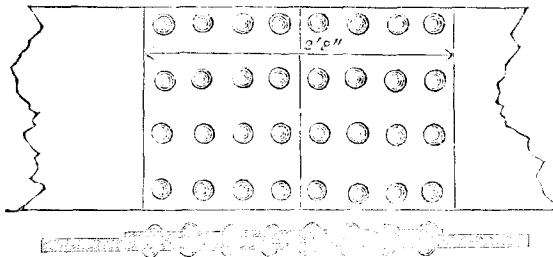


with carbonic acid a vacuum with the air pump so perfect as to exercise no appreciable tension, as no difference in the level of the mercury in the siphon-gauge could be detected. On trying the discharge in the vacuum-tube after the potash had cooled, I found it gave the cloud-like stratifications, with a slight reddish tinge; consequently not only was the vacuum not perfect, as denoted by the form of stratifications, but in this tube the color denotes that even a trace of the air remains, probably that portion in the narrow part of the siphon-gauge, which, from its position, was not displaced by the carbonic acid."

"The potash was subsequently heated until the discharge was reduced to a wave line, with very narrow striæ; in this state moisture is seen adhering to the sides of the tube; but even in this state the difference in the level of the mercury in the gauge did not ever vary more than .05 inch. As the potash cooled, the discharge altered through all the well-known phases of the striæ, the mercury again becoming quite level. At first almost the slightest heat applied to the potash alters the form of the stratifications; as the heating is repeated, longer application is necessary; but it shows how sensibly the electrical discharge denotes the perfection of a vacuum, which cannot be detected by the ordinary method of mercurial siphon-gauge.

*Chain Riveting.** By W. FAIRBAIRN, Esq., LL.D., F.R.S., &c., &c.

In the formation of the bottom of a tubular girder, whether composed of cells, as in the Britannia and Conway bridges, or of double plates, as in smaller examples, it is of importance to have as few joints as possible. Hence the plates should be rolled as long as their weight and thickness will allow, and the joints be carefully united by covering plates, *chain riveted*, as shown in the following sketch, with three or more rows of rivets, according to the width of the plates. Eight



rivets are required in each of the lines, four on each side of the joint, to give sufficient strength, and the area of the rivets collectively should be equal to the area of the jointed plates, taken transversely through one line of the rivets, the area of the parts punched out in that line being deducted. These proportions give the required security to the joint, and afford nearly the same strength to a tensile strain as the solid plate; that is, if the covering plates be as much thicker as will give the same area of section through the rivet holes as the imperfo-

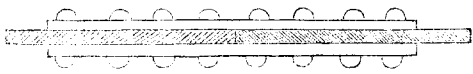
* From the Lond. Mechanics' Magazine, June, 1860.

rated double plate. These precautions being taken in covering the joints of the plates and in securing the angle irons which unite the sides with the bottom, it will meet in practice all the requirements of a uniform power of resistance to strain from one end of the girder to the other.

In a long experimental inquiry which I undertook some years since, it was shown that there was a loss in the riveted joint, as compared with the solid plate, of 30 to 50 per cent.; that is, taking the strength of the solid plate at 100, that of the double riveted joint would be 70, and that of the single riveted joint 50.

This great deficiency in the strength of joints subjected to a transverse strain, caused considerable difficulty in designing the Britannia and Conway bridges; double, treble, and quadruple riveting was thought of; but one after another was abandoned, on account of the rivet holes weakening the plates; and I should almost have despaired of attaining the object in view, but for the system of longitudinal or chain riveting having occurred to me, after repeated trials of other modes and forms. Experiment, however, established the perfect security of this method, as the following tables clearly demonstrate. Two distinct methods were tried, one with a single thickness of plates, the joint having a covering strip on each side; the other with two thicknesses of plate, there being a joint in one of them covered by a plate, and kept in position by a line of rivets as already described. The jointed plates having been prepared, the experiments were effected by a powerful lever, tearing the joints and plates asunder in the direction of the line of rivets.

Chain Riveting. Single Plates, with double Covers over the Joint.


No. of Experiment.	Weight in lbs.	Elongation in inches.	REMARKS.
1	5,600		<p>Weight of the lever.</p>  <p>Torn asunder through a rivet hole after sustaining the load a few seconds.</p>
2	26,656		
3	28,448		
4	30,240	·021	
5	32,032	·034	
6	33,824	·034	
7	35,626	·044	
8	37,418	·052	
9	39,210	·056	
10	41,002		

		Sq. in.
Area of section through solid plate,	$3\cdot5 \times 25$	$\equiv 875$
Area of the covering plates,	$3\cdot5 \times 26$	$\equiv 910$
Area of section through rivet hole,	$3\cdot0 \times 25$	$\equiv 750$
Diameter of the rivets, each $\frac{1}{2}$ inch, four on each side of the joint.		

If we take the area of the plate at the point of fracture $\equiv 750$ inch, it will be found that it required a power of 21·41 or nearly $21\frac{1}{2}$ tons per square inch to tear it asunder.

From the following experiment, it appears that the fracture took place through the solid plate on one side, and by shearing off the rivets on the other. Hence the area of section of fracture $= .875 \times .785 = 1.66$ inches, and proceeding as before, we have 18.73 tons per square inch as the breaking weight.

Chain Riveting. Double Plates, and a single Cover over the Joints.

No. of Experiment.	Weight in lbs.	Elongation in inches.	REMARKS.
1	5,600		Weight of the lever.
2	26,656	.016	
3	37,408	.025	
4	46,368	.028	
5	55,328	.075	
6	62,496	.100	
7	69,664		Broke by shearing off the rivets close to the plate.

Area of section through plates,	$2 \times .875$	Sq. in. $= 1.750$
Area of section through rivet holes,		$= 1.5$
Area of covering plate through rivet holes,		$= 0.91$
Rivets as before, $\frac{1}{2}$ -inch diameter.			

Finding the resisting powers of the rivets unequal to the strength of the double plates, they were afterwards increased from half an inch to five-eighths of an inch in diameter, or until the area of the rivets approached nearly to the area of the plates, which gave the required strength. In joints of this description it will be found that the resisting powers of the rivets is nearly equal to that of the plates, *i.e.*, the resisting power of the rivet is to that of the plates as their sectional areas respectively. This is an agreement with the following laws, which have been deduced from experiment:—1st, that the ultimate resistance to shearing, in any bolt or rivet, is proportional to the sectional area of the bar torn asunder; and, 2d, that the ultimate resistance of any bar to a shearing strain is nearly the same as the ultimate resistance of the same bar to a direct longitudinal strain.

For the Journal of the Franklin Institute.

Particulars of the Steamer Zouave.

Hull built by John Engles. Machinery by Morgan Iron Works, New York. Owners, Sandford's Independent Line, New York to Philadelphia.

HULL.—Length on deck, 220 ft. Breadth of beam (molded), 30 ft. 8 ins. Depth of hold to spar deck, 12 ft. 3 ins. Frames, molded, 14 ins.,—sided, 6 ins.,—24 ins. apart from centres, and strapped with diagonal and double laid braces, $4 \times \frac{1}{2}$ in. One independent steam fire and bilge pump. One bulkhead. Promenade deck with saloon, cabin, and state-rooms. Draft of water forward and aft, 6 ft. 6 ins. Area of immersed section at load draft of 6 ft. 6 ins., 175 sq. ft. Masts, two—Rig, Schooner. Tonnage, 800 tons.

ENGINES.—Vertical beam. Diameter of cylinder, 50 ins. Length of stroke, 11 ft. Cut-off, one-half.