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

the north. The bluff is five or six miles in length, and scattered along nearly its entire distance are the quarries of various sizes and shapes. The bluff has been caused by a fault which brought the Dakota sandstone to the surface. This sandstone has been metamorphosed into a great variety of quartzites. In color they shade from white to nearly black, and from a light pink to a dark red. They are very fine grained and work so easily by chipping that a novice can make a very good-looking implement in a few minutes.

In the preliminary examination, which was necessarily very limited, nineteen openings were visited. The nature of the openings varied so much that it has been thought best to classify them as follows: 1. Superficial; work of great surface extent where exposed blocks of quartzite have been dug up. 2. Shallow quarries; which are quite extensive, but have not been worked to a depth of more than two or three feet. 3. Deep quarries; worked to a depth, varying from fifteen to twenty feet or more. 4. Tunnels; but one of this class was seen. 5. Shafts; resembling the modern mining shaft, but not appearing to be very deep. All of the work has been done in a very systematic manner, and does not resemble the ordinary quarries so common in Wyoming, and from which the Indians secured most of the material to manufacture implements. In place of delving here and there, these quarrymen opened a quarry along the outcropping quartzite and worked it into the bluff, or dug a hole deep enough to reach the valued stone. In all the openings they had evidently maintained a clean face to work on. The refuse rock was carried back as by modern quarrymen. In fact, one could easily imagine that these quarries were old modern ones.

The largest quarries are located near the center of the bluff and near a very small spring. A description of the largest of this group will give a general idea of the excavations. It covers several acres of ground which slopes gently to the north and east. The workmen had commenced the excavation on a point, but when operations were suspended the quarry face was several hundred feet wide. The ground that has been worked over is covered with irregular mounds of refuse, which in the majority of cases is grass grown. In exposed places, where the wind has had free access, the refuse heaps are as the quarrymen left them. No fragments of rocks were seen that would make a heavy load for one man to carry. Near the old quarry face, which in most places was entirely obliterated, and where the fragments of rock have not been covered with the drifting sand, there were

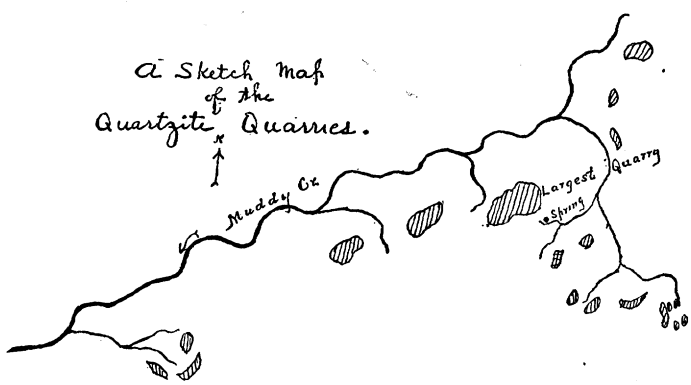

FIG. 1.

numerous circular depressions. These had been made with rock fragments, and were from two to three feet in diameter and from twelve to sixteen inches in depth. Within these depressions were numerous roughly formed implements. These pits were beyond question collecting places for the quarrymen, and the pieces left behind were rejected on account of some defect. Near the old quarry face some enthusiastic prospector has in recent years sunk a shaft, probably in search of gold. This shaft, although partly caved, was nearly twenty feet deep. On one side rock in place could be seen, but the shaft had been sunk in the débris.

The implements found about the quarries were unusually large and rudely made. No finely finished implements of any kind were found. The hammers and mauls were all made from boulders of quartz and granite that had been brought from the neighboring mountains, some twenty miles away. With the exception of the mauls and hammers, all of the implements found were made of quartzite. Spear points, scrapers, axes and anvils were all of the implements found that have been classified. The axes are exceptionally rude, and according to Dr. Wilson, of the Smithsonian, are the first reported from the Rocky Mountains. Some three hundred implements were collected. For some distance about the quarries the ground was strewn with chips and fragments of quartzite, but in no instance were any heaps of chips and refuse, as are usually seen where the implement maker has labored.

There were no signs of any habitation except the tepee rings, which were scattered all around the quarries, in valley and on hill alike. No burial places were found. On the northeast slope, leading from the largest quarry, the workman left a very peculiar figure. It faces the east, and has been made by arranging fragments of rock along the ground. There were circular piles of stone at either end of the figure. (See Fig. 2.)

The most striking points associated with these quarries are as follows: The vast amount of work done, the absence of chip heaps, the rude nature of the implements and their great size. All estimation of the tonnage of rock moved must be left for some future investigation. Suffice it to say that it will be estimated by the hundreds of thousands, if not by millions, of tons. The absence of chip heaps leads one to suppose that the quarrymen carried the quartzite away to manufacture. Which, if true, would signify that these quarries were neutral ground where the aborigines from all quarters worked for the implement stone, and that they took it to their respective haunts to work up. The unusual positions of many of the tepee rings also strengthens this supposition. Quartzite implements made from quartzite resembling that quarried from this region are very common on the plains and in the mountains. The rudeness of the implements can not be explained satisfactorily at this time. It might have been due to the age in which they were made, or it may be possible that only rejected implements have been found. The size is, no doubt, due to the nature of the stone. It would make a large implement, but possibly not a small one.

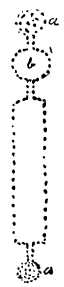

Fig. 2. — *aa*, piles of stones; *b*, circle; length about eighty feet.

The quarrymen must have been the aborigines, but unlike the Indians of modern times, they must have been laborers, and have worked for centuries to have accomplished so much, with the very crude tools that they used. Who they were will never be known. The trails over which they traveled are entirely obliterated, and most of the quarries are covered with drift-

ing sand and overgrown with the scanty vegetation of an arid region.

Central eastern Wyoming is a very noted place for prehistoric quarries, but as a rule they are small and very shallow and are in no way comparable to the recent discovery. Usually the Indians have worked for jasper and agate and have dug irregular openings that do not represent systematic development. Quartzite quarries are extremely rare and these are by far the largest that have been reported from Wyoming.

WILBUR C. KNIGHT.

UNIVERSITY OF WYOMING,
LARAMIE, December 30, 1897.

ASSOCIATION OF AMERICAN ANATOMISTS.

UPON the invitation of Cornell University, the Association met at Ithaca, N. Y., December 28–30, 1897. Morning and afternoon sessions were held on each of the three days excepting Wednesday, when all the affiliated societies met in the afternoon with the American Society of Naturalists. Notwithstanding the small attendance the sessions were fully occupied with reports, papers and discussions, and several papers were read by title for lack of time.

After a brief introductory by the President, Dr. Frank Baker, Dr. B. G. Wilder read an obituary notice of Dr. Harrison Allen, one of the founders and Presidents of the Association. The report of the Secretary-Treasurer, Dr. Lamb, showed that there were 105 active and 4 honorary members. Dr. Allen, and Dr. Wm. Laurence Dana, of Portland, Me., had died and Dr. P. J. McCourt, of New York City, had resigned. Beginning with the present year the annual dues are three dollars.

The circular and blanks in reference to the anatomical peculiarities of the negro race were ordered to be modified and copies sent out for report of cases.

The Association adopted the report of the majority of the Committee on Anatomical Nomenclature, and ordered it to be published and distributed as soon as practicable, accompanied by the objections of the minority of the Committee, and comments thereon by the Secretary of the Committee. Of the neural terms recommended, more than 100 were identical with those adopted in 1895 by the Anatomische Gesellschaft.

The following papers were read and discussed; they were illustrated by specimens, photographs and diagrams:

Dr. P. A. Fish, Ithaca, N. Y.: 'A fluid for the retention of natural colors of anatomical specimens' and 'Mummification of small anatomical specimens.'

Dr. George S. Huntington, New York City: 'Comparative anatomy and embryology as aids to the teaching of human anatomy in the medical course.'

Dr. B. G. Wilder: 'An adult and healthy living cat, lacking the left arm, excepting the scapula and having the heart apparently at the epigastrium.'

Dr. Woods Hutchinson, Buffalo, N. Y.: 'Relative diameters of the human thorax.'

Dr. D. S. Lamb, Washington, D. C.: 'Pre-Columbian syphilis.'

Mr. Charles H. Ward, Rochester, N. Y.: 'A cranio-mandibular index.'

Professor Howard Ayers, University of Missouri: 'The membrana basilaris, membrana tectoria and nerve endings in the human ear.' Read by Dr. Hopkins.

Dr. Wilder: 'Certain resemblances and peculiarities of the human brain.'

Dr. B. B. Stroud, Ithaca, N. Y.: 'The ape cerebellum.'

Dr. Fish: 'The brain of the fur-seal, *Callorhinus ursinus*.'

Dr. Huntington: 'The eparterial bronchial system of mammalia.'

Dr. J. A. Blake, New York City: 'The relation of the bronchi to the thoracic wall.'

Dr. Thomas Dwight, Boston, Mass.: 'The distribution of the superior mesenteric artery.' Read by Dr. Lamb.

Dr. D. W. Montgomery, University of California, San Francisco: 'Sebaceous glands in the mucous membrane of the mouth.' Read by Dr. Lamb.

Dr. Stroud: 'Notes on the appendix.'

Professor S. H. Gage, Ithaca, N. Y.: 'On the relation of the ureters in the cat to the great veins, with variations.'

Dr. Wilder: 'A number of specimens of either unusual or specially instructive character.'