Consequently the engine would do what the gentleman considers absurd, viz.—Use most horse-power when doing least work, and least horse-power when doing most work.

The method he gives us for computing the power of an engine exclusive of friction is equally erroneous, as he supposes the friction to be the same, whether the engine is doing work or not, which is evidently wrong.

Again he says, "It must be admitted that a better test of the superior economy of one man's make of engine over another could scarcely be had than that of the amount of steam consumed in running any engine alone." I believe that the gentleman is also mistaken on this point. The fact is that a toy engine, like the one of which you give an illustration on the same page on which the gentleman's article appeared, would run with less steam alone than the most perfect engine yet made, on account of the simplicity of parts. I think it capable of demonstration that the poorest engine would run alone with the least steam, and also that a very bad engine may show a good card by indicator. B.

Newark, N. J.

Large Centrifugal Pumps.

MESSRS. EDITORS:—In a recent number of your paper you published an extract, from the *Colliery Guardian*, about two large centrifugal pumps which had lately been made in England, and which were said to be the largest in the world. The writer of the article in question cannot have been very well "posted" as to the dimensions of some of the large pumps at present in operation—as I know of two (and there are probably others), each of which exceeds in size those described in the article referred to. These pumps are at present at work on the sugar estate of Messrs. Ewing, of Glasgow, in Demarara, and were made from the designs of Prof. James Thomson, C. E., Belfast, Ireland. The larger of the two was constructed under my supervision by Messrs. Harland & Wolff, Belfast, and as some of your readers may desire to know some of the particulars I give you the principal dimensions. Diameter over all, 15 feet 6 inches; diameter of wheel, 7 feet 9 inches; breadth of wheel at periphery, 2 feet 7½ inches; diameter of shaft, 7¼ inches; diameter of suction pipes (2), 4 feet 9 inches.

St. Louis, Mo. JAS. SIMPSON.

THE LAW OF STEAM.

BY PROF. JULIEN M. DEBY.

Regnault, the celebrated chemist and natural philosopher, in the published results of his admirable researches on steam, undertaken at the requisition of the French Government, while speaking of the intimate relation existing between the pressure and the temperature of steam, says: "The question we are at present studying is probably one of the least complex of the theory of heat, and if the law which governs it has not been made manifest by our experiments, this depends probably on the empirical definition given of *temperature*, which definition, in all likelihood, does not establish any simple relation between various temperatures and absolute quantities of heat."

He further says: "We are at present totally unacquainted with the theoretical law which connects the elastic forces of vapors with their temperatures."

Dalton, long before Regnault, propounded a law, stating that, while the pressures increased in geometrical ratio, the temperatures did so in an arithmetical one; and Faraday, to a certain extent, corroborated Dalton's theory during his investigations on the expansion of gases. More recent observations have, however, proved the fallacy of this supposed law, especially when applied to long ranges of pressures or to great differences in temperature.

Neither the researches of Arago and Dulong, nor those of the Franklin Institute, nor of other modern physicists have, to our knowledge, been able to solve the mystery, and we have, to this day, been reduced either to direct experiment or to the use of empirical formulæ in order to determine the temperature of any given pressure of steam, or, *vice versa*, to determine the pressure from the temperature.

The formulæ for this purpose are quite numerous; but as I have said before, they are, without exception, purely empirical; and their results must be considered only as rough approximations to practical results. Many of these formulæ are complex, involving quantities to be raised to the fifth or sixth power or require the extraction of the fifth or sixth root, and combine the use of various constants and coefficients with multitudinous rows of decimals attached to them.

How much more simple the matter really is, I shall now proceed to show, leaving those who take interest in the subject to judge for themselves, whether or not Dame Nature has long mystified the mathematicians in this special case.

While reflecting on the theory which regards heat as a mode of motion, it occurred to me to think of the cause of the well-ascertained fact, that the latent heat of steam decreases as the tension increases, and this naturally led me to the conclusion, that, in all probability, as the pressure of steam increases so is a portion of the latent heat really converted into this pressure itself, or, more properly speaking, the tension is in reality itself only modified latent heat.

Expressed mathematically, if such be the case, no matter what the tension is, we have: Tension of steam (a certain amount of motion) + latent heat of same steam (a certain amount of motion) = total amount of heat (total motion) in steam.

In order to ascertain if I was right in my supposition, I took up—not any of the tables calculated by the formulæ of various authors, but the results of direct experiments made by the most reliable scientific authorities—and I soon had the satisfaction of discovering that I had, to all appearance, solved the gordian knot.

The tension of steam, or its elastic force, does not present any natural simple relation to either thermometric temperature or to the total units of heat supposed to be contained in steam, but is most intimately related to its latent heat, a portion of which, in fact, it really is. According to my views, the simple law reads as follows:

While the pressure of steam increases in a geometrical progression, the latent heat decreases in an arithmetical progression, and vice versa.

If the pressure in atmospheres be as 1, 2, 4, 8, 16, 32, etc., the corresponding diminution in latent heat will be, respectively, as 1, 2, 3, 4, 5, 6, etc. The same would occur with the series 3, 6, 12, 24, 48, 96, etc., or 5, 10, 20, 40, 80, etc., or any other

If we take 537 C. units of caloric as the quantity of "latent heat" in steam, indicating 100° C. on the thermometer under atmospheric pressure, we find that the difference between the terms of the above arithmetical progression is 17, or a number which approximates to it within a very minute fraction.

This number of 17 units of heat is an average of the differences found by me to exist between a large number of the carefully *observed* temperatures, noted by Arago, Dulong, and Regnault, as corresponding to *observed* pressures.

It gives us:

Pressure in atmosphere.	Latent caloric.
1	537 units.
2	$537-17$
4	$537-17\times2$
8	$537-17\times3$
16	$537-17\times4$, etc.

By interpolation, I have formed the following table, showing the latent heat (which may always be readily calculated from the thermometric indications, by means of Regnault's formula T ·305 + 506·5 for Centigrade degrees, or (T—32)·305 + 911·7 for Fahrenheit degrees, and the corresponding pressures of steam in atmospheres, from 1 to 16. The temperature is also readily calculated from the latent heat by the formula T=606—L÷·695, in which L represents the units of latent heat.

The letter A indicates the units of latent heat of steam of 100° C., or 212 Fah. or of atmospheric pressure, and b indicates the number corresponding to the difference between two terms of the arithmetical progression. I shall here only exhibit the Centigrade series in numerals.

Pressures in atmospheres.	Corresponding units of latent caloric.	In general.
1	537	$A-o$
2	$537-17$	$A-b$
3	$537-(17+\frac{17}{2})$	$A-(b+\frac{b}{2})$
4	$537-(17\times2)$	$A-(b+b)$
5	$537-[(17\times2)+\frac{17}{4}]$	$A-(b+b+\frac{b}{4})$
6	$537-[(17\times2)+(2\times\frac{17}{4})]$	$A-(b+b+2\frac{b}{4})$
7	$537-[(17\times2)+(3\times\frac{17}{4})]$	$A-(b+b+3\frac{b}{4})$
8	$537-(17\times3)$	$A-(b+b+b)$
9	$537-[(17\times3)+\frac{17}{8}]$	$A-(3b+\frac{b}{8})$
10	$537-[(3\times17)+(2\times\frac{17}{8})]$	$A-(3b+2\frac{b}{8})$
11	$537-[(3\times17)+(3\times\frac{17}{8})]$	$A-(3b+3\frac{b}{8})$
12	$537-[(3\times17)+(4\times\frac{17}{8})]$	$A-(3b+4\frac{b}{8})$
13	$537-[(3\times17)+(5\times\frac{17}{8})]$	$A-(3b+5\frac{b}{8})$
14	$537-[(3\times17)+(6\times\frac{17}{8})]$	$A-(3b+6\frac{b}{8})$
15	$537-[(3\times17)+(7\times\frac{17}{8})]$	$A-(3b+7\frac{b}{8})$
16	$537-[(3\times17)+(8\times\frac{17}{8})]$	$A-4b$.

I am at present occupied in computing the latent heat of all pressures, from 1 to 16 atmospheres and up to 1,000ths parts, which will furnish more complete data than any extant.

In order to facilitate at once to others the verification of my statements, I will limit myself to showing how the 10ths, 100ths, and 1,000ths are interpolated by an example.

PRESSURE FROM ONE TO TWO ATMOSPHERES.

TENTHS.

		Units.
Atmospheres	1	537
"	1·1	$537-\frac{17}{10}$
"	1·2	$537-2\times\frac{17}{10}$
. . .	. . .	. . .
"	1·9	$537-9\times\frac{17}{10}$
"	2	$537-17$

HUNDREDTHS.

		Units.
Atmospheres	1	537
"	1·10	$537-\frac{17}{10}$
"	1·11	$537-(\frac{17}{10}+\frac{17}{100})$
"	1·12	$537-(\frac{17}{10}+2\times\frac{17}{100})$
. . .	. . .	. . .
"	1·99	$537-(9\times\frac{17}{10}+9\times\frac{17}{100})$

THOUSANDTHS.

		Units.
Atmospheres	1	537
"	1·101	$537-(\frac{17}{10}+\frac{17}{1000})$
"	1·102	$537-(\frac{17}{10}+2\times\frac{17}{1000})$
. . .	. . .	. . .
"	1·999	$537-(9\times\frac{17}{10}+9\times\frac{17}{100}+9\times\frac{17}{1000})$

I have applied my formula to most of Regnault's practical observations, taken high and low in the scale, and find the discrepancies to be really insignificant.

He gives, for instance, pressure 1·905 atmospheres; observed temperature, 119·16; latent heat, 523; I find 521,615, or a difference of only 1·385 units. Another is T=119·16; pressure, 1·924 atmospheres; latent heat, 522·2; I find 521·292 units, or a difference of 1·008 units.

Among the higher pressures, we find: Pressure, 13·344 atmospheres; temperature, C., 193·8; latent heat, 472·2. We here, by our theory, have 473·662, a difference of 1·42 only; and again, P=13·625; T=194·8; latent heat, 471·2, when I find 474·047, a difference of 2·847 units.

The above are only a few examples, taken at random from among many, to serve as a verification of my law, but all those I have tried have approximated as closely to the practical results of experiment as those we have just quoted.

I have rapidly penned the present notice for the purpose of eliciting the opinion of others upon this important and interesting subject.

In a future article I may furnish various practical formulæ in connection with it, and will enter into the discussion of the relation existing between, so-called, latent heat and the volume of steam, as also its connection with the present theory of expansion and condensation, all of which we hope to show, have the most intimate dependence on its amount.

Let us conclude by reminding the reader, that we are, in all probability, fast approaching the day when it will be admitted by all sound philosophers, that only one law exists in nature, MOTION, the modes of which are familiarly known as heat, light, electricity, chemical affinity, molecular forces, gravitation, innervation, etc., all of which will be found to be perfectly convertible into one another. This will constitute a sufficient proof of their identity.

THE SEWING MACHINE---ITS ORIGIN AND SUGGESTIONS FOR IMPROVEMENT.

In the year 1825, there lived in the city of Saint Etienne, in France, a poor and obscure tailor whose patrons were few and far between. His carelessness about the work intrusted to him, joined to his eccentric habits, obtained for him throughout the neighborhood an unenviable reputation, the natural consequences of which were that his business declined from day to day and he ended by becoming a veritable pauper. In 1827, he was considered as laboring under the constant influence of hallucinations, and in 1829, he was unanimously regarded by the gossips of his precinct as insane.

This madman was no other than Barthlemy Thimonnier, the inventor of the first sewing machine. He was born at Abreste in the year 1793, and was the son of a dyer of Lyons.

It is an old custom with many manufacturers of the south of France, to give out large quantities of needle-work and embroidery to the country girls residing around their establishments. This attracted the notice of Thimonnier and originated in his mind the first idea of a sewing machine. On its construction he worked without help or money during four successive years, at the expiration of which, in 1830, he obtained his letters patent.

A government engineer by the name of Beaunier, living at Saint Etienne at the time, examined the machine, and appreciating at a glance the value of the invention, took the tailor with him to Paris, where a firm was soon started under the title of "Ferrand, Thimonnier, Germain, Petit & Co., with a view to the profitable working of the patent.

In 1841, in the Rue de Sevres, might have been seen a workshop, in which eighty wooden sewing machines were constantly employed in making army clothing.

That same year, however, the tide of a fierce revolutionary outbreak swept over France, and the laboring men of the capital, in their blind and ignorant fury, saw in this new substitution of machinery for manual labor, nothing but a means of robbing their wives and daughters of their daily bread. The consequence was exactly the same as in the case of the canal boatmen of Münden, who destroyed the first steamboat started there in the year 1707, and of the Belgian weavers, who some years ago broke up the first flax-spinning machinery imported from England into the city of Ghent. An armed and infuriated mob smashed all of Thimonnier's machines, and he himself had to flee for his life.

Soon after this Beaunier died, and the firm of Germain, Petit & Co., was dissolved leaving our poor tailor out in the cold.

In the year 1834, Thimonnier returned to Paris, and having improved his machine, attempted to make a living by taking in sewing. In this, however, he failed, and was at length obliged to walk all the way back to his native home with his machine upon his back, exhibiting it as a curiosity along the road in order to enable him to purchase his daily meals.

After this sad experience it would be thought Thimonnier would have given up the matter in despair, but, on the contrary, he went to work and constructed several new machines which he disposed of with the greatest difficulty.

In the year 1845, the date of Howe's patent in America, the French machine was already making two hundred stitches a minute

M. Magnin, of Villefranca, at this crisis joined our inventor, and furnishing the necessary funds, the construction of ten-dollar machines was at once begun by them, with a fair prospect of pecuniary reward. In 1848, these machines made three hundred stitches per minute, and could sew and embroider any material from muslin to leather inclusive. The woodwork had now also been replaced by metal.

In the memorable month of February, 1848, another convulsion of the people took place in France, and for the second and last time were Thimonnier's hopes of success entirely blighted, himself and his partner being completely ruined by it.

He sold his English patent to a Manchester company for a trifle, sent his best machine in 1851 to the great London Exhibition, but too late to be noticed; and, finally, after thirty years of a life of incessant struggle and adversity, he died at the age of 64, in the greatest poverty, on the 5th day of August, 1857, at a place called Amplepuis.

While our poor tailor was starving in Europe, the sewing machine was being perfected on a new principle, in the United States, and in 1845, Elias Howe, Jr., obtained his patent out of which he eventually made quite a large sum of money.

Since 1852, American sewing machines by various makers