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 the necessity, of establishing a governmental bureau for investigating and reporting upon the efficiency of the machines and tools that are used by the farmers. The need of such an institution is now felt all the more as a safeguard against imposition in connection with these proposed new motors and new methods of manufacturing power out of nothing.

DUST WHIRLS AND FAIRY DANCES.

Mr. O. C. Pepoon, of Medicine Lodge, Barber County, Kans., sends the following description of a dust whirl observed at that place in the summer of 1897:

In the summer of 1897, the exact date is forgotten, at about 3 p. m., I noticed a whirlwind moving from the northwest to the southeast. It was in every way similar to an ordinary whirlwind, including the straight wind which accompanied it, except that instead of one circular wind five small whirlwinds whirled around a common centre. Each whirlwind resembled an ordinary whirlwind in form and velocity. They whirled on their individual axes, also on their common axis to the right. The whirlwinds were about 15 feet high.

The day was clear, warm, and still, with occasional gusts, from different directions generally westerly. The whirlwind was first seen at the northwest corner of a field of last year's stubble, at the north end of an 8-foot osage orange hedge, running south.

The whirlwind ran a few rods and vanished.

The diagram accompanying this article by Mr. Pepoon shows that the system of little whirls revolving about a common center was formed on the leeward side of the hedge to which he refers. These whirls were undoubtedly due in part to the presence of the hedge, since similar whirls are encountered in the rear of every obstacle. But they were also due in part to the hot, dry surface of the ground, since every small mass of air that is heated hotter than its neighbor rises and carries the lightest dust with it. Pictures of similar and many other forms of dust whirls are given in the volume of plates accompanying the work on Whirlwinds and Duststorms of India by P. F. H. Baddeley, London, 1860. He gives diagrams showing several dust whirls rushing along one after the other until finally all combine into one large whirl; or again, a group of thirty or forty whirls forming a continuous series like the front of an advancing squad of soldiers, or even circling around a central region like the outside boundary of a tornado. His diagrams suggest that in some cases a circle of dust storms, representing ascending whirls, incloses an area in which the air is descending, but this may be a hypothesis of the author and not the result of actual observation. Baddeley was a very enthusiastic student of the subject, and followed these whirls on horseback or in a buggy, note book and pencil in hand, noting and sketching as he went along. He attributes to electrical action the phenomenon that we believe can easily be explained without electricity as being due simply to the wind and the heat. He says that:

Dust whirlwinds are common in all parts of India, especially during the dry season. Sometimes a slender lofty cylindrical pillar of dust is seen revolving on its axis, or several such pillars moving on together in the same direction, or revolving in a circle, or as a dense cloud of dust sweeping over the country like a tornado, the cloud of dust occasionally presenting to the view a distinctly columnar structure. In northern India the smaller whirlwinds appear in dry, windy weather. They occur with singular regularity during the middle of the day. Sometimes a slowly-moving whirlwind instead of appearing as a simple column is found to be composed of several distinct vortices, each one rotating on its axis as it revolves around in the whirling circle. Each separate vortex has attached to it a fan-shaped train of dust.

This remarkable sight gives the idea of a fairy dance round a ring, and the motions are, from all accounts, exactly imitated by the dancing Dervishes of Turkey, one of their holy exercises being to whirl round and round like a top, singly, or in company with several others, performing at the same time a gyration round in a circle, as if their dance originated in the very phenomenon now described. We may sometimes watch this motion for a length of time without changing our position more than a few yards.

Mr. Baddeley says that—

The essential portion of the whirlwind always appeared to him as a lofty cylindrical pillar preserving apparently the same diameter throughout its entire height for thousands of feet. A dust storm or tornado is occasioned by an accumulation of whirlwind columns moving en masse or in rapid succession over the earth's surface in a direct or wavy line. Thousands of these spiral columns pass by in one direction during six or seven hours of the hottest portion of the day, and on other days repass in another direction as if a host was mustering for battle.

Among the numerous details given by Baddeley, we quote the curious fact stated by him:

Birds, such as kites and vultures, are often seen soaring high up just above and around these dust whirlwinds, following them for some distance, soaring about and around them, diving at each other as if in sport, keeping pace with them, seemingly with no other purpose than that of enjoyment.

The reader will find a very interesting description of mechanical methods of forming whirling columns of air with the attending dust whirls and waterspouts in a French work on Tourbillons, by Weyher. The method adopted by him consists in placing a wheel or fan at some distance above a basin of water or table covered with dust. The rapid horizontal rotation of the fan sets all the air of the room in motion, producing a spiral ascending whirl over the table, having a crude resemblance to a dust whirl, waterspout, or tornado.

Much more natural imitations of the atmospheric dust whirls have been made and described by Vettin in the Annalen für Physik und Chemie for 1856 and 1857. Experiments of this kind have lately been carried out quite perfectly by one of America's most skillful experimentalists, Prof. R. W. Wood, of Madison, Wis. (See an article by him entitled Some Experiments on Artificial Mirages and Tornadoes, L. E. D. Phil. Mag., April, 1899, Vol. XLVII, p. 349.) Professor Wood uses flat metal plates about a yard long and a foot wide covered with a little sand. By heating the plates the air above the sand becomes warmed and produces mirage effects; but when heated still hotter most beautiful little whirlwinds of rising hot air can be seen running about over the surface and carrying up the fine silica powder that is scattered upon the plate. When sal ammoniac is used instead of silica, dense clouds of white vapor immediately arise, and he has observed a most perfect miniature tornado of dense smoke about two yards high.

The preceding notes suffice to show how eddies and whirls of dust are formed on the hot plains of Kansas. It seems natural to infer that special combinations of winds and temperature may give rise to the large whirls or waterspouts and tornadoes, but we think it more likely that the latter have an analogous but slightly different origin. The solar rays that heat the ground on a clear day have an effect analogous to that of those rays that are stopped by the clouds in ordinary weather. In the formation of a waterspout, it is quite common to see its slender axis form at the base of a cloud and descend toward the sea level. This has been properly explained by Ferrel, who showed that the velocity of gyration can easily be very much greater high above the earth's surface than lower down, and that the cloud that is formed in the region of low pressure along the axis of the whirl must begin at the upper end of the waterspout and grow downward. The whirls in both waterspouts and tornadoes are, therefore, explained mechanically as originating in the clouds and extending downward, under favorable conditions, to the earth's surface. It is only the small dust whirls that originate at the earth's surface and only in rare cases do these extend upward to the clouds.

MONTHLY CHARTS FOR THE WEST INDIES.

We are pleased to be able to present in the accompanying charts, XII and XIII, a first attempt to draw monthly iso-