55 min. 14 sec. The declination of Vega (marked v) is 38 deg. 41 min. plus; therefore this star is less than ¼ deg. south of the zenith, i. e., almost exactly overhead when it crosses the meridian.

If the observer will turn his back to the pole of the heavens, and look directly south, the celestial sphere will appear to revolve from the east to the west, i. e., from his left toward his right. The highest point of the celestial equator is about 51 deg. above the horizon. Each of the twenty-four hours of right ascension is represented by 15 degrees. The degrees of declination on one side of the equator are marked plus, and those on the other side minus.

Comparing the illustrations in Fig. 3 with the right ascensions and declinations given in the table, it is easy to become familiar with this method of locating a star on the celestial sphere.

If the conditions assumed in Fig. 1 were true, every star would come to the meridian exactly four minutes earlier each day, and four minutes multiplied by 360 $(360 \times 4 \div 60) = 24$ hours.

It is then clear that the sidereal day being shorter by four minutes than the solar day, 361 of the former would be equal to 360 of the latter. But there are actually 366¼ sidereal days to 365¼ solar days. Dividing one by the other, $366.25 \div 365.25 = 1.002738$; and $1.002738 - 1.0 = 0.002738$, the excess of the length of the solar day over that of the sidereal day. Reducing this to minutes and seconds, 0.002738 of a day = 3m. 56.5s. The sidereal day is then three minutes and fifty-six and a half seconds shorter than the solar day.

If the months were of the same length, we should be able to say that the same star crosses the meridian exactly two hours earlier on the same day of each succeeding month.

Fig. 4 is a map of that portion of the heavens which contains the stars whose positions on the celestial sphere are shown in Fig. 3. If the observer will place himself in the position already described, the heavens will appear to move in the direction of the arrow; and during a single night he will be able to identify several bright stars.

The heavy arc ZZ marks the zenith-parallel, and the arc HH the horizon. The distance between the zenith and the horizon (= 90 deg.) may be roughly divided by the eye, and with the aid of the map a conspicuous star may be located.

In observing the stars α Persei (a); α Aurigæ or Capella (c); η Ursae Majoris (s); and α Cygni (x), the observer should face the pole, as these stars cross the meridian a little north of the zenith. The observation of Capella which is very near the zenith will assist very much in identifying a large group of stars, including the magnificent constellation Orion and the Dog Star Sirius (h). Capella crosses the meridian about forty minutes after Aldebaran (b); and these are followed by some of the brightest stars in the heavens. Some knowledge of the positions of these stars makes it a comparatively simple matter to use a star map, and thus to command a fair knowledge of the heavens in detail.

Vega (v) is very near the zenith when it crosses the meridian early in the evening in September. Its right ascension is between XVIII and XIX. It is followed a little over an hour later by Altair (w) which is about a third of the distance between the zenith and the horizon.

Next in order is α Cygni (x) which is a little north of the zenith, and can be seen by facing the pole, and a little over two hours later Fomalhaut (y), less than one-fourth of the distance from the horizon to the zenith, will cross the meridian.

TABLE.

Name.		Right Ascension.		Declination.	
		Hrs.	Min.	Deg.	Min.
α	Persei ....(a)	3	17 +	+ 4ɩ	31 +
α	Tauri or Aldebaran.......(b)	4	30 +	+ 16	19 +
α	Aurigæ or Capella.........(c)	5	9 +	+ 45	54 +
β	Orionis or Rigel ....(d)	5	10	— 8	18
β	Tauri.....................(e)	5	20 +	+ 28	31 +
ε	Orionis...................(f)	5	31 +	— 1	15
α	Orionis or Betelgeuse.....(g)	5	50 +	+ 7	23 +
α	Canis Majoris or Sirius...(h)	6	41	— 16	35
ε	Canis Majoris ....(k)	6	54 +	— 28	50
δ	Canis Majoris. ....(l)	7	4 +	— 26	14
$α^2$	Geminorum or Castor....(m)	7	28 +	+ 32	5 +
α	Canis Min. or Procyon ..(n)	7	34 +	+ 5	27 +
β	Geminorum or Pollux....(p)	7	39 +	+ 28	15 +
α	Leonis or Regulus ....(q)	10	3 +	+ 12	25 +
α	Virginis or Spica..........(r)	13	20 +	— 10	40
η	Ursæ Majoris.............(s)	13	43 +	+ 49	46 +
α	Bootis or Arcturus........(t)	14	11 +	+ 19	40 +
α	Scorpii or Antares........(u)	16	23 +	— 26	13
α	Lyræ or Vega ....(v)	18	33 +	+ 38	41 +
α	Aquilæ or Altair..........(w)	19	46 +	+ 8	37 +
α	Cygni or Deneb...........(x)	20	38 +	+ 44	56 +
α	Pis. Austr. or Fomalhaut..(y)	22	52 +	— 30	7

There are now more than 750 motor omnibuses in London. Eighteen months ago their number was under fifty. No fewer than 184 million passengers are, it is said, now being carried annually.

A HYDRAULIC AIR-COMPRESSING PLANT.

One could scarcely conceive of a more direct method of seizing the power of a stream and coverting it into a more flexible form of energy for distribution to various points of application than that employed at the Victoria mine in the northern part of Michigan. The mine is located near the Ontonagon River, the power of which is converted into compressed air, and with this the machinery and tools of the mine and the mill are operated. However, instead of using turbines, as is ordinarily done, to convert the hydraulic into mechanical power, and then using compressors to transform the mechanical into pneumatic power, in this system the air is compressed directly by the water, and without any intermediate mechanism. The action is similar to that of the aspirator pump, in which, as is well known, a current of water acts by adhesion to exhaust the air from a receptacle. In the present case the reverse takes place, for bubbles of air are taken from the free atmosphere and then trapped in a chamber.

The hydraulic system of compressing air is not new, even as a commercial enterprise. In the SCIENTIFIC AMERICAN of April 8, 1900, we described a plant of this character installed at Magog, Quebec, to furnish power for the Dominion Cotton Mills Company. Several other hydraulic compressors have since been established. However, the plant of the Victoria mine, aside from being one of the largest of its type ever built, possesses a number of very novel features which are most interesting.

A concrete dam has been built across the Ontonagon River, at a point 4,000 feet above the plant, and thence water is conducted through a canal under a head of 71 feet. At the forebay of the canal three shafts have been sunk through solid rock to a large subterranean chamber. These shafts are fitted with intake pipes 5 feet in diameter sealed in with concrete. The chamber is 281.5 feet long, 18 feet wide, and 26 feet high. At the end opposite the intake pipes it terminates in a tunnel 10 feet high and 18 feet wide, communicating with a large shaft 18 x 20 feet in cross section, which leads to the tailrace. The chamber collects the air, which is sucked down by the water pouring down the intake pipes. The air is here held under a compression of 114 pounds gage, due to the difference between the water level in the chamber and the tail-water level. Under normal conditions this difference in level amounts to 271 feet, while the vertical distance from the water level in the chamber to the level at the top of the intake pipes is 343 feet. Hence, the total working head, from intake to tailrace, is 72 feet.

A receiving tank is built over each intake pipe. Within this tank, and mounted on the upper end of each pipe, is an intake head consisting of an annular funnel. The funnel is arranged to telescope over the end of the pipe, and is normally supported on a floating bell or inverted tank, which serves to hold the mouth of the funnel just below the level of the water. Around this funnel, and also supported on the bell, is an annular air tube, which is supplied with air by means of feed pipes extending well above water level. This annular tube is fitted with series of small tubes, which project radially inward into the mouth of the funnel. The tubes are only ⅝ of an inch in diameter, and there are 1,800 of them for each intake head. The water flowing into the funnel over these tubes acts, on the aspirator principle, to draw air from them in bubbles, which are carried to the chamber below. At the bottom of the shaft the intake pipe is somewhat flared, and extends about 15 inches below the normal working level of the water in the chamber. Directly below each pipe is a conical concrete block, as shown in one of the illustrations. The water striking this block is spread out in an annular stream, thus delivering the air bubbles near the surface of the water. During the comparatively slow passage through the chamber, the air bubbles, owing to their buoyancy, rise out of the water and are trapped, because the water level in the chamber is 18 inches above the roof of the outlet tunnel. The water, however, continues out through the tunnel and up the inclined shaft, whence it discharges into the tailrace.

The compression chamber above the normal level of the water therein has a capacity of 80,264 cubic feet. A 24-inch pipe conducts the air to the various pneumatic machinery used in the mine. In order to prevent an excess of compression, a small blow-off pipe is provided, which leads up to the bell that supports the intake head of the central pipe. The lower end of the blow-off pipe is submerged to a depth of a few inches below the normal level of the water in the chamber. When the pressure becomes excessive, the water is depressed, uncovering the mouth of the blow-off, and permitting compressed air to rush up this pipe into the bell. The latter is then buoyed up by the air, lifting the intake head out of the water, and thus preventing further inflow until the compression has been reduced. In addition to the small blow-off, a larger blow-off pipe, 12 inches in diameter, is provided, which leads to the tailrace. The mouth of this blow-off is submerged to a somewhat greater depth than that of the small pipe, and when the water in the chamber is sufficiently depressed, air discharges through the blow-off, carrying with it a quantity of spray, which shoots out like a geyser to heights of from 150 to 700 feet. This artificial geyser presents a most pleasing spectacle, particularly in winter time, when the spray freezes and forms huge icebergs about the discharge nozzle.

When all three of the intake pipes are in operation, a total of 5,000 horse-power is available. However, one intake pipe has been found to furnish all the power necessary for operating the machinery of the mill and mine. With this single intake, while delivering 11,930 cubic feet of air per minute at an absolute pressure of 128 pounds, an efficiency of 82 per cent is shown. A turbine operating with a loss of 10 or 12 per cent may be considered remarkably efficient; but before this mechanical power can be converted into compressed air, a loss of at least 30 per cent more must take place. The remarkable efficiency of the direct hydraulic compression is thus made apparent; but we should also take into calculation the remarkable economy of operation; for the hydraulic compressor contains no machinery which requires attention or is liable to become deranged.

As was stated in our previous article on the hydraulic compressor, one of the chief advantages of this system is the fact that the compression is isothermal. As the bubbles of the air are carried down the intake pipe they are compressed, but the heat of compression is conducted off by the water which surrounds them. In the ordinary systems of compressing air a great deal of difficulty is experienced, owing to the increase of temperature due to the compression, and also owing to the condensation of water vapor which occurs with a fall of temperature, or an increase of pressure, or both. However, the air which is trapped in the rock chamber at the Victoria mine is of a temperature almost as low as that of the water, and is practically free from moisture.

Correspondence.

Gyroscopic Resistance of Motors on Railroad Curves.

To the Editor of the SCIENTIFIC AMERICAN:

One point in the cause of the New York Central wreck which I have not seen mentioned, and which appears to me to be of possible importance, is the gyroscopic action of the motors on the electric locomotives. When one considers how stubbornly a toy gyroscope of only a few ounces weight will resist deflection from its plane of rotation, what must be the stress required to deflect from tangent to curve, at express train speed, the heavy revolving motors of a powerful locomotive? C. H. KENNISON.

Ayer, Mass., March 4, 1907.

[One effect of the gyroscopic action of the rotors and wheels of an electric locomotive would be to resist the angular movement round a curve; but since at express speed it would take from 20 to 30 seconds to turn the locomotive through 90 degrees of a 3-degree curve, this resistance would be insignificant compared to the other resistances encountered.—ED.]

Tornadoes in Kansas.

To the Editor of the SCIENTIFIC AMERICAN:

While in Kansas a few years ago I had a very clear view of a tornado. It was about ten miles distant, passing swiftly over the prairie. It presented the appearance of a long rope about two feet in diameter. It extended from a dark, irregularly-shaped cloud to the earth, and was slightly curved. It was of nearly uniform thickness, and leaned about 35 deg. from a perpendicular toward the cloud. A line drawn from where I stood to the cloud would have made an angle of about 40 deg. with the earth's surface. After this rope-like projection had parted, I noticed in the irregular cloud a perfectly-shaped spiral of silver whiteness. It was shaped like a great auger, and extended from the point where the funnel or rope had been connected with the cloud forward in the direction the cloud was moving. All around it was in wild commotion, but the spiral itself seemed to stand like a great white ribbon coiled auger shape and fixed secure. This spiral, at the time I caught sight of it, was lying in nearly a horizontal position; the forward end being only slightly elevated. I have never met anyone who has seen this spiral in the tornado cloud; but by one who came dangerously near being caught by a passing tornado, I was told that the center of the whirling funnel was as white as milk. From his statement, taken in connection with my own observations, I have formed the opinion that the center of all tornadoes is a perfectly-shaped electrical spiral, and that when in operation it connects the earth with the cloud. It is manifest that such a spiral would give the middle of the tornado funnel a white appearance. But it is not likely that one looking at it in its upright form would detect its spiral form. Indeed, it would have to turn itself in a most favorable position in order to reveal to the eye of the observer its spiral form.

La Porte, Tex., February 26, 1907. W. T. HALL.