simple enough, and yet the men who thought of these things conferred lasting benefits upon the world and received the rewards of inventors.

In *Crandall v. Watters* (20 Blatchf., 97) the patent was for a box loop for carriage tops made of thin metal, from which the loop was struck up. It was used as a substitute for the old leather housing. In sustaining the patent the remarks of Judge Blatchford are so applicable to the case at bar that I quote briefly from the opinion. At page 102 he says:

"Various old devices are introduced. . . . But no article like the plaintiff's, capable of being taken and used for the purposes for which the plaintiff's can be used without alteration and adaptation requiring invention, existed before. Almost all inventions at this day that become the subject of patents are the embodiment and adaptation of mechanical appliances that are old. In that consists the invention. When the thing appears, it is new and useful. No one saw it before. No one produced it before.

"It supplies a need; it is at once adopted; all in the trade desire to make and use it; yet it is said to have been perfectly obvious and not to have been patentable. Where an article exists in a given form and applied to a given use, and is taken in substantially the same form and applied to an analogous use, so as to make a case of merely double use, there is no invention; but it is very rarely that a thing of that kind secures a patent."

There should be a decree for the complainants for an injunction and an account, with costs.

THE ATMOSPHERE OF CAVES.

The largest volume of subterranean atmosphere with which we are acquainted is found in Mammoth Cave, Ky. This cave, or rather system of caves, is very extensive, greatly exceeding the other two notable caverns in our country: the Luray of Virginia and the Wyandott of Southern Indiana. The passageways of Mammoth Cave have a combined length of over 150 miles, and their area covers hundreds of acres. It is estimated that the entire volume of atmosphere thus inclosed exceeds twelve million cubic yards. In this underground world the ordinary atmospheric changes are unknown, summer and winter are unknown, and the heat of the sun never reaches its unbroken night.

Like all our larger caverns, the temperature is alike at all times and seasons. In the summer there is a brisk outward current, having a temperature of 53° to 54°. This current is doubtless fed by certain leakages of air which filter through the sinkholes, which discharge their moisture at certain points in the cave system.

In the winter, there is a current of air setting inward. This is not perceived at a distance of one-fourth of a mile from the entrance. It nevertheless depresses the thermometer a few degrees, and its effect upon the humidity of the air is evident at the distance of three-fourths of a mile.

For the first time hygrometric observations have been carefully made as to this unique body of atmosphere. The dryness of the air has often been noticed, and the resultant niter beds were esteemed a matter of national importance during the war of 1812.

In the "Gothic Gallery," several miles underground, visitors have been wont to deposit their cards, and these cards have remained for years, fresh as new, save where moist finger prints have left behind them the germs of mould. The ground is seemingly dusty, but still the dust, if stirred, will not rise in the air, nor soil a polished shoe. In these portions of the cave, which seemed destitute of moisture, the wet and dry bulbs of the hygrometer showed the same figure, the variations seldom exceeding one-fourth to one-half a degree. The humidity ranged between 96 and saturation. With the thermometer at 54°, the wet bulb would range between 53½ and 54°, and the dew point would be between $53\frac{1}{10}$° and $53\frac{7}{10}$°. The singular fact was noted that the same temperature prevailed at the roof as upon the floor of the cave; and where differences of 200 to 300 feet of elevation occurred, the thermometer would be depressed one or two degrees at the higher as compared with the lower altitude. The humidity would, however, remain a constant quantity. This can be accounted for only on the supposition that the supply of air, slowly admitted from above, is chilled by the absorption of moisture during the first stages of its descent, and becomes slowly warmed before completing its full descent of 300 feet. Mould is rarely seen in the cave, but wherever it occurs, a snowy whiteness and luxuriance of growth are noted.

One avenue of the cave is devoted, with excellent success, to the growth of mushrooms, and no doubt such an atmosphere might have an industrial value for other purposes.

Several consumptives once tried to live, and get well, in the cave. But the result was disastrous. The lack of light was, no doubt, one reason of this; but the hygrometric condition of the air, of which nothing was then known, by greatly retarding healthy perspiration, doubtless hastened the fatal result.

R. NORTON.

DIRECT USE OF STEAM AS MOTIVE POWER OF AEROSTATS.

M. Duponchel, Chief Engineer of *Ponts et Chaussees*, became convinced that the substitution of hydrogen for heated air as the source of ascensional power, while in some respects a progress, had operated to turn aside the new science of aerostation from its natural channel. He believed that the modest Montgolfier balloon of Pilatre de Rozier, carrying with it its own ascensional organ, was nearer to the solution of the problem than the great captive balloon, fresh in the memory of every one. General Meunier, member of the Institute at the beginning of the century, had fully determined the construction of aerostats designed for the transformation of vertical into horizontal motion. For this end he gives the balloon an envelope of fixed shape, with two separate cavities of variable volume, not communicating with each other; but being so constructed that as one expands under any given conditions, the other contracts in exact proportion.

M. Duponchel thinks that he thus will arrive at the solution of the problem of guiding balloons. The school of mechanical solution having only succeeded in constructing toys, and having reached their limit, the study of bird movements must give place to balloon aerostation. To-day, after the results obtained by MM. Tissandier, Renard, and Krebs, the velocity of aerial currents presents the principal difficulty. Upon the surface or under water, a steam vessel capable of reaching a velocity of 19 feet can be master of its movements in the midst of currents never exceeding one-half that velocity; but the aerostat, in the midst of winds whose ordinary velocity is 30 to 40 feet, and which may be as great as 130 or 160 feet in tempests, must be capable of a higher speed if to be used at all times.

M. Duponchel has concluded that a velocity of 60 to 100 feet, enough for all ordinary conditions, could be obtained with a fish-shaped balloon of 700,000 cubic feet capacity, 282 feet long and 70 feet 6 inches high, half filled with hydrogen, and hence having an ascensional force of 26,460 pounds. For velocities of 30, 60, or 100 feet, 60, 480, and 1,620 horse power will be respectively required. It is perfectly evident that no machinery known to us will be available for the production of such power as this in a balloon. But this enormous motive power, though beyond the scope of our machinery, can be obtained from the direct employment of steam as heating agent in a Montgolfier balloon, following in the footsteps of Pilatre de Rozier. Thus, if we inject into a volume of 35,000 cubic feet of hydrogen, contained in the aerostat just described, a quantity of steam sufficient to raise its temperature 78° Fah., its volume is dilated 22 per cent, giving an extra ascensional force of 3,000 pounds, or the equivalent of 700 horse power for one hour. Two systems are described by M. Duponchel. We shall only speak of the first.

An aerial fish of the Meudon model, but with rigid envelope, is the base. Its interior is divided by a flexible membrane into two parts, the upper containing hydrogen gas, that can be more or less expanded by the injection of steam into the lower chamber. Vertical and horizontal fins are used to determine the movements. By shifting ballast the aerostat is inclined and steam is injected, expanding the hydrogen one-fifth of its volume. This causes it to rise and move forward, owing to its inclination. When the gas is cool, the aerostat is brought again into a horizontal position, or inclined the other way, by further shifting of the ballast, and allowed to descend. When near the ground, the ballast is again shifted and the hydrogen heated, so that by a succession of undulations the movement in advance is obtained.

In the case of a balloon of 700,000 cubic feet capacity, the maximum elevation would be 9,800 feet, and the undulations in a distance of seven miles would be gone over in 33 minutes, thus giving a speed of 13½ miles per hour, nearly, with the expenditure of about 350 pounds of coal. This would necessitate renewal of fuel about every 30 miles.—*Abridged from Revue Scientifique.*

PROPULSION FOR OCEAN STEAMERS BY THE STEAM JET.

Having recently in your columns discussed the practicability of the propulsion of boats by using a jet or current of compressed air as our motive agent, the question very naturally occurs, Must we necessarily in this matter limit ourselves to small motors and small boats? If so, the application is somewhat limited, and we fail to take hold of a thing of really general interest.

The plan which I suggested in that article does actually seem restricted in its extension by its own terms.

It involves a reservoir, which is to be filled before starting, and the energy therein stored gives us our limit, and it must, of course, be narrow. A period of a few hours at the furthest is all that we can command. This of itself is certainly of immense practical value; but we will try to look for something better. We need to keep the open sea; we need a power which we can renew incessantly, as we now generate our steam. Can we do it, and still use, in the manner which I have suggested, direct propulsion?

I belive the thing is practicable, and I will try to show it. We may, of course, make use of compressed air for driving our largest ships precisely in the same way as directed by me for the Whitehall boat. It is merely a question of the size of the jet or jets. One-sixth or one-tenth of a horse power, as with the boat, or 1,000 or 5,000 horse power, as with the ocean steamer, what does it matter? If the smallest will do its work, the largest can be equally trusted for its full efficiency. We can certainly employ compressors by means of which the entire power of the steam generated constantly shall be as constantly employed in keeping up a steady pressure in a suitable reservoir, from which the air jet or jets beneath the ship's bottom are supplied, and by which the ship is driven forward, precisely as was the boat. This is surely possible, and if we can drive the boat, we can drive the ship; but this is by no means the plan which it is my object here to propose.

In the double transfer of energy which has been here mentioned, we encounter loss, and it is a loss that seems to me not necessary and not advisable. It is true, we have counteracting advantages which vastly overbalance in their gain the loss which we shall have made, and were there no other way but this, I should be prepared to advocate it most strenuously. We dispense with such an enormous amount of weight in engine and driving machinery, as well as saving the immense space which they now occupy. Our steamers, freed from the huge bulk with which they are now loaded down and lumbered up, would almost double their capacity by the very fact. But, as I stated, the loss by transferring the energy of the steam into that of compressed air I propose to save.

My plan is to propel the ship by jets of *live steam direct from the boiler.* To illustrate and enforce my meaning, I will take a ship of definite size, as I did in the case of the boat. It shall be a steamer which is using in her daily work a constant service of 5,000 horse power. Her boilers supply steam to that extent, and we have it at command. I propose to make no change in them; they go on doing their present work. All that I do is to change the direction of the steam pipe from each boiler. It no longer goes to the cylinder or cylinders. It goes to make its exit as directly as possible by the side of the keel.

This is a mighty change from all present plans. I am prepared to find my views rejected as being entirely unworthy of perhaps even investigation. I am prepared to find them presently adopted in, it may be, modified forms, for I believe that they embody true principles, which will prevail.

My designs in the case of the ship are identical with those which I specified in the case of the boat. The point of exit of the discharge pipe is lateral to the keel; the body of water on which the steam expends its projectile force is, in this instance, three feet in width, the longitudinal confining wall being at that distance from the keel.

In a ship of this size I propose that each jet be matched by one on the opposite side of the keel, and that there be two of these pairs, the first pair being 100 feet from the stem, and the second pair 250 feet. This, then, gives us our system of propulsion. Four pipes of ejection, at the points designated, are pouring forth a torrent each of steam directed backward, and, as before, slightly downward. At each of the orifices the issuing steam exerts constantly a force of 1,250 horse power, for this is what the boilers are steadily supplying. This terrible energy, almost appalling to contemplate, is expended on the open, or rather the confined, water beneath the ship's bottom, and the inevitable result must be a rapid movement of the ship.

No plan can be more simple and compact than this. The theory seems to me without flaw. Its efficiency can be demonstrated only by actual trial. Any one having a steam yawl at command can put the matter to proof with the expenditure of a very few dollars. Without injuring the boat in the slightest, a steam pipe, connected with the boiler, can be passed through her bottom and arranged as specified, and a thorough test made of the *principle*, for, of course, what the yawl will do the ship will do, *mutatis mutandis*, as nearly as yawls and ships work alike in common experience.

The condensation of the steam at the point of impact may be held by some as a source of loss; but, practically, it will be of no moment. The propulsive force of the steam is exerted at the instant of ejection, and not later. The condensation of the steam requires two elements, time and expansion, which are not present.

The advantages to accrue from this mode of *direct propulsion by live steam* are so exceedingly great that I most earnestly hope the trial will speedily be made.

W. O. AYRES.

THE first almanac was printed by George von Purbach in 1640.