CLEARNESS OF THE ATMOSPHERE IN ARIZONA.

The early astronomers of Persia were of course unacquainted with the telescope, and are credited with sharp vision and great persistence in the accumulation of astronomical observations. It is popularly supposed that their observations were greatly facilitated by the purity of the atmosphere in that part of the globe. The observations made at Mr. Lowell's fine astronomical observatory at Flagstaff, Ariz., have, during recent years, established the fact that no region of the globe can offer a clearer atmosphere for the observation of the stars than is to be found in that Territory. An independent confirmation of this fact is found in an observation noted in the March report of the Arizona section. Mr. G. O. Scott, voluntary observer at Tonto, in Gila County, notes that on the morning of the 7th he observed a star before sunrise, closer to the moon "than any I have seen in years." Dr. W. E. Day, voluntary observer at Prescott, Yavapai County, northwest of Tonto, noted "a star traveling along with the moon all day, plainly visible until 2 p. m. of the 8th."

The bright star seen by these two observers was undoubtedly the planet Venus. At noon on the 8th on the one hundred and twentieth meridian, or 8 p. m., Greenwich time, the moon was in right ascension 21h. 2m., and in declination S. 13° 37′. At the same time the planet Venus was in right ascension 20 h. 19m., and declination S. 18° 10′; therefore at this time Venus would appear about 5° to the north, and 10° west of the moon. It usually requires a combination of favorable circumstances to see the brighter planets with the naked eye in the daytime, but we understand that these observers in Arizona detected the planet without any special effort.

LIQUID AIR AS A SOURCE OF POWER.

During the past few weeks the Editor has received many inquiries as to the possibility of doing wonderful things with liquid air. Erroneous ideas as to the properties of liquid air seem to be rapidly spreading through the country by the dissemination of hasty conclusions emanating from those who are fond of dwelling upon the marvellous. Science is no fuller of marvels than nature herself, but neither of these deals in impossibilities. There is no doubt but that air which has been cooled and compressed until it is liquified (by methods that have been explained and practised frequently during the past twenty years by such men as Pictet, Cailletet, Wroblenski, Olzeffski, Dewar, Fleming, Linde, and Ramsay, and which methods can easily be put into operation on a commercial scale) must when it is warmed and evaporated reproduce an immense pressure that can be utilized to drive engines as we do the steam in the ordinary boiler. Water expanding into steam at ordinary atmospheric pressure and temperature increases its volume by about 1,700 times. Liquid air expanding under the same conditions will occupy 800 times its volume. If this expansive power is converted into mechanical energy, the gallon of liquid air will do about 1,500,000 foot pounds of work. If this work is accomplished in one hour, it will represent about 25,000 foot pounds per minute, and is, therefore, equivalent to about three-fourths of a horsepower working continuously for an hour.

But it has been argued that liquid air being so cold is warmed up by the radiation of heat into it from all surrounding objects, and, therefore, we shall not need to burn expensive fuel in order to convert it into gas. While this may be true, yet it is also true that the surrounding heat will penetrate the liquid air so slowly and evaporation will take so long a time that the process would become exceedingly wasteful. A steam engine of 10-horsepower is of little use in ordinary work unless it can be brought into a state of full efficiency within an hour after lighting the fire and be kept in that state of efficiency continuously. The liquid air engine that draws upon surrounding objects for its heat would be the feeblest imaginable machine. A 10-horsepower engine is useless if you give it no hot steam; its usefulness increases in proportion as hot steam can be rapidly supplied to the cylinder in order to produce a quick succession of powerful strokes. A horsepower is an expression that involves two ideas, viz, the raising of 33,000 pounds one foot and the doing of this in one minute. The power diminishes both in proportion as the work that is done is less and in proportion as the time required is greater.

With regard to the expense, it may be stated that at the present time the cost of manufacturing liquid air is said to be 20 cents a gallon and the advocates of the liquid air motor propose to expend nothing for fuel since they would draw their heat from nature. On the other hand, the advocates of the steam engine get their water from nature for nothing and have to pay about one cent for the fuel and expenses. Even if they paid four cents for the necessary fuel, still the liquid air machine would be five times as expensive. The principal manufacturer of liquid air on a commercial scale, viz, Mr. Tripler, of New York, states that he requires a 50-horsepower engine in full activity for a day (presumably ten hours) to make 50 gallons of liquid air. This is at the rate of one gallon per 10-horsepower per hour. There is, of course, a great deal of power lost by friction and leakage, which waste may amount to 25 or 50 per cent, or even more, of the power employed.

Now let this gallon be put into the boiler of a liquid air motor and made to do work. If we supply heat to it as rapidly as was done by the fire of the original steam engine, it will expand rapidly and can be made to do such work, for instance, as the manufacture of more liquid air. The gallon of liquid will, of course, be rapidly evaporated in its little boiler and soon be entirely consumed; let the heat be so regulated that it shall last just one hour; at the end of that hour we shall find that the original gallon of liquid air has been instrumental in developing about three-fourths of a horsepower per hour, in accordance with the law of mechanics as above stated. This can manufacture only three-fortieths of a gallon of liquid air, since in Mr. Tripler's most efficient machine 10-horsepower per hour can only make one gallon per hour.

If we suppose the gallon of original liquid air in its little boiler to be heated, not by expensive coal, but by the cheaper heat conducted and radiated from all surrounding objects, this would be a slow process; it may take several hours for the evaporation to be completed, and we should, therefore, be subject to a greater loss from friction and leakage, and at the end of several hours should have even less liquid air to show for our mistaken effort at economy. In this case the time required is so much greater than one hour that it wholly destroys the efficiency of the machine.

A fuller exposition of liquid air fallacies is given in the Scientific American by Prof. Henry Morton, President of the Stevens Institute at Hoboken.

It may be worth while calling attention to the fact that similar argumentation holds good in reference to the so-called solar motors. It is perfectly possible to boil water in a closed vessel at the focus of a great mirror or lens by means of the concentrated solar rays and work may be done by the steam thus generated, but the inflow of heat is not sufficiently rapid to give these solar machines much value as compared with the steam engine or even the windmill. In fact, the windmill is an efficient form of the solar machine. In this case the whole atmosphere represents the steam, and the earth's surface represents the lower side of a boiler, while the windmill works like the cylinder and piston placed inside of the boiler. In the MONTHLY WEATHER REVIEW for April, 1895, p. 131, the Editor called attention to the propriety, and even