"The above methods are now in use in two important sugar establishments, and the quantity of sugar made by them up to this time is about 300 tons. They can be applied with equal success in the manufacture and refining of sugar from the cane."—*Cosmos*.

On the Maximum Density of Sea Water. By M. V. NEUMANN.

From the Lond. Ed. and Dub. Phil. Mag., November, 1861.

Von Neumann, in an inaugural dissertation (Munich, 1861), has published a new determination of the maximum density of sea water. Like Kopp and other physicists, who have made this determination for pure water, he measured the volume at different temperatures in a glass vessel, analogous in construction to a thermometer, the co-efficient of expansion of the glass being carefully determined. This method is well adapted for liquids whose freezing point is above the point of greatest density. The sea water used was obtained from Trieste, Genoa, and Heligoland, and was previously well mixed. Its freezing point was found to be -2.6°C. , and its specific gravity at 0°C. 1.0281; its point of greatest density was -4.7364°C.

This number is more than that obtained by Despretz (-3.67°C. for sea water of 1.0273 sp. gr.) and Erman (-3.75°C.), but would probably agree with that of Marcet (-5.25°C.) and Horner (-5.56°C.), if a correction for the expansion of glass were introduced.—Poggendorff's *Annalen*, August, 1861.

Resistance of Square Bars to Torsion. By W. J. MACQUORN RANKINE.

From the Civ. Eng. and Arch. Jour., March, 1862.

SIR—It is very desirable that the attention of writers on the strength of materials should be called to the theoretical investigations of M. de St. Venant, especially those on torsion, which were published in the "*Mémoires des Savans Etrangers*," vol. xiv., about six years ago, but appear to have been almost wholly overlooked, although some of their results are of much practical importance.

According to the ordinary theory of the torsion of a straight uniform bar, each originally plane section perpendicular to the axis, continues to be plane and perpendicular to the axis when the bar is twisted. It is easy to see that this supposition is rigorously exact for a cylindrical bar only; but it seems to have been generally taken for granted that the errors to which it leads when applied to bars of other forms are unimportant in practice. M. de St. Venant shows that they are of importance; and, by a very skilful and laborious mathematical investigation, he obtains approximate formulæ in which allowance is made for the effect of what he calls the "*gauchissement*" (which may be translated the *warping*) of the originally plane cross-sections of bars that are not cylindrical. He arrives at the result, that the whole

of the ordinary formulæ relating to torsion are erroneous, except those for cylindrical bars.

The most important case in practice to which the method of M. de St. Venant has been applied, is that of a square bar, wrenched asunder by torsion.

Let h denote the side of the bar; f , the modulus of rupture by wrenching, or greatest intensity of the stress when the bar gives way; then the moment M of the force required to wrench asunder the bar is,

According to the ordinary formula, $M = .2357 f h^3$;

According to the improved formula, $M = .281 f h^3$.

In the reduction of experiments on wrenching equal bars asunder, the following are the values of the modulus f :

According to the ordinary formula, $f = \frac{M}{.2357 h^3}$;

According to the improved formula, $f = \frac{M}{.281 h^3}$.

To these may be added the corresponding formula for cylindrical bars, in which alone M. de St. Venant makes no alteration,

$$f = \frac{M}{.196 h^3}.$$

An easy test of the accuracy of the formulæ for square bars is to try whether, when applied to experiments, they give values of f agreeing, or nearly agreeing, with those deduced from experiments on round bars. I have lately applied that test to them by the aid of the experiments of Mr. George Rennie and Messrs. Bramah on square bars of cast iron, and Mr. Dunlop on round bars of the same metal, as quoted by Mr. Hodgkinson in his work on Cast Iron (articles 201 to 204 inclusive), with the following results. (See also, as to Mr. Dunlop's experiments, Tredgold on Cast Iron, page 98.

	MODULUS OF WRENCHING, f .	
	Ordinary formula.	M. de St. Venant's formula.
<i>Square Bars.</i>	lbs. on the sq. in.	lbs. on the sq. in.
Mean of Mr. Rennie's experiments, .	32,227	27,070
Mean of Messrs. Bramah's experiments,	37,747	28,640
General mean, . .	34,987	27,855
<i>Cylinders.</i>		
Mean of Mr. Dunlop's experiments, .	27,534	27,534
Difference, . . .	7,453	321

It is obvious that the difference between the results of experiments on square and round bars, according to M. de St. Venant's formula,

falls within the limits of the ordinary variations of experiments on the strength of materials; which limits it greatly exceeds when the ordinary formula is applied.

GLASGOW, 4th February, 1862.

A Description of a Steam Hammer for Light Forgings. By Mr.
RICHARD PEACOCK, of Manchester.

From Newton's London Journal, Aug., 1861.

Power hammers are almost indispensable for the production of sound smiths forgings, and their extensive introduction into the smithery has been attended with most valuable results. Their application is not of recent date, but the extraordinary demand for forged iron work for steamboat and railway work has given an impetus to their use, and their adaptation to the more general wants of the smith's shop is marked by great advantage as regards both efficiency and expedition.

The steam hammer described in the present paper, is now in use at the author's works, Gorton Foundry, Manchester; and is brought before the meeting by request, as an example of a practical and useful steam hammer for light forgings, heavy smith's work, stamping, &c. This hammer is worked by hand, and is either single or double acting; that is, it can either be lifted by steam and allowed to fall by gravity alone, or, after it has been lifted, steam can be used above the piston to give increased effect to the blow.

The steam cylinder is 10 inches diameter, and constructed for a 24 inch stroke. The valve is cylindrical, turned to fit well in the valve chest, but to move easily within it. The top end of the valve is made longer on one side than on the other, and, in one position, therefore, of the valve, steam is admitted above the piston in the down stroke, but by turning the valve half round, by means of a handle, the additional lap is brought into use, which prevents the admission of steam above the piston, and allows the hammer to fall by gravity alone. The valve is worked up and down by a hand lever; it is open through the centre, and the weight of the valve, valve rod, and hand lever, is counterbalanced by a spiral spring. To prevent the piston from rising too high in the cylinder, a trigger is fixed on the side frame, which when struck by a roller on the hammer block, lowers the valve, and allows the steam to escape from beneath the piston.

The piston is secured to the rod in the usual way by a cone and nut. The bottom end of the rod has a solid head, by which it is secured to the hammer block. This head is rounded on the top and bottom, and is made $\frac{1}{4}$ inch less in diameter than the hole in the hammer block, to allow of any twist or vibration, and prevent the breaking of the piston rod, which, from the oblique strain due to the varied character of the forgings, has hitherto given great trouble in steam hammers. The weight of the piston, piston rod, and hammer block, is $12\frac{1}{2}$ cwt., or 1400 lbs.

From diagrams which the author exhibited, the mean pressure of steam in lifting the hammer was shown to be 25.7 lbs. per square inch,