-iron piston, which are held together by turned pins riveted over, forming a hollow piston flush on both faces, fast upon the piston rod, and without any loose part besides the two packing rings.

The ends of the rings, where divided, are made either with a butt joint or a lapped joint. The piston body is turned to pass through the cylinder easily; and the joints of the rings have been found to be practically steam-tight. In some cases the joints have been tongued, as shown, but in the writer's experience this has not been found requisite; the butt joint has invariably worked well, whilst it has the advantage of perfect simplicity of construction. In pistons where the packing ring travels over the opening of the cylinder port, a small stop is fixed in the bottom of the groove, entering a short slot in the packing ring, to prevent the ends of the ring coming opposite the cylinder port, but still leaving the ring free to travel round a little in the piston grooves; but it is preferred for the packing rings not to travel over the cylinder ports.

These steam-packed pistons have been used more than seven years in the locomotives of the Great Southern and Western Railway, and have proved so satisfactory and advantageous that their use has been extended to all the 94 locomotives working upon that line. The following are the results of the working in the engines running from Dublin, as regards the durability of one set of rings, the period of their wear, and the mileage of the engines whilst wearing them out. Nineteen engines working with one set of steel rings averaged 33,020 miles and 16½ months' running, one engine having worked for 3 years and run as much as 98,073 miles with one set of packing rings. Five engines working with one set of brass rings under the same circumstances averaged 30,986 miles and 19 months' running, the greatest work amongst them being 2¼ years and 43,197 miles. Twenty other engines with steel rings, which are still in use, have also averaged 40,444 miles and 21 months' work, one of these having worked for 3¼ years and run 94,399 miles with the original set of rings.

The general result of the above is that one set of steel packing rings have lasted 37,000 miles and 19 months' work, and one set of brass rings 31,000 miles and 19 months' work, the difference in durability being about 16 per cent. in favour of the steel rings. In some of the individual cases of the pistons with steel rings, a very considerable variation from the average result of 37,000 miles is found in the durability of the packing rings, some of them having lasted 2⅔ times the average, and some only as much below the average. In the cases of the brass rings the variation is not so great, amounting to 1¾ times the average in the highest, and about as much below the average in the lowest. This variation in wear has not been fully accounted for; it may have occurred from a different character of metal in the cylinders, from priming of the boiler, and from the presence of grit in the water; but the writer has reason to believe that the rings have been frequently put in to work and set with a pressure upon the cylinder from their own elasticity, thus causing a source of wear. It is found the best plan to turn the rings to the exact diameter of the cylinder, and to put them in without any spring upon them, so that they are not subjected to any wear except when the steam is acting on them. The steel rings are now slightly tempered, to admit of their being sprung into the grooves without altering their form. In all these pistons the steel packing rings were $\frac{5}{8}$ in. thick originally, and $\frac{5}{8}$ in. wide, and they were worn down to about $\frac{1}{4}$ in. thick in the thinnest part before being removed. The brass rings are worn down from 7-16ths in. until they are $\frac{1}{4}$ in. thick. Specimens were exhibited of steel rings from four engines that have worked 38,000, 61,000, 84,000, and 96,000 miles respectively, since first put into the pistons. It must be remarked that, when opportunities occur, as when engines are under repair, the rings are taken out and reset to the size of the cylinder.

It is found in practice that two steam ports of $\frac{1}{4}$ in. diameter are quite sufficient for each of the steel packing rings. The rings must be made to fit easily in their grooves, so as to move freely, with a clearance of 1-16ths in. at the bottom of the grooves for the steam to pass round behind the rings. No difficulty has been experienced from the steam passages becoming stopped up a moderate use of tallow in the cylinders.

The use of this piston-packing in locomotive engines has been productive of economy by reducing the friction, and by prolonging the wear of both pistons and cylinders. It will be observed that only one ring is in action at the same time, and

* Read before the Institution of Mechanical Engineers: Charles F. Beyer, Esq., in the chair.