raised; therefore, it would be necessary, as a very first step in any process of liquefying air, to remove this heat of compression, and this is exactly what is done by Mr. Tripler, or anybody else who carries on a process of producing liquid air. By means of appropriate condensers, the air, as it is being compressed, is cooled so that when it reaches the final pressure, which is 2,500 pounds to the square inch, it is at the temperature of the surrounding air, or rather of the water used as a cooling material.

It should be noticed at this point that in so removing the heat from the air, said air has been deprived of a considerable amount of the energy transferred to it from the expansion of the liquid air in the cylinder, *A*. In other words, this first action or step of cooling has thrown away or removed from the apparatus a portion of the energy developed in it. If we could compress the air and retain the heat in it with no loss, then we might expect to recover from said compressed air so heated an amount of energy equal to that which had been used in compressing it; but if we have cooled the air, we have removed heat from it (which may be measured by the amount of water used and the temperature added to said water), we have taken away a portion of its contained energy and its power of doing work.

In several points where this matter is referred to by the author of this pamphlet, he seems to have made the strange mistake of transferring what we might call a debit item to the credit side of an account, and estimated as a gain what is in fact a loss.

Now, then, let us assume that by vaporizing air in the cylinder, *A*, or by any other means, we have developed energy which has been applied to compressing air in the cylinder, *B*, and that we have removed or thrown away a portion of that energy by cooling the compressed air down to an atmospheric or water temperature; what more must we do to obtain any liquid air? This is not hard to answer, because we need only to refer to what is done by Mr. Tripler, Mr. Linde, or anyone else who is carrying on substantially the same process; that is, we allow the highly compressed and cooled air to escape under certain conditions, whereby its expansion in so escaping reduces its temperature and finally brings it to a point at which a portion of the air becomes liquid. It is obvious, however, that in so doing we must throw away or allow to escape a very large proportion of the compressed air, which as far as it went represented what was left of the energy developed by the expansion of the liquid air in the cylinder, *A*.

As a matter of fact, from data which I know to be reliable, in the apparatus used by Mr. Tripler, the amount of air obtained in the form of a liquid represents only about one-twentieth of the compressed air which he allows to escape or expand at this point of the operation. According to certain publications by Linde, in Germany, it would appear that he has done about the same thing, and gets about one-twentieth of the compressed air in the form of liquid air. Either of these figures, however, shows the perfect absurdity of the statement which I have quoted from the note, since it makes it obvious that only a very small fraction of the liquid air used in developing energy by expansion in the cylinder, *A*, is recovered or reproduced or could be recovered or reproduced from the compressed air in the cylinder, *B*, even with the aid of sufficient cooling water to abstract all the heat of compression.

If this state of affairs is clearly understood, as I think it may be by anyone reading the above remarks, the utter fallacy of pretty much all that is stated in this pamphlet will be manifest. Thus, on page 6 of this pamphlet, we find as follows:

> "However, there is an outside force mentioned casually by Tripler in all his statements, but which is not dwelt upon by either him or the 'scientists' as being capable of furnishing the looked-for surplus. It is the water used to cool the air heated by compression in his condenser.'

As I have above shown, however, the water used to cool the air, so far from increasing the amount of energy present in the air which is to be liquefied in consequence of the work expended upon it by the compressing agent, is simply a means of removing and wasting such energy, and therefore obviously is as far as possible from accounting for any such imaginary "surplus"; or, in other words, there would be a great deal more energy or capacity for doing work in compressed air if the cooling water was not applied and such compressed air was used in its heated condition.

It would be tedious and I think quite useless, after what I have said, to quote and further point out the fallacy of succeeding statements in this pamphlet in which this same idea is developed in various forms. The fallacy is obvious at once to anyone realizing what is the actual or true condition existing when air is compressed by the application of force and what conditions must exist before any liquid air can be produced.

In my article on the liquid air fallacy, published in your issue of April 22, 1899, I pointed out what were the true conditions as regards the possible utilization of atmospheric heat in the production of motive power or the doing of work, and I there draw attention to the fact that for such utilization it was necessary, not only to have a certain temperature in the air, but a notably lower temperature in an abundant supply of water, and that the amount of energy derivable was measured simply by the amount of heat transferred from the air to the water. In that case I confined my attention to the calculation of the amount of air at a temperature of say 70°, which must be supplied to the imagined machine if an unlimited supply of water at 50° was also available, and the result so obtained showed the impracticability of such a method so fully that it seemed unnecessary to take any account of the quantity and cost of water. If, however, we choose to consider this, it is easy to calculate, accepting the data given in this pamphlet, what amount of water would be needed, and from such calculation we find that this amount would be very large, so that if the water cost anything, which as a matter of fact it invariably does, it would be a serious element in the expense of a process and would make such process still more impracticable than it is shown to be by the mere consideration of the amount of warm air required.

I refer to this only as showing that in my original article there was no oversight or failure to appreciate the true action of cooling water as an absolutely essential element in any plan or process for the obtaining of power from atmospheric temperature. I also pointed out in that article that if we expected to get power free from nature the cooling effect of the water as well as the heating effect of the atmosphere must be obtained as a free gift, and that if the cold or cooling effect was in any sense manufactured, or if a greater degree of coldness or lowering of temperature beyond that which nature would supply in a stream of cold water was introduced as an element in the problem, then the cost of producing such additional low temperature or cold would be fully equal, and as a matter of experience in the case of liquid air, enormously in excess of any power which could be had by reason of its use. In other words, that if it was too costly to operate the machine between the limits of the temperature supplied, let us say atmospheric air at 70° and cooling water at 50°, this cost would be vastly greater if we attempted to operate a machine by employing the temperature of the atmosphere as a source of heat and liquid air or any other artificially cooled substance as the cooling agent. It would be then, as I said, exactly analogous to an attempt to add to the efficiency of a head of water by digging a well into which we could run the escaping water but out of which we should be obliged to pump such escaping water in order to keep the well empty and thus avail ourselves of the head or extra pressure developed by its depth.

The pamphlet referred to contains in addition a great many less important errors and fallacious arguments, but I think I have gone far enough to show its utter unreliability and to save any of the readers of the SCIENTIFIC AMERICAN from being misled by its extraordinary assertions and unsupported statements.

THE HEAVENS IN JULY.

BY GARRETT P. SERVISS.

There is no time when the stars exercise a greater charm than in midsummer. After a near-by sun has stricken us with his fiercest rays, thousands of distant suns, glimmering through the dark, bring a contrasting sense of coolness and relief. The spirit of romance has always recognized the influence of starlight on a summer night, although psychologists, as such, appear not to have noted it. Yet the spell exists, and millions experience its effects without undertaking to account for them. But there is nothing mysterious in the phenomenon, and the astrologers can derive from it no support for their superstition. It is simply an expression of the innate poetry of humanity. Those lines of Longfellow's,

> "Stars of the summer night,
> Far in yon azure deeps,"

may awaken for the astronomer thoughts different from those that arise in the mind of the unscientific reader, but the impression on both is substantially the same—a half-dreaming consciousness of vastness, sublimity, and superhuman power, set over against a sense of the insignificance of the earth, and mingled with a dim perception of beauty transcending terrestrial standards. Savages and civilized men alike yield to this fascination of the starry heavens, and it is capable of subduing, for a while, the most untamed spirits.

The stars and constellations are most beautiful in the absence of the moon, and this year the opening evenings of July will be free from the presence of that "lesser light" which rules, and sometimes, for the astronomer at least, mars the night.

At 10:30 P. M. on July 1, at 9:30 P. M. on July 15, and at 8:30 P. M. on July 31 the principal attractions of the starlit firmament will be arrayed as here described. Overhead shines the constellation Hercules, recognizable by a quadrilateral figure formed by four of its chief stars, and lying between the beautiful circlet of the Northern Crown on the west and the brilliant Vega, with its two little attendants forming a minute triangle, on the east. Directly north of Hercules is the head of Draco, marked by a conspicuous diamond figure of stars. Below the head of Draco stands the Lesser Bear, Ursa Minor, erect on the end of his long tail which terminates in the Pole Star. West of the Northern Crown is Boötes, the giant huntsman, with his great lone brilliant Arcturus blazing on his garter. North of Boötes appears Ursa Major with the Great Dipper descending, bowl downward, toward the northwestern horizon. The broad constellation of Virgo spreads over the lower part of the western sky, still resplendent with the glory of Jupiter's presence within its borders. Sprawling across the south, and touching the horizon, is Scorpio, the center of the constellation made conspicuous by the fiery red Antares, one of the most remarkable of stars. East of the meridian the sky is spanned from the northern to the southern horizon by the most brilliant portion of the Milky Way. Starting under the Pole Star it passes through the zigzag figure of Cassiopeia's Chair, and higher up, opposite Vega, seems to bear the Northern Cross afloat in its nebulous stream. Next it passes by Aquila and its three notable stars—a bright one between two fainter—and then breaks into alternate deeps and shallows of starry radiance, as it pours downward through Sagittarius and the eastern part of Scorpio to the horizon.

In the constellations named above the owner of a telescope may feast his eyes on innumerable celestial beauties. Take for instance the celebrated Star Cluster in Hercules. The naked eye does not show it, but it can easily be found between the two stars in the quadrilateral before mentioned which lie nearest to the Northern Crown—look about one-third of the way from the northern toward the southern star. A 3-inch telescope will show it; a 5 or 6-inch will reveal it as a wonder.

The northernmost of the two little stars near Vega, called Epsilon Lyræ, is a famous "double-double." An opera glass separates it into two stars; a telescope of 3 inches aperture, or more, divides each of the two again.

A little north of an imaginary line from Arcturus to the brightest star in the Northern Crown is Epsilon Boötis, a beautiful double with contrasted colors. It is a good object for a 3-inch telescope.

The bottom star in the long beam of the Northern Cross, known as Beta Cygni, is a most charming double, the smaller star being bright blue in color. A very small telescope suffices to show it.

Southwest of the last star in the handle of the Great Dipper a lone twinkler of between the second and third magnitudes, Cor Caroli, will be seen. The telescope shows it to be a remarkably fine double, the smaller star having a lilac hue.

Antares is an exceedingly interesting double and can be seen better than last month. A 4-inch telescope will show the little bright green companion of the great red star.

With a low magnifying power sweep the telescope all along the Milky Way from the Northern Cross to the southern horizon; the galactic riches are a perpetual source of astonishment and delight.

THE PLANETS.

Mercury, as an evening star, moves eastward from the sun until July 22, about which time it should be easily seen after sunset. It passes from the constellation Cancer into Leo.

Venus, moving rapidly from Taurus into Gemini and across the latter constellation eastward, is a morning star, fast diminishing in brilliance.

Mars, which passes during the month from Leo into Virgo, is an evening star setting before midnight.

Jupiter, in Virgo, is still conspicuous, although not so favorably placed for observation as in June. On July 2 the shadow of Satellite III. will be on the planet from 9:14 until 10:58 P. M. On July 6 the shadow of Satellite I. will be in transit between 8:42 and 10:54 P. M. On July 7 at 10 h. 1 m. 41 s. P. M. Satellite II. will disappear in eclipse.

Saturn, in Ophiuchus, between Scorpio and Sagittarius, rises before sunset and crosses the meridian, in the middle of the month, about 9 P. M. Accordingly it is well placed for observation. The rings are now opened to about their widest extent, so that the south pole of the planet is hidden behind them while the north pole appears projected against the rings as a background. Titan, the largest satellite, will be west of the planet on July 4; north on July 8; east on July 12; and south on July 16. These dates represent the greatest elongations in each direction.

Uranus remains in Scorpio, and Neptune in Taurus.

THE MOON.

New moon occurs on the afternoon of the 7th; first quarter on the evening of the 15th; full moon on the afternoon of the 22d; and last quarter on the morning of the 29th. The moon is nearest on the 23d, and farthest on the 10th. The lunar conjunctions with the planets occur as follows: Venus July 5, Neptune July 5, Mercury July 9, Mars July 12, Jupiter July 16, Uranus July 18, Saturn July 19. On July 6 about 5 P. M., Venus and Neptune will be in conjunction, less than a degree apart.