

In determining the temperatures, the Callendar platinum instrument was employed; but a peculiar and ingenious special construction was adopted to secure safety of the instrument against injury by the action of the charge. Among other interesting determinations made with this thermometer, were the temperatures of the charge at various distances from the cylinder-wall. It was found that the charge was distinctly hotter at the core than adjacent to the metallic surface of the cylinder, the difference ranging from one to two hundred degrees centigrade.

The gas used required 5.49 volumes of air for combustion and produced 0.5672 volumes of CO and 1.257 volumes of steam. After combustion the volume is, total dry, 4,996. The weights were, gas, per meter, 0.6; air, 1.29. Heating values were 553 B. T. U. per cubic foot, 4,850 cal. per cubic meter.

The engine was six inches by twelve and ran at about 200 revolutions per minute and at from 90 to 100 per cent. of its rated power; usually at about 95. The compression in Series I. ranged up to from 200° C. to 300° C., and the index of the compression-curve, $pv^n = C$, from 1.28 to 1.445; its maximum being found at 311° C.; but the irregularities of the figure are too great to reveal any law. Probably 1.33 may be taken as the figure for approximate computations. The expansion-curve value of $n = 1.4$, as an average, or very nearly that, ranging from 1.328 to 1.501. The mechanical efficiency was from 68 to 80 per cent., averaging about 75.

In the final series of trials, with compression ranging from 327° C. to 452° C. as maxima, the index of the expansion-curve was about 1.3, varying from 1.2 with an exhaust temperature of 637° C. to 1.344 with a temperature of exhaust of 862° C. The compression-curve was less variable; the index averaged very nearly 1.35. The mechanical efficiency varied from 0.64 to 0.83, and the thermal efficiency from 18.1 to 22.7 per cent.

The employment of compression produced, on the whole, an increasing total efficiency with increasing terminal pressure, though reducing mechanical while augmenting thermodynamic efficiency. From 13 to 16 per cent.

of the heat-supply appeared as useful work outside the machine. The gas used ranged from an average of 24.6 cu. ft. per I.H.P. per hour to 19.7, and from 34.9 per B.H.P. to 28.5. The jacket carried away about 30 per cent. of the heat developed, the exhaust about 45 per cent. and radiation about 3. The heat-balance for the most efficient case was

$$\begin{array}{rcccccc} \text{I.H.P.} & \text{Jack.} & \text{Exh.} & \text{Rad.} & \text{Loss.} & \text{Total.} \\ 23.1 & + 30 & + 42.6 & + 3 & + 1.3 & = 100. \end{array}$$

R. H. THURSTON.

THE NEW STAR IN PERSEUS.

PROFESSOR W. W. CAMPBELL, director of the Lick Observatory has issued the following bulletin:

A discovery of extraordinary interest to astronomers has just been made by Professor Perrine in reference to the new star in the constellation Perseus. This star appeared suddenly and unexpectedly last February, having been discovered by Anderson in Edinburgh. In some four days its brightness increased from invisibility in ordinary telescopes until it became the brightest star in the northern sky. All available astronomical resources throughout the world were immediately devoted to the investigation of this remarkable object.

Many interesting facts concerning it have been brought to light. To mention only a few, its brightness diminished irregularly from that of the most prominent star in the northern sky in February until in June it was on the limit of visibility for trained and sensitive eyesights, where it has since remained. The star's atmosphere was violently disturbed, as shown by a study of its spectrum in the spring months and since June, at least, the spectroscope has shown that it is now a nebula, though retaining to the eye and in the telescope the point-like form of an ordinary star. The disturbance that gave rise to the new star was sufficiently violent to convert it from a dark invisible body into a gaseous nebula.

In August Professor Max Wolf, of Heidelberg, Germany, secured a four-hour exposure photograph of the region of the sky containing the new star. His negative showed the existence of some extremely faint nebulous patches

about five minutes of arc south of the star, but with no evidence of any relationship between the nebulous clouds and the star.

On September 20 Ritchey at the Yerkes Observatory photographed the same region with a more efficient instrument and found that the nebulous cloud was very nearly circular, some ten minutes of arc in diameter, but of varying intensity in its different parts with the new star situated near the middle of the nebulosity.

A recent photograph, secured by Professor Perrine with the Crossley reflector, recorded the principal features of the nebulous cloud. He compared his photograph with the Yerkes photograph of the same object and made the interesting discovery that the brightest portion of the nebula, at least, and perhaps the whole nebula, had moved to the southeast more than one minute of arc in the past six weeks.

This observation is in every respect unique. Motion on this enormous scale or one fiftieth part of this scale has never been observed for any celestial body outside the solar system, and it is morally certain that the observed phenomenon is closely related to the violent disturbances which gave birth to the new star. It is perhaps as wonderful and important as any fact yet determined in connection with new stars.

THE U. S. NAVAL OBSERVATORY.

IN his annual report to the President, Hon. John D. Long, Secretary of the Navy, indorses the recommendation of the board of visitors to the Naval Observatory, that a civilian astronomer be placed at the head of that institution. Mr. Long says:

"Attention is called to the first and very important report of the board of visitors to the Naval Observatory. I earnestly commend its recommendations to careful consideration. This board was created by act of Congress in March last. I believe its visitations will be found valuable in making the observatory efficient and in rank with the best institutions of the land. It appears that no other observatory in the world has the expenditure of so much money, but also that its results are not commensurate with those of some other observatories the expenditures of which are less. Its

head should of course be the best astronomer' who has proper administrative qualifications, that can be found in the country. It is especially desirable that he should have continuity of tenure, and the observatory has undoubtedly suffered from frequent changes in its superintendents.

"While the average term of service of superintendents at Greenwich has been twenty-eight years and at Harvard fifteen, at the Naval Observatory it has been only a little over three. I urgently recommend that the legislation of the last Congress to the effect 'that the superintendent of the Naval Observatory shall be, until further legislation by Congress, a line officer of the navy of a rank not below that of captain,' be repealed, and that on the contrary it be enacted that there shall be no limitation upon the field from which the superintendent is to be selected. As well might the above-quoted statute have provided that the Commissioner of Fish and Fisheries should be selected from the line of the Marine Corps, or the Director of the Geological Survey from the line of the army.

"There is no vital relation between the navy and the observatory. It may happen that some naval officer is preeminently qualified for such a place, in which case he would be appointed to it, but the country is entitled to have unlimited range of selection. The present limitation, which shuts out the whole body of civilian astronomers and even any astronomer in the navy who does not happen to be in the line, or, if in the line, below the rank of captain, is peculiar. Only a very small proportion of naval officers are not below the rank of captain, and as most of them are required for naval services—a requirement which is now increasing—the list from which selection can be made is a noticeably small one. It is evident, too, from the wording of the above quotation from the statute, that Congress in passing it had in mind further legislation in this respect."

SCIENTIFIC NOTES AND NEWS.

THE Council of the American Association for the Advancement of Science will meet at the Quadrangle Club, adjoining the grounds of the University of Chicago, on the afternoon of Wednesday, January 1. Section H, Anthro-