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ON THE CAUSES OF KNOCKING IN HIGH-PRESSURE ENGINES.

By JOSHUA ROSE.

[Concluded from page 1.]

IN some cases the crank-pin may stand practically true with the hole in the crank, and the main-shaft may be lined true with the bore of the cylinder, and yet the connecting-rod applied as a test (as before described) may disclose that the crank-pin does not stand at a right angle to the bore of the cylinder, the effect being the same as though the hole for the crank-pin had not been bored parallel with the hole in the crank which receives the main-shaft, the causes of which are to be looked for in the method of fastening the crank to the main-shaft.

If the part of the main-shaft on which the crank fits is tapered to the slightest degree, the crank should be made with a corresponding taper in the hole; otherwise, when the crank is upon its place, it will fit at one end only, and driving in the key, which locks the crank to the shaft, will in all probability strain the crank out of true. Suppose, for instance, that in Fig. 5, which represents a crank main-shaft and key,

the crank fitted the shaft closely at and towards the end D D, but was not so perfect a fit at and towards the end C C, then driving the key B would set the crank over so that its centre line (before being keyed up) E would stand at F when the key was driven home, especially if the key chanced to fit the closest at the end C. The natural tendency of the metal in the crank is to give way the most at the under side, G, because the crank is the weakest there.

If the crank is made to be put on by hydraulic pressure, it is equally as important that it should fit the shaft equally from end to end, otherwise it will set over as described, especially if it should be a little tight to its place, in which case the metal at G would be apt to give way. The difficulty of boring a slightly conical hole to fit a taper shaft when the two can not be easily handled to try them in fitting, and the almost impossibility of detecting in such large work any slight incorrectness in the taper, render it advisable to make the end of the shaft and the hole in the crank as parallel as practicable. And if with these precautions the proper amount of *and not too much* allowance is made for forcing over by the hydraulic ram, the crank will go to its place true, and is not at all apt to be sprung by the key, even though the latter should not bind equally from end to end of its length.

If it is intended to contract or shrink the crank to its place, but very little allowance should be made for shrinkage, otherwise the metal at the end G of the crank will give way, and will tend to increase the length of the crank, if it is of wrought-iron, and to split it at G if it is of cast-iron. Furthermore, the crank will be apt to give way more at the end that is hottest than where it is coolest, which would throw it, and consequently the crank-pin, out of true. Just as much care should be taken to make the hole in the crank and its bed upon the main-shaft quite parallel when it is intended to shrink on the crank, as though it were to be made a driving fit only, because the metal in shrinking is sure to give way the most in the weakest place, and at that part of the same which is hottest; to obviate which the amount allowed for shrinkage should not be more than, for a six-inch shaft, the $\frac{1}{16}$ of an inch, or an amount which is barely perceptible by careful usage of the callipers, the latter being set so as to merely appreciably touch the work, and therefore not to spring at all, as they will if allowed to touch heavily.

Whether the crank beds evenly upon the shaft or not, the key should be carefully fitted to bed upon the key-seats in the crank and upon the shaft, from end to end.

Another and not infrequent cause of knocking is, that the crank-pin and the cross-head journal wear oval, for the reason that they are not subject to much wear when the engine is on or near either of the dead centres; this cause, however, is mainly confined to the cross-head journal, especially in those cases in which the cross-head guide-blocks and cross-head journal are of cast-iron and in one piece. The remedy of course is, in this case, to file off the protruding parts, in which case it is well to ease them off a little below the proper curve, which plan should always be adopted in fitting them up when new.

When an engine that has run for a long time suddenly commences to knock, the cause in many cases will be found

to be that the piston-head or follower strikes against a projection at either or both ends of the bore of the cylinder, which projections are due to the wear of the bore of the cylinder (and there may possibly be similar projections at each end of the guide-bars). Thus, in Fig. 6, suppose it to be a cylinder, and the stroke of the piston therein, when the

engine is new, to be denoted by the line B, there will be therefore a short piece of each end of the bore of the cylinder over which the piston does not pass, and which does not therefore abrade or wear away, so that, in the course of time, there will be left a projection at each end of the cylinder. It is usual, it is true, to counterbore each end of the cylinder; but in time the cylinder-bore wears below the counterboring (or recesses), and even were such not the case, the ridge would still form, because the connecting-rod wears longer or shorter according to the form of its construction. For instance, if the rod has both its straps held to it by jibs and keys only, as shown in Fig. 7, it will wear shorter from cen-

tre to centre of the bore of the brasses, the straps passing farther up the block-ends of the rod as the brasses wear and let the key down.

The natural consequence of the rod wearing shorter is, that the position of the stroke of the piston in the cylinder gradually alters, approaching the cylinder-cover nearest to the crank, and receding from the cylinder-cover opposite. If, therefore, the counterboring was made to come just fair with the ends of the piston-stroke at first, there would form a ridge at the end of the cylinder farthest from the crank.

A connecting-rod whose cross-head end has a strap secured by a jib and key, as shown in the above figure (as is usually the case at that end), and whose crank-pin end has its strap secured to the rod-end by bolts, as shown in Fig. 8, the key

being located between the bolts and the brasses, would maintain its original length, notwithstanding the wear, provided that the latter was as great at the cross-head as it is at the crank-pin end of the rod. Since, however, such is not the case, such a rod wears longer to half the amount of the difference in the wear of the respective brasses, the result being that as the rod-brasses wear, the stroke of the piston in the cylinder approaches the cylinder-cover farthest from the crank, and recedes to a like amount from the opposite cylinder-cover, and hence the ridge will, in this case, form at the end of the cylinder nearest to the crank. And the same remarks apply to a rod having both straps secured to the rod ends by bolts, one strap having the key between the bolts and the brasses, as shown in Fig. 8, and the other strap having the key located between the brasses and the crown of the strap, as shown in Fig. 9.

This latter form of rod is, however, preferable to the others, in consequence of the firmness with which the straps are locked to the rod-ends.

The formation of the ridge referred to will, it is true, be very gradual, but it must be borne in mind that when the

connecting-rod brasses have become so much worn that the key has passed through the rod or strap, as the case may be, and it hence becomes necessary to place liners behind the brasses to set the key back again, the machinist regulates the thickness of the liner on each side of the brasses, so as to

bring back the distance from centre to centre of their bores to the original length; which of course brings back the stroke of the piston to its original position in the cylinder, and if, therefore, there be a ridge at either end of the cylinder-bore, the piston strikes against it, and thus causes a knock. It is obvious that as the position of the stroke of the guide or motion-blocks alter in the guide or motion-bars, and that a ridge will also form at their ends. To remedy these defects in both cases, it would be a good plan to make the distance of the recesses at the ends of the cylinder-bore, and at the ends of the guide or motion-bars, shorter than is the stroke of the engine, to an amount about equal to the amount of taper allowed on the connecting-rod keys, so that even when the wear of the connecting-rod brasses has let the keys down, both the piston and the guide or motion-blocks will still travel over the recesses at each end of the stroke. It would appear that since the movement (by wear) of the key is not more than half that of its length, an amount equal to half the taper of the key would suffice; but it must be borne in mind that a quarter of an inch of difference in the length of the rod alters the position of the stroke of the piston in the cylinder $\frac{1}{4}$ inch at each end, or $\frac{1}{2}$ inch in all.

When an engine knocks, the location of the knock may be ascertained as follows: Take a piece of iron wire, or any slight body, such as a lead-pencil, and place one end on an end of the cylinder, taking the other end between your teeth; then pass to the other end of the cylinder—to the steam-chest, guide-bars, and bearings of the main-shaft, repeating the operation in each place, and the sense of feeling will distinctly indicate the location of the knock by imparting a more severe shock to the teeth when the vicinity of the knock is approached.

THE ROYAL ALBERT BRIDGE.

MR. LEGGE, Civil Engineer, and staff, are engaged preparing plans of the proposed bridge which is to span the St. Lawrence at Montreal, with St. Helen's Island as a stepping-stone.

The *Witness* says: "Leaving the level of the ground at Sherbrooke street, it is carried as a viaduct east of Colborne avenue, at a level of ninety feet above the surface of the ground, in spans ranging from 150 to 200 feet each, striking the navigable channel of the river St. Lawrence near Molson's brewery. It passes over to St. Helen's Island by means of six spans. The main span over the navigable channel of the river will be from 500 to 600 feet in the clear, at the height of 130 feet above summer level of the water in the harbor, or 120 feet above ordinary winter level (being the height of the Britannia bridge above mean tide level, as determined by the British Admiralty as a suitable height for navigation purposes). The remaining spans over this channel will be five in number, each 300 feet in the clear, carried on same level to the north shore of St. Helen's Island, from which point four spans of 240 feet each will be built, striking the natural surface of the ground on St. Helen's Island near its highest point, where this portion of the bridge proper terminates. From the south side of St. Helen's Island a second bridge will be carried over the unnavigable channel, striking the south shore with 21 spans of 200 feet each; from the south shore the bridge is continued as a viaduct with five spans of 200 feet each, until it meets the embankment leading up to the Grand Trunk and the Montreal and Chamby Railways. The total length of the bridge and viaduct will be fifteen thousand five hundred feet, and the extreme distance from point of departure on the Montreal, Ottawa, and Western Railway on the Mile End heights, near Sherbrooke street, to the point of intersection with the Grand Trunk and Montreal and Chamby Railways, will be about five and a half miles."

M. EDLUND gives (Poggendorff, No. 10, 1875) an experimental demonstration that galvanic resistance is affected by the motion of the conductor. He made a current pass, in two opposite directions from the middle part of a tube, through water that was sent through the tube; and with a galvanometer proved that the resistance was less where the galvanic current went *with* the liquid one. There is another electrical paper, in which Dr. Bleekrode recommends ebonite as preferable to glass in many ways for the disks of "electro-machines."