meaning: they make themselves a people with; that is, with thunder they make themselves or become a people. The We'-zhi*n*-shte gens, the Elk people, were called O*n*-pa i'-ni-ka-shi-k̈i-dhe—o*n*-pa, elk; with the Elk they make themselves a people. The word i'-ni-ka-shi-k̈i-dhe clearly indicates the constructive character of the totem in the gens.

The set of names which belonged to each gens referred to the sign or totem of a family group; these names were called ni'-ki-e—spoken by a chief, or originated by a chief. The word ni'-ki-e points to the formative period when means were being devised to transform the family into a distinct political group; it argues a central authority, a man, a chief; the individual names which he bestowed allude solely to the power behind the chief, the manifestation of his vision represented by his totem, in the favor of which he and his kindred had made themselves a people, i'-ni-ka-shi-k̈i-dhe.

The Osage equivalent of the Omaha word i'-ni-ka-shi-k̈i-dhe is zho'-i-ga-ra, meaning associated with. The Otoe word used for the same purpose is ki'-gra-jhe, they call themselves.

The word for tribe u-k̈i'-ẗe, when used as a verb, means to fight, to war against outside enemies, indicating that the need of mutual help impelled the various To*n*'-wo*n*-gdho*n* (gentes) to band together for self-preservation; but the order of their grouping was, as we have seen, controlled by their totems.

Summary.—In the word for tribe, in the formation of the gens within the tribe, and in the rite which brought the individual into what he believed to be direct communication with Wa-k̈o*n*'-da, we trace the workings of man's consciousness of insecurity and dependence, and see his struggles to comprehend his environment and to bring himself into helpful relations with the supernatural. And we find in this study of the Omaha totem that, while the elements, the animals and the fruits of the earth were all related to man through a common life, this relation ran along discrete lines, and that, his appeal for help once granted, relief could only be summoned by means of the Wa-*h*u'-be, the sacred object, the totem, which brought along its special line the desired supernatural aid.

It is noteworthy that the totems of individuals, as far as known, and those of the gentes, represented the same class of objects or phenomena, and as totems could be obtained in but one way—through the rite of the vision—the totem of a gens must have come into existence in that manner, and must have represented the manifestations of an ancestor's vision, that of a man whose ability and opportunity served to make him the founder of a family, of a group of kindred who dwelt together, fought together and learned the value of united strength.

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*MULTIPLE-CYLINDER STEAM-ENGINE.**

THE following is a very brief abstract of the paper presented to the American Society of Mechanical Engineers, by Messrs. Thurston and Brinsmade, at the last convention, New York, Deceber 2, 1897:

The paper was a statement of the results of the experimental investigation of the relative efficiency of standard forms of compound and triple-expansion engines and a newly introduced type in which the high-pressure cylinder is given about one-half the size ordinarily assigned for a stated power, as compared with the magnitude of the low-pressure cylinder. Remarkably

*Presented at the New York meeting (December, 1897) of the American Society of Mechanical Engineers, forming part of Volume XIX. of the *Transactions*.

high efficiencies had been reported and it had become important to ascertain what relation the new sustained to the old system. The machines employed in the research were, in fact, the available combinations of of the largest of the triple-expansion 'experimental engines' of Sibley College, and the combinations adopted were:

1. The triple-expansion engine in its usual condition.

2. The intermediate- and the high-pressure elements combined to make a compound engine of usual proportions—three to one.

3. The low- and the high-pressure elements combined to produce a compound of the peculiar sort above mentioned—seven to one.

Earlier reports upon the performance of engines of these several types had been made to the same Association and the results so reported had been as below; the second of the three cases illustrating the novel practice which it was here sought to study:

several types of engine. Taking the best performance of the ideal engine as varying as the logarithm of the pressure employed, as also found by experience to be approximately the fact with good engines, the gain to be fairly anticipated by adopting the higher pressure, other things being equal, should be such as to give the figures 11.8, 12.84 and 11.16 pounds of feed-water per horse-power per hour, for the three cases respectively. The relative efficiency will then be expressed by the figures 0.95, 0.87, 1.00. The engine of usual type, as a compound, when well-designed and built, thus gives a performance within 5 per cent. that of the best known triple-expansion engine; the compound, with exaggerated cylinder-ratio, lacks 13 per cent. of the efficiency of the triple-expansion and 7 per cent. that of the standard type of compound. Leavitt's Chestnut Hill engine, for which the figure 11.2 is reported, may be taken as identical with the Reynolds pumping engine in relative efficiency; correction being made for

CASE OF COMPOUND *vs.* TRIPLE AND INTERMEDIATE FORMS.

Engine.	Standard Compound.	Intermediate Form.	Triple Expansion.
Number of cylinders in series	2	2	2
Steam-pressure, absolute	151.6	175.5	135.5
Vacuum, in. mercury	27.75	25.3	27.6
Ratio of expansion	20.40	33. (nom.)	19.55
Revolutions per minute	18.57	76.4	20.31
Length of stroke, ft.	10.0	4	5
Piston speed, per minute, ft.	371.5	611.2	203
Cylinder-ratio	4	7	1, 3, 7
Drop between cylinders	None	14 lbs.	None
Dry steam, per I. H. P. per hr	12.156	12.84	11.678
Difference favoring compound	0.684 lbs. = 5.3%		
Difference in favor of triple	0.478 lbs. = 4%	1.16 lbs. = 9%	
	a	*b*	*c*
St. cons. reduced to 175 lbs	11.8	12.84	11.16
Comparative effic. on this basis	0.95	0.87	1.00

The table contains, in the last two lines, figures added to bring into more perfect comparison the relative economy of the difference in pressures. Were correction made for differences in ratios of expansion, the result above indicated would have been somewhat more marked, as the engine of novel proportions has, nominally at least, 65 per cent. higher ratio than its rivals; but, as a considerable part of this apparent expansion-ratio measures free expansion without performance of work, the comparison on this basis would not be strictly correct. No correction is attempted for differences in speeds of piston or of revolution, on which score the intermediate type of engine would apparently have a very marked advantage; for, as was long ago pointed out by the writer, where jacketing is adopted successfully, variation of piston-speed seems to have little effect on economy.

The three experimental engines being compared, as proposed, and as indicated in the introductory paragraph, the novel proportions are found, in this case also, to give an efficiency intermediate between the standard compound engine and the standard triple-expansion under similar steam-pressures.

The following table shows the conditions during the most efficient periods of test of the three systems:

test of the triple and the most economical test of the 7-to-1 compound there is a difference of an inch and a half of mercury in the vacuum, and of four pounds in the boiler pressure. The column showing the three tests reduced to a common back-pressure was obtained by increasing or diminishing the mean effective pressure in the low-pressure cylinder of each by the amount each varied in back-pressure from that of the required mean. In this case the mean was taken as the back-pressure in the triple-expansion test. This correction brings the triple and 7-to-1 compound nearer together, but we shall still have a difference in steam consumption of 1.48 pounds of steam per horse-power per hour between the triple and the 7-to-1 compound, and a difference of 2.1 pounds between the latter and the compound with the 3-to-1 ratio of cylinder volumes.

The performance, absolute and relative, of these three engines with varying power is illustrated in the accompanying diagram, which well exhibits the curious variation of relation, in this respect, produced by changing conditions of operation.

COMPARISON OF THE MOST ECONOMICAL TRIALS.

	Triple.	7-to-1 Compound.	3-to-1 Compound.
Boiler gauge	119.1	115	117.5
Revolutions per minute	84.95	87.65	85.52
Vacuum in inches of mercury	24.3	22.84	22.7
Condensed steam in pounds	1,205	1,753.7	1,030
Total jacket-water	335.4	316.7	190.97
Total steam used	1,540.3	2,070.4	1,221.2
Total I. H. P.	112.65	129.97	67.7
Distribution of work between cylinders, H. P. = 1	I. C. = 1 L. P. C. = 1	1.29	.635
Mechanical efficiency	84.1	86.6	90
Steam per I. H. P. per hour	13.68	15.8	18.03
Number of expansions	22	18.89	15.45
Steam per I. H. P. corrected to a vacuum of 24.3 inches mercury	13.68	17.1	17.3

It will be noticed that in the triple-expansion tests both the vacuum and the boiler pressure are better than in either of the others. Between the most economical

The curves in this figure leave no room for doubt in regard to the relative economy of the three engines. At about 37 horsepower the steam consumption in each case is about the same. The curves then diverge, the 3-to-1 compound reaching a minimum steam consumption at 75 horse-power, of 18 pounds. The minimum points on the other curves, owing to their larger low-pressure cylinder volume, lie further along, and are 15.8 pounds for the 7-to-1 compound, and 13.7 pounds for the triple-expansion engine. We have thus a gain of 2.2 pounds of steam per indicated horse-power per hour of the 7-to-1 over the 3-to-1 compound, and a gain over the former by the triple-expansion engine of 2.1 pounds of steam per indicated horse-power per hour.

Comparing the best work of each type, as given by the records to the date of the preparation of this paper, the best work of good engines of each class may be taken as, approximately, measured by the weights of steam, per horse-power per hour, or by the number of thermal units, proportional to the reciprocal of the logarithm of the pressure adopted. Thus, the following are given as the relative efficiencies of these three engines, in terms of steam demanded, or of weight of feed-water consumed per horse-power per hour:

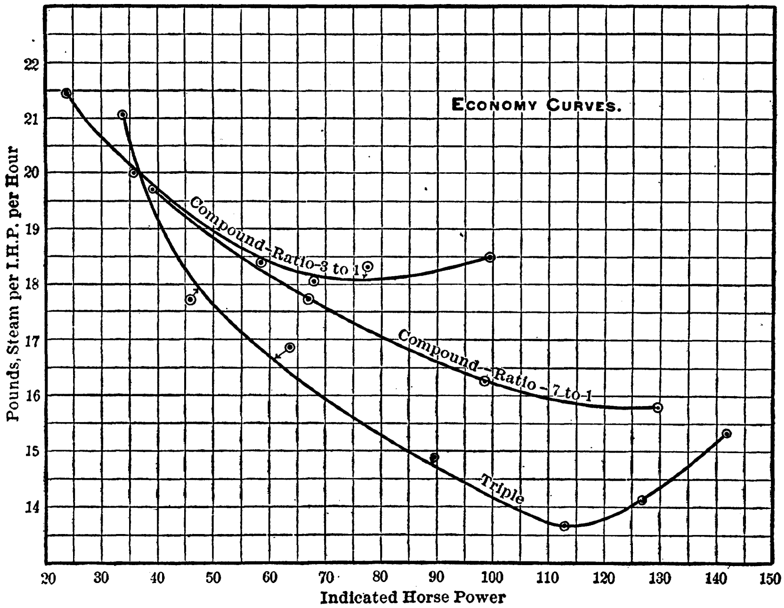
For the triple-expansion engine, $$W = \frac{24}{\log p} \quad (1)$$

For the standard compound, $$W = \frac{27}{\log p} \quad (2)$$

For the special form of compound, $$W = \frac{29}{\log p} \quad (3)$$

"The latter is seen, on examination of its proportions, to be a form of engine designed for an abnormally high total ratio of expansion at the proposed pressure, and assigned an abnormally heavy load; so that when actually in action under its average load it must work with a low ratio of expansion in the high-pressure cylinder, and must exhibit an abnormally large 'drop' at its exhaust."

The outcome of the investigation is that it is concluded that this novel, intermediate form of multiple-cylinder engine is also intermediate in its economical performance



Thurston

EFFICIENCY OF MULTIPLE-CYLINDER ENGINES.

between the standard compound and standard triple-expansion engines, sometimes so closely related to the latter that it becomes a question whether the third cylinder of the more complex machine may not be profitably dispensed with. This question will be answered in the negative or in the affirmative, apparently, accordingly as the costs of fuel are small or large, relatively to the costs of the possibly superfluous cylinder. With variable loads, also, the new type or proportion of engine is found to give indications of possessing some special advantages.

Referring to the principles which must control in any attempt to approximate more closely to the best possible thermodynamic employment of heat-energy, as transformed in the steam-engine, the following are given as the conclusions of the writers of the paper, as the essential guides of the engineer designing economical forms of steam-engine.

The Requisites of Maximum Thermodynamic Efficiency with Constant Load are:

(1) A steam distribution approaching most closely the ideal of Carnot; or, assuming the cycle of Rankine to be that in which the machine is constructed to act, the closest possible approximation to the ideal conditions of distribution for that cycle.

(2) As nearly as practicable, a non-conducting cylinder, or its equivalent, a non-heat-transferring working fluid, insuring, approximately, at least, adiabatic action, so far as heat transfers between working fluid and enclosing walls are concerned.

(3) Maximum possible range of pressure and temperature during expansion.

The Requisites for Maximum *Total* Efficiency are the above, together with:

(4) Minimum friction of engine and heat-losses.

(5) Limitation of the expansion-range by that volume at which the expansion line meets the line, parallel with the back-pressure line, marking the sum of the useless resistance of the machine *plus* that added quantity which is a fraction of the mean effective pressure equal to the ratio of the steam and heat wastes, internally and externally, due extra thermodynamic causes, to the total steam and heat supply.

The Requisites for Maximum *Commercial* Efficiency are, further:

(6) Such an adjustment of the proportions and of the steam-distribution of the engine that any change would cause a larger loss in the dividend account than would be saved by better conditions in the direction in which improvement was sought.

PREHISTORIC QUARTZITE QUARRIES IN CENTRAL EASTERN WYOMING.

In July, 1894, while our scientific expedition was passing through eastern central Wyoming, we came upon some prehistoric quarries, which, owing to their number and extent, are of more than usual scientific interest. They are located some forty or fifty miles north and east of Badger, a station on the Cheyenne and Northern Railroad, one hundred and twenty-five miles north of Cheyenne. There are no roads or trails leading to this discovery, but the old overland trail, following the north side of the North Platte River, passes some four or five miles west of the largest quarries. The drainage from the quarries is to the northward, into Muddy Creek, which flows westward to the Platte River. In the vicinity of the quarries the stream is dry, and water is found running only in the spring and during heavy rains. The country about is very arid, and there is but a scanty supply of both water and vegetation.

Passing through this region from the northeast to the southwest is a very prominent bluff, with precipitous slopes facing