ON THE STRENGTH OF TRIPLE-RIVETED BUTT-STRAP JOINTS.

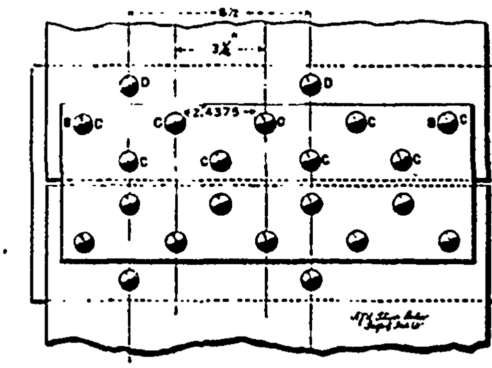
In the October issue of the *Locomotive* we gave Mr. John H. Cooper's solution of a problem in riveted joints, and in this issue we take pleasure in reproducing a solution of a similar problem by Mr. Van Clain, of the Baldwin Locomotive Works. The dimensions of the joint in question are as follows. The plates are of steel, ⅜ of an inch thick, and with a tensile strength of 55,000 pounds to the square inch. The rivets are of iron, ¾ of an inch in diameter, with a shearing strength of 45,000 pounds to the square inch. In the double riveted portion the pitch is 3¼ inches, and in the outside row it is 6½ inches. The problem is, to decide what the strength of the joint is, in terms of the solid plate, and in accordance with the Philadelphia City Ordinance, which does not expressly provide for joints of this character. Mr. Van Clain's solution of the problem was given in the September number of the *Locomotive*; but, as it was there given, it contained several typographical errors, which have been corrected in what follows:

There are three ways in which a joint of this character may fail: (1) by shearing all the rivets, which involves rivets *D* in single shear, and rivets *C* in double shear; (2) by a fracture of the plate across the line *BB*, and a simultaneous shear of the rivets *DD*; (3) by a fracture of the plate along the line *DD*.

Let us consider a portion of the joint 6½ inches long, say the portion included between the two long vertical lines passing through the rivets *DD*. The strength of the solid plate in a unit of this length is

Strength of solid plate $= 6\frac{1}{2} \times \frac{3}{8} \times 55{,}000 = 134{,}062$ pounds.

If the joint break in accordance with the first supposition, there are four whole rivets, *CCCC*, to be double-sheared, and one whole one, *D*, to be single-sheared. The diameter of the hole filled by



the rivet being, say, 13 16 of an inch, the sectional area of each rivet is .5185 sq. in. Hence

Shearing strength of *CCCC*	$.5185 \times 4 \times 2 \times 45{,}000 =$	186,660 lbs.
Shearing strength of *D*	$= .5185 \times 1 \times 45{,}000 =$	23,332 lbs.
Strength of joint, on supposition (1) =		209,992 lbs.

The diameter of the hole filled by the rivet, 13-16, when expressed decimally, is .8125. If the plate breaks across *BB*, in accordance with the second supposition, the effective section in the part of the joint under consideration is reduced by twice this amount on account of the two holes punched or drilled for the rivets *CC* that lie on the line *BB*. Hence, the effective width of plate along this line is

$$6.5'' - (2 \times .8125'') = 6.5'' - 1.6250'' = 4.875''$$

Hence, the resistance of the 6½ in. section to fracture in this manner is

Tensional strength of plate along $BB = 4.875 \times \frac{3}{8} \times 55{,}000 =$	100,547 lbs.
Shearing strength of one rivet in row $DD = .5185 \times 1 \times 45{,}000 =$	23,332 lbs.
∴ Strength of joint, on supposition (2) =	123,879 lbs.

On the third supposition, we have merely to break the plate across

$$6.5'' - .8125'' = 5.6875''.$$

Hence, tensional strength of plate across $DD = 5.6875 \times \frac{3}{8} \times 55{,}000 = 117{,}305$ lbs.

In accordance with the Philadelphia rule, we are to take the least of the three strengths of the joint computed above, and divide it by the tensile strength of 6½ inches of the solid plate, which strength we have already found to be 134,062 lbs. Obviously, the joint is weakest along the line *DD*, so that we have to call its strength 117,305 pounds. Hence, the percentage of strength of the joint is

$$117{,}305 \div 134{,}062 = 0.875$$

Hence, the joint, in its weakest part, has 87½ per cent. of the strength of the solid plate.

It may be well to say that the number 2.4375 in the cut represents the distance in the clear from edge to edge of the rivet holes, though for the sake of clearness, it is shown as though it extended only from the head of one rivet to the head of the next.

IT LITERALLY FILLS A LONG-FELT WANT.

KINGSTON, April 18th, 1891.

Editor ELECTRICAL NEWS.

DEAR SIR, I have received four issues of your valuable paper, the ELECTRICAL NEWS, and I find each number more interesting. It was just what we needed in Canada. I often felt annoyed that we were compelled to go to the States for such information, but thanks to your efforts that is now a condition of the past.

Yours respectfully,

CHAS. BAYLIE,

Electrician Kingston Penitentiary.

HORSE-POWER OF ENGINES.

Editor ELECTRICAL NEWS.

DEAR SIR,—Mr. John Galt, C. E., undertakes to act as a "governor" to me as to rate of travelling of horse to find horse-power of engine. This is all right as long as the "safety" and "throttle" valves are untampered with, the work will still go on with perfect "safety." I find it is necessary now for me to act as an "automatic regulator" to him, in that matter, to put him on *terrr firma*.

Horse power of steam engine is only a conventional way of expressing a certain size engine, and no two makes of engines are alike as to their horse power. But we will assume that H. P. is definite and alike in all engines for the sake of argument. All engineers from Watt down, except Mr. Galt, agree that a horse can exert his power to better or all advantage at two and a half miles per hour or 220 feet per minute, and *take that rate in calculating*. Mr. Watt calculated his H. P. on the largest London horse (Bourin). He was desirous of his engines doing all the work possible, or of rating them higher rather than lower, so that where steam was substituted he could dispense with a greater number of horses to do the work required.

Mr. Galt says that "rate at which horse is travelling is only one element in the calculation." Certainly it is only one element but it is *the* element that is wanting in his calculation.

Again, he says "note the rate at which the horse is travelling has every thing to do with the effect but has nothing whatever to do with the result." In mechanics this is incompatible. As I said before if you do not take the rate at which the horse travels into calculation, why take into calculation the rate at which the engine travels? The one must, of necessity, have the same units as the other in order to compare them, *which is 220 ft. per minute for rate at which horse travels*, in calculating the H. P. of steam engines. For illustration: H. P. of steam engine in numerator; power of horse in denominator

$$\frac{33{,}000 \text{ lbs.} \times 1 \text{ ft.} \times 1 \text{ minute} \times \text{speed of piston}}{33{,}000 \text{ lbs.} \times 1 \text{ ft.} \times 1 \text{ minute} \times \text{what?}} = 1 \text{ H. P.} + X,$$ when rate at which horse is required to travel is not taken into calculation. In formula form it is thus for calculating the H. P. of an engine.

Let A = area of piston.

P = steam pressure.

S = distance travelled by piston in feet per minute.

$$\text{H. P.} = \frac{A \times P \times S}{33000 \times 220}$$

If you would build an engine, by your formula, and guarantee it to be of a certain H. P., it would be like the New York street car horse—you would have to sing "Little Annie Rooney" to it before it would "budge" at the stated H. P.

We are all differently constructed—see, feel and think differently, and have different opinions. I like to see a man have his own opinions, and have backbone enough in him to assert his opinions, whether right or wrong.

Anyone who wishes to pursue the subject further may with profit study any of the following works: "Hutton's Practical Engineers' Handbook," "Mechanic's Own Book," Rankin's "Manual of the Steam Engine," Northcott's "Steam Engine," &c.

D. W. ROSS,

C. & M. E.