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JOSEPH LOCKE, M.P., President,
in the Chair.

No. 960.—“On Shearing, Punching, Riveting, and Forging Machinery.” By THOMAS SPENCER SAWYER.

THE apparatus employed in the manufacture of boilers was, until within a recent period, of a very rude description; the punching of rivet-holes in boiler-plates being accomplished by a punch simply mounted in guides, the matrix being secured to a block below,—and the necessary force for the operation being derived from a hammer. Cutting, or shearing, was also produced in a somewhat similar manner. In both operations the first step towards an improvement was made by attaching the punch, or cutting instrument, to the end of a lever, mounted on a centre as a fulcrum, in a strong framework; the other end of this lever being actuated by a crank and connecting-rod, from a shaft driven by powerful gearing from the motive-power. This form is still in use for some of the lighter work; but the usual arrangement is one which admits of the two operations of punching and shearing being performed simultaneously. To accomplish this object, the punch-slide is mounted in vertical guides, and receives motion from an eccentric on one end of a shaft, which is mounted in horizontal bearings in a strong frame; the shears, or cutting instrument, and slide at the other end also receive motion by these means, and the shaft and eccentrics are caused to revolve by a large wheel fixed in the centre, actuated by a pinion on the driving-pulley shaft. The matrix for the punch is secured in its proper position in a boss, by a screw, and there is a channel, or passage, formed to allow the punched-out metal to fall from the matrix. In some cases there is an apparatus for throwing the punch, or shears, out of gear; this is generally effected by a stop-piece, which, when the punch slide-rod is at the top of its stroke, retains them. The advantage of this combination is, that as the two forces counteract each other, an increased speed is obtained, with greater steadiness; and the machines are more simple in construction. A small engine is sometimes attached to these machines; in this case the cylinder is placed horizontally, and communicates the power by direct action, to a pinion working a spur-wheel on the shaft. The power of the machine in this modification will, of course,

greatly depend upon the diameter of, and pressure in, the cylinder, which is generally, however, made large enough—say 7 inches diameter, with a length of stroke of 9 inches. In one form of this apparatus, the pressure of the steam acts upon a piston in a horizontal cylinder. The punch is attached to the piston-rod end, which moves in guides formed in the frame, the matrix being secured in a pillar, or block, at a suitable height, the boiler-plates to be operated upon being usually slung from a crane. The waste steam from the ordinary engines is employed in the cylinder of the punching apparatus, so that it is necessarily required to be large, and the machine is rendered unwieldy in its action. Other combinations may also be mentioned, such as employing the pressure on the piston in the cylinder, at the end of a lever, having the punch arranged as stated in the first illustration, or the pressure of a hydraulic ram acting in a somewhat similar manner. With an accurate and firmly-constructed machine, rivet-holes varying from $\frac{1}{4}$ of an inch to 1 inch in diameter can be punched, or cut, in boiler-plates of the same thickness; and the plate may also, if desired, be at the same time cut to the required form.

Riveting machinery is also arranged in a similar manner. The direct action of steam is sometimes used to form the rivet, when the metal is heated to a red heat; but this plan is not generally substituted for manual labour. It is desirable that the present laborious process of riveting should be simplified, and on this account more attention should be paid to this class of machinery, which, it is believed, could not fail to produce better joints, and so tend to increase the safety of steam-boilers.

Another machine has been recently introduced, for forging rivets employed in the construction of boilers. It is simple and effective in its mode of action, which may be thus described:—The bars of iron of the desired diameter, being heated, are fed into the machine, by the action of suitable cams, so that when the length of iron required for the rivet has been measured, it is cut off. By another arrangement of cams, the length of iron is forced into the rivet-head matrix, so as to give it the required form. It is afterwards released from the moulds, by an apparatus for withdrawing it, and the rivet, ready for use, is allowed to fall into a receptacle beneath. By this machine, one ton of well-formed rivets can be produced in ten hours.

Forging-machines are also of recent introduction, the object being to forge, with rapidity, a number of bolts, or other pieces, of any desired length and diameter, with corresponding exactness. To accomplish this, vertical hammers, or slides, mounted in frames, or guides, are raised, or lowered, by a corresponding number of cams formed on a revolving shaft; the elasticity of the

blow being produced by the hammers falling against springs, or the anvils resting upon an elastic bed. Bolts and similar articles are now generally forged by this machine. For larger, or heavier work, another arrangement is employed, termed a compressed air-hammer. The construction, in this instance, may be varied to a considerable extent, but that which is found to answer the purpose, has a horizontal tappet, or cam-shaft, for raising the hammer, which is allowed to fall, by its own gravity, against the pressure of air in a cylinder, acting against the descent of a piston attached to the hammer guide-rod; the elasticity of the blow being regulated by a tap, or valve, for allowing the escape of the air from the cylinder. One great evil in this machine is, that the tappet-shaft cannot effect a direct lift for the hammer, in consequence of the different line of centres, so that a constant jarring and vibratory action is produced, rendering the wear and tear very great.

Having thus briefly described the arrangements of a few of the machines used in connection with the manufacture of boilers, it will be evident, that a greater amount of manual labour might be dispensed with in this department, if a system of machinery was employed to operate upon boilers and other plate-iron constructions; but their size and form preclude this being done to any great extent. No doubt the time is not far distant, when larger plates, and a more correct mode of making the joints, will be introduced, and eventually the plates may be welded together, thus forming a correct circle, which would be a great improvement, as no boiler, under the present system, can be said to be mathematically correct in this respect.

The communication is accompanied by a series of diagrams of the different machines, from which Plate 5 has been in part compiled, and by detailed descriptions, which are given in the Appendix to the next Paper.