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USEFUL RECEIPTS.

To Preserve Beans and Peas.

A new method of keeping the above quite fresh for any length of time, so that they shall lose neither their taste nor original softness, has been lately introduced into notice by A. Albert, of Paris. Take the beans when not much bigger than large peas, and pursue the following directions for both vegetables:

Plunge them for a minute in boiling and afterwards in cold water, and after having washed off the water, spread them out for several hours on canvas frames. Then place them in an oven slightly heated on frames covered with paper, leave them long enough to be of the same warmth as the oven, and then expose the frames to a current of air until the articles are cold. The frames are then to be replaced in the oven and again exposed to the air, these operations being repeated until the beans or peas are perfectly dry, not so as to break, but almost like beans dried naturally. The articles should be gathered and dried on the same day, if not, they should be left during the night in the oven; they should be kept in dry and clean bottles, and to each bottle of beans there should be added a bunch of dry savory. Before using the vegetables they should be steeped for some hours in tepid, or over night in cold water; if they are beans the water is thrown away and they are cooked in the usual manner, but if peas, they are only just covered with the water, which will be entirely absorbed, and they are cooked like green peas. Vegetables prepared in this manner are quite as good as if they had been just gathered.—[Genie Industriel.

Coloring Black.---Scruples about becoming a Subscriber.

I called on an individual, in this place, and advised him to subscribe for the Scientific American, but he had doubts about becoming a subscriber. He said, however, if you could tell him how to color a black on cotton and wool, that is, a cotton white weft, and a woollen white warp, without injuring the cloth, he would then believe you understood your business, and would take your paper. I want to be clearly understood: the cloth is white composed of wool and cotton. The person I speak of is a cloth manufacturer. J. T.

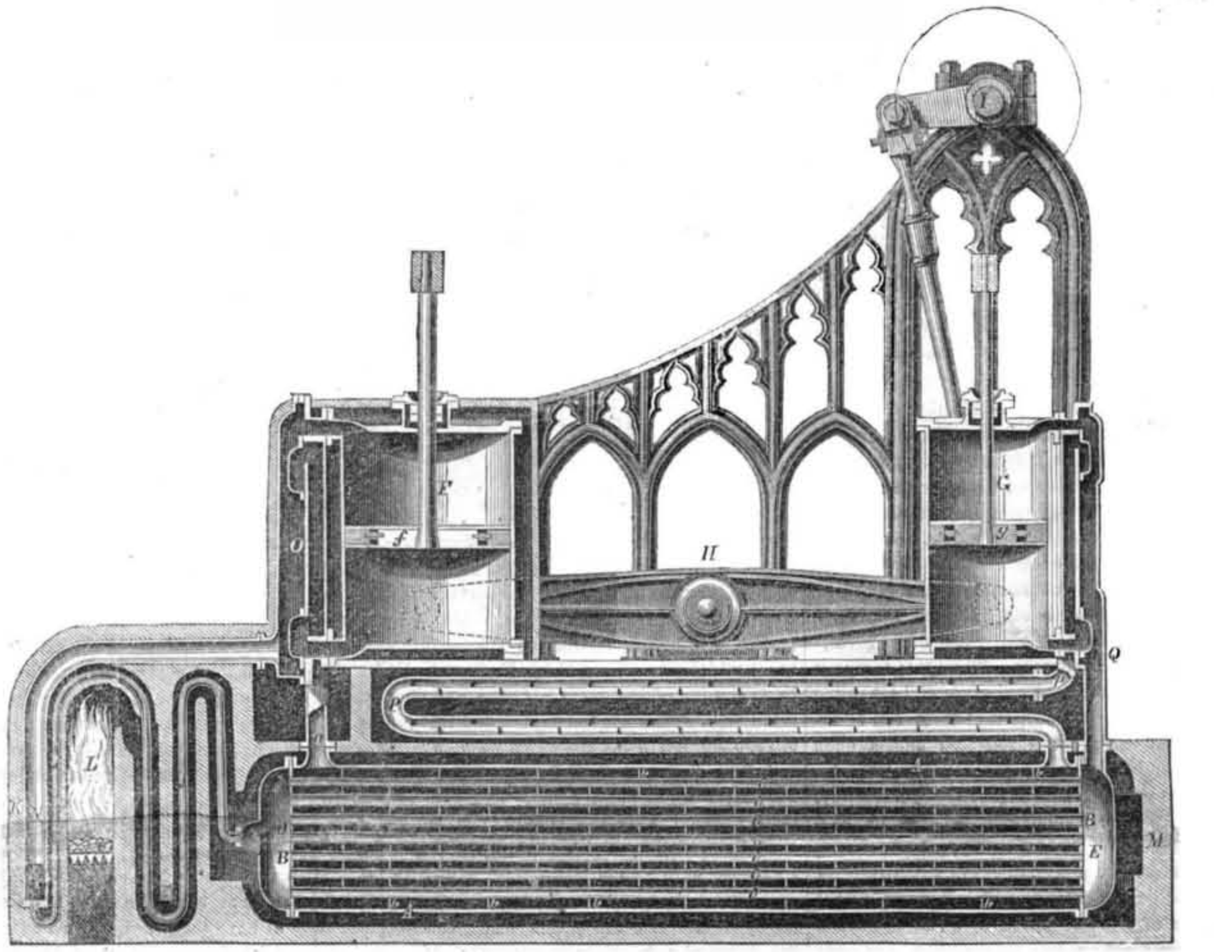
Aiva, Canada West, Jan. 12th, 1853.

[We are not solicitous about the scrupulous gentleman's patronage, but we can do the very thing he wants. We know how to color a piece of white goods, half cotton and half wool, a good black, and not injure the qualit of the goods as much as if it were composed of cotton and wool dyed separately. We can furnish practical receipts for doing this or any other color whatever.

A Golden Fashion.

The latest Paris fashion is powdering the hair with gold dust and filings of silver. This fashion will suit California and Australia; but the expensiveness of the powder is likely to speedily explode the fashion.

ERICSSON'S CALORIC ENGINE.---Figure 1.



We will now present a "History of the Caloric Engine," accompanied with such remarks as our readers expect us to make.

Figure 1 is a longitudinal vertical section of Capt. Ericsson's first Caloric Engine, patented in England in 1833, and described in Sir Richard Phillips' "Arts of Life," published the same year.

"A is the regenerator, consisting of a cylindrical vessel, closed at the ends by the plates, B B; through these plates a number of small tubes, C, pass from end to end, terminating in the caps, D and E, thus forming a free communication between them, but not communicating with the body of the regenerator. A number of division plates, *b*, divide the regenerator into as many chambers, and these are made to communicate with each other, by segments being cut out alternately from the tops and bottoms of the division plates. The tubes, C, are also provided with division plates, or small metallic discs, placed in opposite directions to each other. F is the working cylinder of the engine, called the hot cylinder. G is a smaller cylinder, called the cold cylinder, which receives the air that escapes from the former, and then forces it back again, for every stroke of the piston, thereby keeping up a constant circulation of the impelling medium and promoting a constant transfer of heat. The pistons of the two cylinders are connected by a beam, H, side-rods, and cross-heads, similar to a common marine-engine, and the cylinders are provided with slide-valves, nearly of the common construction, moved by suitable gear from eccentrics fixed on the crank shaft, I.

J is one of a series of pipes inclosed in a stove, K, acted upon by a fire, L, the combustion being supported by ordinary draught, caused to circulate round the regenerator, and passing off from M, into a chimney. The pipe, J, in the stove, all terminate at one end, in the cap, D, and at the other end in the pipe, N, which communicates with the slide-box, O, of the hot cylinder. P represents a cooler, and consists of one or more pipes, exposed to some cooling medium, these being, like the longitudinal pipes in the regenerator, provided with a number of metallic discs.

Previous to describing the action of the engine, let us suppose that the stove with its pipes and the working cylinder, have been brought to some considerable temperature, and likewise the regenerator with its tubes brought to the same temperature nearest to the stove, gradually lessening so as to be, at the opposite end, equal in temperature with the surrounding atmosphere. By examining the positions of the slide-valves, as represented in figure 1, it becomes evident that if air be, by some means, forced or pumped into the caps of the regenerator, such air will on the one hand, find its way through the stove-pipes, &c., into the top-part of the hot cylinder, and on the other hand, through the connecting-pipe, Q, into the top-part of the cold cylinder. Now, since the hot cylinder is larger, say double the size of the cold cylinder, it follows that the power of the piston, *f*, will vanquish the power of the piston, *g*, and make it ascend, at the same time itself descending: thus motion will be produced, and the crank-shaft begin to revolve, and, by reversing the position of the slide-valves, when the pistons have performed their full strokes, that motion will be continued.

By further examining figure 1, it will be seen that the cold cylinder receives its supply of air from the *body* of the regenerator through the cooler, P, and the pipe, *p*, entering under the slide valves, it will also be seen that the hot-air from the hot cylinder escapes under the slide-valves, through the pipe, *n*, into the body of the regenerator,—hence the same air that escapes from the hot cylinder supplies the cold one. In like manner it will be found, by referring to fig. 1, that the air forced from the cold-cylinder into the cap, E, must pass through the pipes of the regenerator, stove-pipes, &c., to supply the hot cylinder.

From what has been already said, the action of the engine, and the transfer of the heat become almost self-evident; it need, therefore only be briefly stated, that the hot-air, in escaping from the hot-cylinder, will, during its passage through the body of the regenerator, give out its heat to the tubes, C, being, by the peculiar arrangement of the division plates, *b*, compelled to ply round those tubes. And the cold air, coming from the cold cylinder, will, in its passage through the tubes, C, naturally take up the heat imparted to them, its particles being kept in a constant state of change by the small metallic discs. A transfer of heat being thus effected, it becomes evident that the office of the cooler will be that of carrying away any heat from the air which has not been taken up in the regenerator, and that the office of the stove will be to give an additional quantity of heat to the circulating air, previous to its entering the hot cylinder, in order to make up for a small deficiency which will always be unavoidable in the transferring process, besides the losses caused by radiation.

The power of the engine will mainly depend on the density of the circulating medium, —accordingly, by having a small pump attached to the engine, the power and pressure may be varied at pleasure. High pressure will, of course, produce the greatest proportionate effect; since the losses, by radiation, will remain the same under whatever pressure.

The trial engine, which has been erected by the inventor, and the action of which has been found in every respect satisfactory, may be fairly estimated at five horse-power; it makes fifty-six revolutions per minute, having a break wheel fixed on the fly-wheel shaft, loaded with upwards of five thousand pounds weight. The working cylinder is fourteen inches in diameter, and the cold cylinder ten and a quarter inches in diameter, both making eighteen inches stroke, working under a pressure of thirty-five pounds to the square inch. The regenerator, in this trial engine, is eight inches and a half in diameter, and seven feet six inches long, containing seven tubes, of two inches diameter each; and its operation is so the Caloric Engine in the Herald; some gentlemen on board also called it "the breathing ship." Mr. Stirling said, on page 565 and 566, London Mechanics' Magazine. "In an early patent (1827, his first,) he had specified the arrangement of the respirator, intending to use a series of *perforated plates or wire gauze.*" This was in print four years before Capt. Ericsson obtained his last patent. We quote fairly, and treat the matter candidly, giving our authorities, so that any person can examine for himself, and see that we set down nothing but truth—truth long known to us, but with which our newspaper editors cannot be supposed to be acquainted,—on that very account they should have been more moderate in their language. So much then for the history of the hot air engine.

We have only to add that it was stated at the aforesaid meeting, that Stirling's hot air engine, of 30 horse power, had been in operation for two and a-half years, driving all the machinery of the Dundee foundry, and that the fuel it consumed was only 2½ lbs. of coal per horse power in an hour.

POWER OF THE ENGINES.—In the Caloric Ship, there are four working cylinders, each having 22,300 square inches of piston area (each single acting) and six feet stroke. The supply cylinders (air feed pumps) have each 14,794 square inches of piston area, and the same length of stroke. The horse-power of the caloric engines is set forth in the following extract from the "New York Herald," which was an answer to a correspondent of the "Brooklyn Eagle," and has been sanctioned by Capt. Ericsson as being correct. "Atmospheric air, enclosed in a tight vessel, and elevated to a temperature of 384 degrees, acquires, it is well know, a pressure of 12 pounds per square inch. This happening to be the working pressure of the engines under consideration, it will be quite easy to test the accuracy of the calculation of the scientific correspondent, by estimating the force of the working piston, and the resistance of the supply piston, each by itself. The latter deducted from the former will obviously exhibit the theoretical power of the engine. Now, each working piston of the Ericsson contains 22,300 square inches, operated upon by heated air of 10·96 pounds, mean pressure—the actual pressure of 12 pounds being reduced by cutting off at three-fourths of the stroke. The mean force of the working piston will thus be $22{,}300 \times 10\ 96 = 244{,}408$ pounds. The active space passed through by the four working pistons being $6 \times 14 \times 4 = 336$ feet per minute, the active power developed will be $244{,}408 \times 336 = 82{,}121{,}128 \div 33\,000 = 246{\cdot}88$ horse power. The supply pistons, each containing 14,794 square inches, in compressing and forcing the cold air into the receivers, operate against a mean resistance of 9·34 pounds per square inch. The contracting force of these pistons will thus be $14{,}794 \times 9{\cdot}34 \times 336 = 46{,}527{,}936 \div 33{,}000 = 1{,}409$ horse-power, which deducted from 2488, leaves 1079 horse-power differential or effective force, losses by friction, &c., being disregarded. Make the liberal allowance of 479 horse-power for such losses, and 600 horse-power remains—a force sufficient to effect far more than the projectors of the Ericsson expect. Some time may yet elapse, it is reasonable to suppose, before the pistons, valves, &c., will be rendered air-tight enough to retain the internal pressure of the machine, which is so essential in bringing out its full power. ENGINEER."

There were many typographical errors in the Herald,"—we have corrected some of them, so as to state the question as fairly, as viewed by those interested in the "Caloric Ship." The above calculation however is not correct and we will endeavor to point out more than one error. We allow the 384° to be above the common temperature of the air, which if it is $40^\circ + 384^\circ = 424^\circ$ it will not have a pressure of 12lbs on the square inch, but 11.731lbs. Air doubles its volume by an increase of its temperature to 491° according to the latest experiments of Regnault and Magnus, not 480° as Capt. Ericsson calculates, therefore when air is heated from 40° to 531° it will exert a pressure of 15lbs on the square inch thus $491^\circ \div 15 = 32{\cdot}733$, therefore $384 \div 32{\cdot}733 = 11{\cdot}731$lbs. pressure on the square inch, not 12lbs.

The horse power of an engine, is equal to the average pressure on the piston in pounds per square inch multiplied into the velocity of the piston per minute, divided by 33,000. The calculation of Engineer, is not therefore correct, for the air feed pump only allows a certain quantity of air every stroke, and no more; it is not like the steam engine, having a reservoir of power in the boiler; for the pressure of the steam is as the quantity, and so it is with hot air. The pressure then of the hot air in the working cylinder, is not 12 lbs. nor 11·731 lbs., but about 7½ lbs. on each square inch. The large cylinder, although it has 22,300 square inches area, surely cannot be filled with more air each stroke than the capacity of the feed cylinder, if it were, it must be fed in by some hidden *extraneous steam engine.* Well as 384° of heat is imparted to the quantity of air fed in by the feed pump, we will have a pressure equal to 11.731 upon each square inch of 14,794 piston area, but even allowing the pressure to the 12lbs. on the square inch, the average pressure on the working cylinder will be $14{,}794 \times 12 \div 22{,}300 = 7.956$ pressure on the square inch of the working piston, it has 312 ft. 670 in. of greater cubic capacity; for as is the difference of capacity in the feed pump and working cylinders, so, is the pressure reduced by the expanding. The power of the engines are as follows: $22{,}350 \times 7.95 \times 54 \div 33{,}000 = 290 \times 4 = 1160$, for the power of the four cylinders. We give 54 ft. per minute as the velocity of the piston, or 9 revolutions of the shaft per minute, as we counted them on the trial trip. Now what power do the engines expend in working the pumps; namely an average pressure of 9.34lbs on the square inch of 14,974 inches area of piston, therefore $14{,}974 \times 9.34 \times 54 \div 33{,}000 = 228.857$ h.-p. $\times 4 = 915.428 - 1160$ h. p. $= 244.572$ or nearly 250 horse power which the engines have to spare to drive the paddle wheels. We make no allowance for the cut off, for the feed is entirely different from the steam engine; it is forced in, and the quantity of air fed in is the only data for calculation along with the heat imparted.

The power required to feed must be very great, for as the molecules of cold air expand while passing through the Regenerator they exert a back pressure in proportion to the heat they imbibe. What then is the value of the Hot Air engine in comparison with the steam engine? It is in its very nature, owing to the element it employs (hot air) very inferior. Its motion must be sluggish for at every stroke, 616 cubic feet of cold air must be heated to 384° and the faster cold air is passed over a heated surface, the slower it takes up heat.

In the steam engine, for every 1728 cubic feet of steam, it only requires one cubic foot of cold water fed into the boiler. The Caloric Engine consumes nearly all the fuel used upon itself; it is not so with the steam engine. It has been stated that the Caloric Engine only consumes 1 lb. of coal per horse-power per hour; its speed was no more than seven miles per hour by the Coast Survey measurement; therefore, to double its speed, it would consume eight times more fuel, as calculated by engineers, this is half a pound more per horse-power than the Arctic uses, which has made 18 miles per hour in smooth water.

It is said to be more safe than the Marine Steam Engine; but when did we ever hear of a *steam ship* using low pressure steam, bursting her boiler. The steam engine is a safe machine, under the charge of good men, and so is a ship without steam or hot air, but not otherwise.

We would welcome hot air, as a superior and more economical motive power to steam, if it really were so, but it is not. The same amount of fuel applied to a boiler to produce steam from water, will produce a greater mechanical effect than if applied to air, which is a very bad conductor, and absorbs heat so slowly that it must always be sluggish in its motion. A steam engine can be built—boilers and all, which will give out triple the power of the Caloric Engines to the main shaft, and occupy less room. The combustion of fuel in the Caloric Ship is very perfect, and deserves credit, but the amount of leakage must be very great every stroke, as a portion of the fed air must always be lost, and it will be very difficult to keep the pistons air-tight. We therefore cannot have any other belief than that the "Caloric Ship Ericsson" will not be successful.

We have used no scoffing language, nor have we such a spirit towards this enterprise.

In speaking of the fuel, we have allowed 6 tons of coal per day for the Ericsson, with 600 horse-power engines. We have nothing to add to the remarks we published on page 141.

Machinery and Tools as they are.---Geared Wheels.

(Continued from page 147.)

No branch of machinery, probably, has received more valuable assistance from mathematical science than that which formerly was known more especially as "Mill-work," but which is now generally designated by the titile that forms the heading of this article. What were the uncouth and almost ludicrous-shaped wheels of the past race of millwrights may be conceived on inspecting the mechanical works of the last century. While the beautiful symmetry of their construction as at present made, is well known to all who are in any way employed about machinery. Not that the machinists of past times were less ingenious than their successors, but they worked mostly at random, unaided by the light of science, whose followers, at that period, spurned for the most part, the researches of any knowledge that could not, strictly, be classed under pure mathematics. A more liberal and enlightened spirit, however, has at length prevailed, and many of the most illustrious disciples of Newton have since, like him, been practical philosophers. More especially with regard to geared wheels have their studies been found of inestimable advantage to mechanics, as all can testify who have heard of Professor Willis, or who have availed themselves of his theory for the construction of toothed wheels. But, as the study of theories is often neglected, and the theory itself sometimes too intricate for the hasty seeker of information, we will here mention that the practical application of the above is to be found in a scale termed the "Odontograph," and which is extensively employed by machinists.

Before entering upon the shape of the teeth, it is worth while to enquire what are the mechanical laws affecting systems of geared wheels, which, if traced to their simple origin, are found in reality to be only a form of the compound lever, and that the conditions of equilibrium are the same. From the fact that the arms of wheels are as levers fixed at one end, and loaded at the other, and that, consequently, the greatest strain is upon that part of the arm next the axle, is derived the mode forming the arms strongest at the axle and tapering towards the rim.

In order that the power applied through the intervention of gearing may be used with the greatest effect, it is necessary that the wheel-work be properly designed and executed, otherwise power is expended to no purpose, and it should be especially noted that the primary object aimed at in the construction of toothed gear is the uniform transmission of the power, supposing that to be constant and equal. This implies that the one wheel ought to conduct the other, as if they simply touched in the plane passing through both their centres,—these considerations will show the importance of a right form of tooth for the wheels. Of the various methods which have been employed to determine the forms of teeth, that which is termed the epicycloidal curve, has been an especial favorite. This shape is produced by rolling a circle equal in diameter to the radius of the pinion upon another circle equal in diameter to the radius of the wheel, the diameters being taken at the pitch lines, which are the circles described by the wheel and pinion at their point of contact, the curves so struck, commencing at the pitch lines, form the points of the teeth. They are struck in opposite directions, the space between their starting points being the thickness of the tooth; and from these two points radial lines are drawn to the centres of the wheel and pinion, which forms the sides of the teeth included between them, within the pitch line. This form, it will be observed, made the tooth smallest at the root by the convergence of the radial lines, and consequently tended to weaken it; this was remedied in the pinion by casting a plate upon the teeth, which, forming part of them, served not only to bind, as it were, all the teeth together, but to strengthen the body of the pinion, perforated and weakened by the axle passing through it. "The roots of the teeth" upon the wheel were strengthened by small angle pieces, for which space was found without the curved line described by the teeth of the pinion. Such teeth worked freely and equably together. But it will be observed that the side of each tooth of the wheel consisted partly of a radial line, partly of an epicycloidal curve, and partly of such a concave angle piece as might be found to clear the pinion: and it will also be observed that the wheel and pinion were adapted to each other; consequently another pinion, differing much in diameter from the first, would not act well with the same wheel. A mode of forming the teeth of wheels, by which this inconvenience is obviated, has been proposed by Professor Willis, and the form of tooth thus produced is much superior to the old-fashioned plan. If for a set of wheels of the same pitch a constant-describing circle be taken to trace those parts of the teeth which project beyond each pitch line, by rolling on the exterior circumference, and those parts which be within it, by rolling on the interior circumference, then any two wheels of the set will work correctly together. The describing or "Pitch Circle" should be equal in diameter to the *radius* of the smallest pinion, which, in this case should not have less than twelve teeth. When rolled upon the interior circumference of a circle equal in diameter to the pinion, a point upon the periphery of the pitch circle will describe radial lines through the centre of the larger circle representing the pinion, which is twice the diameter, so that the form of the pinion teeth within the pitch line may be at once drawn in straight lines from the centre. When rolled on the exterior circumference, epicyloidal curves, forming the teeth of the pinion beyond the pitch line are described by the tracing point. But when these operations are performed by rolling the pitch circle upon another of much larger diameter, representing the wheel, the interior and exterior epicycloids form a tooth of very different shape; it is no longer contained within radial lines, but spreads out at the root, giving great strength and firmness at the point, where they are most needed. The exterior epicycloid forms the point of the tooth in a manner similar to that already described; but any wheel or pinion having teeth described by a common pitch circle will work together; even the teeth of a rack, which, being placed upon a straight line, may be regarded as the segment of a wheel of infinite radius can be formed in the same manner, and will work equally well with the wheels. The principles above discussed are applicable to both spur and bevel wheels; there is, however, another form in which teeth are shaped when the wheel and tangent screw principle is employed, and the thread of a cylindrical screw gives motion to a wheel, a plan which is often employed to diminish a high velocity.

(To be Continued.)

Long Tunnel.

One of the tunnels on the Pennsylvania Railroad now constructing, is to be 3,670 feet in length. Its area at the widest space within the lines of the masonry will be about 24 feet, and the spring of the arch will begin 16 feet from the crown of the arch. The arch itself, of the tunnel, will be rather of an oval form, one of the most beautiful curvatures which Conic Sections can afford. The greater part of the vast arched excavation will be inlaid with strong and substantial masonry. More than half of this masonry will be composed of sandstone well laid in hydraulic cement; and the remainder will be hard burnt brick. This whole masonry will be 22 inches thick.

The tunnel passes the Allegheny Mountain in Sugar Run Gap, and lies partly in Blair and partly in Cambria County. Taking into account the length of the Tunnel and its interior breadth, and the quantity and solidity of its masonry, it may be regarded as the largest work of the kind in the United States.—About 400 men are employed upon it.

* * *

The Seminole Indians have again entered into hostilities against the United Sttaes.

perfect that all the heat lost, that is, heat not returned to the engine, does not amount to more than three pounds of fuel per hour. The total consumption of fuel is nearly two pounds per horse-power in the hour, owing to the great radiating surfaces unavoidable in an engine on a small scale, while these surfaces have not, in this first instance, been properly protected by any imperfect conductors.

The principle of this new engine consists in this, that the heat which is required to give motion to the engine at the commencement, is returned by a peculiar process of transfer, and thereby made to act over and over again, instead of being, as in the steam engine, thrown into a condenser, or into the atmosphere as so much waste fuel. And the well-known phenomenon that temperature, or quality of heat, is always equalized between substances, however unequal they may be in density, forms the basis of this new application of heat. The most accurate experiments prove that the combustion of one pound of the best coal is only capable of raising the temperature of 9000 lbs. of water one degree. So that an engine, in giving motion to the shaft of a mill, will consume from 7½ to 8 lbs. of fuel in the hour for every horse-power constantly imparted to that shaft."

Thus writes Sir Richard Phillips, a most inordinate admirer of the then Caloric Engine. Let us point out its fallacious principles: it is stated that it only uses so much coal to make up the loss of radiation, therefore, if there were no loss of heat by radiation, it would use no coal at all, after the first fire; it would go on for ever—a perpetual motion surely. Capt. Ericsson is also, or has been, laboring under a wrong impression of the value of "Forces," as applied to machinery. Thus this engine is constructed upon the principle of heat force that is, if a certain amount of heat can be retained, it will produce repeated effects upon innumerable quantities of matter—a thing totally at variance with Mechanical Philosophy. It is like this: 900° of heat will give a certain velocity to 900 cubic feet of air, during one stroke of a piston, then the same velocity to another 900 cubic feet of air during the next stroke of the piston, and so on *ad infinitum*. If there were no loss by radiation, and none by exhaustion, upon this principle of reasoning, 500° of heat will give rapid motion to *z* cubic feet of air, and, by so doing, give motion to machinery for ever.

It is a great mistake to suppose that this can be done, for action and re-action are equal —we are no believers in motion derived from static pressure. What is heat? It is the effect of the disturbance of chemical equilibrium like the lightning from the positive seeking the negative cloud. The amount of this disturbance is exactly in proportion to the quantity of fuel used to produce the effect—the fire is just like the electric battery. The amount of this force is more economically employed or directed in some machines or engines than others, but a certain quantity of action cannot produce an infinite amount of reaction. It is, however, upon this principle, that the Caloric Engine is built, and that it is fallacious, we leave to the judgment of every mechanical philosopher. Thus, for example, take this first engine of Capt. Ericsson, and let us cover up all the metallic parts, so that there will be no loss by radiation, and what will we have then, but this engine (by its author's reasoning), going on continually, giving out force without any expenditure of fuel at all, after a certain amount of heat has been imparted to a certain amount of air. But if there were no loss of heat by radiation, the engine would soon stop, and thus we hold, that what some people would call *loss*, is nececessary to *gain*; this loss of heat is the value of the power gained, just like the escape of water from the buckets of the water wheel. Let a millwright build a wheel so that the inlet water will not be able to escape, and how many revolutions will the wheel make, by thus saving the water? Only one. All machine force, is re-action, the result of action and its equal, and was the doctrine which enabled D'Alembert to make a number of beautiful mathematical discoveries.

If we cover up all this first engine of Capt. Ericsson, with a good nonconducting substance and keep the fire under it, the hot air after a certain length of time, will impart its heat to every portion of the Regenerator, and the pressure of the air will be alike in both cylinders, therefore the engine must stop, for the pressure will be alike on both sides of the pistons. The radiation of the heat therefore, what is called the *loss*, is the real value of the power given out by machinery. The quantity of heat required to produce a certain effect in velocity to air, may well be compared to the quantity of fuel required to make a vessel move through water, in other words, give a certain quantity of water a certain rate of motion; the greater the quantity to be acted upon, the greater the amount of heat, or fuel required.

Thus we have described and philosophised on Capt. Erricsson's first engine, and now in Figs. 2 and 3, we have his engine as improved after 17 years' time to perfect it.

Figures 2 and 3 are longitudinal sections of Ericsson's Hot Air Engine, improved and patented in England 1850, in the United States 1851. We do not wish to occupy space in our columns now with a full description of these figures, we refer to page 60, last Vol., Scientific American, for this, but we re-publish the engravings to point out the transformations which this caloric engine has undergone, and we trust we shall make its operation and construction clearly understood. We wish particular attention directed to spherical furnaces which are now used by Erricsson, also to the using of the same air over and over again, both in the original engine, and this one of 1850, but notin the one he now employs.

Figure 2.

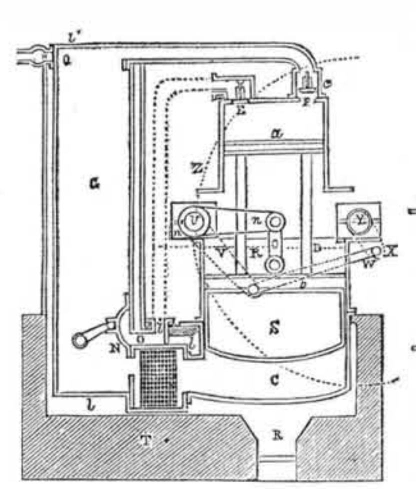
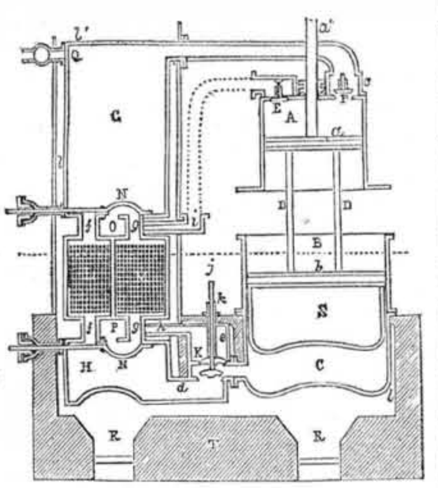
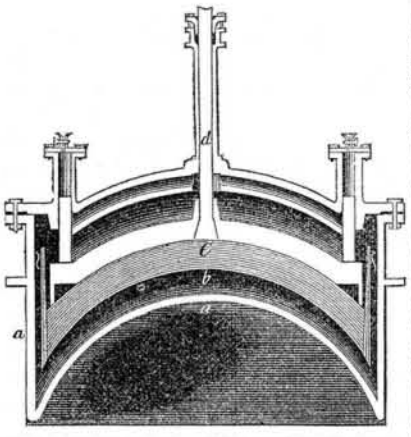


Figure 3.



A B are two cylinders of unequal diameter, but nearly alike in all points; *a*, and *b*, are their pistons; A is the supply, and B the working cylinder: *a'* is the piston rod; C is a cylinder with a spherical bottom, called the expansion heater, and is affixed to the working cylinder. D D are braces which connect the pistons, *a b*. E is a self-acting valve opening inwards to the supply cylinder. F is a similar valve, opening outwards from the said cylinder and contained within the valve box, *c*, which is connected by a pipe with a cylindrical vessel, G. H is a cylindrical vessel with an inverted spherical bottom, called the heater. L and M are two vessels of cubical form filled to their utmost capacity (excepting small spaces at the top and bottom), with discs of wire net or straight wires, closely packed, or with other small metallic or mineral substances, such as asbestos, so arranged as to have minute channels running up and down; the vessels L and M are named regenerators.

Fig. 4.



Operation.—Fire having been kindled in the furnaces, R, and the air chamber heated up, air is forced in by a hand air pump into the receiver until it is about 12 lbs. pressure to the square inch. The conical valve at the lower end of stem, *j*, is then opened, and the air enters under the piston, *b*, which as heat is imparted to the air, ascends, and the air in cylinder A, is forced into the receiver, G, by piston, *a*. Before the piston, *b*, has completed its stroke, the valve of *j*, is closed (this is the cut off); at the end of the stroke, the valve K is opened, and the hot air escapes through the passages, *e h* P and *g*, into the pile of wire gauze or regenerator, M, where it parts with its heat and then passes up the pipe indicated by the dotted lines, and into the upper cylinder through the valve, E, there to be forced out into the receiver, G, by the next up stroke of the piston using the same air over and over again. This was certainly a kind of perpetual motion engine; the same heat and the same air being used over and over again.

Within two years the engine has undergone a change; the same heat but not the same air is repeatedly used. If we suppose the pipe with the dotted lines to be a chimney opening to the atmosphere, and not into the upper cylinder, A, so as to let the spent hot air pass out, we will have the caloric engine as it now is. The cold air is taken from the atmosphere direct into cylinder, A, which is simply a large air feed pump, and compressed into a receiver, and the spent air is sent away into the atmosphere. Figures 2 and 3 are somewhat different, but the principle is the same, the links and crank show how the power is conveyed to drive the shaft of the paddle wheels. If we suppose four of those single acting cylinders to be arranged in line, two on each side of the main shaft, giving it motion by a walking beam, our readers will have a good idea of the engines of the caloric ship.

This hot air engine has been denominated "a new motive power," by nearly all our papers. The "New York Daily Times," and "Hunt's Merchants' Magazine" have specially so termed it. Now we wonder at this, for no person who has received an education at a good seminary or university can be ignorant of the fact that "hot air" is capable in its very nature of moving machinery. It certainly takes away much from the character of any editor for intelligence to have used such language.

Hot air engines are very old. In France, hot air was used prior to steam. The great principle of the Ericsson engine, is the regenerator. "Hunt's Merchants'. Magazine" says about the "regenerator":—the wonderful process of the transfer and re-transfer of heat, is a discovery which justly ranks as one of the most remarkable ever made in physical science. Its author, Captain Ericsson, long since ascertained, and upon this is based the sublimest feature of his caloric engine, that atmospheric air and other permanent gases, in passing through a distance of only six inches, in the fiftieth part of a second of time, are capable of acquiring, or parting with, upwards of four hundred degrees of heat. He has been the first to discover this marvellous property of caloric."

Our readers expect of us correct information on this subject, which has not been given elsewhere. We will therefore endeavor to point out what is new and what is not new, in Ericsson's engine. The principle of robbing the escaping hot air of its caloric by passing it through narrow metal plates having small channels in them, and then using this over again, is the invention of the Rev. Dr. Robert Stirling, a Scotch Presbyterian clergyman of Galston, who took out a patent for his hot air engine in 1827. His engine is illustrated and briefly described on pages 667, 8, 9, 10, of Galloway & Hebert's History of the Steam Engine, published in London in 1832, before Capt. Ericsson took out his first patent. It was asked of the author of the "caloric engine," while he was explaining his engines on the trial trip of the caloric ship, it "there was no danger arising from fracturing the top plates of his furnaces by the expansion and contraction of the metal." His answer was, that "owing to the spherical form of his furnaces, the top plates expanded and contracted without danger of fracture." Figure 4 is a vertical section of Dr. Stirling's hot air furnace; it is spherical, and of the form now used in the caloric ship. This figure is taken from the book referred to, page 668. *a a* is the cylinder; *b* is the hot air chamber; C is a piston packed with thin pieces of metal, perforated with zig zag holes, and pieces of brick and other non-conducting substances below. This piston was moved by the rod, *d*, in the hot air chamber, and the cold air passed from the top of the piston, through the small holes, and down into the hot air chamber, and from thence to the working cylinder, which was double acting, and had an air vessel for each end, just as the present caloric engine uses two hot air furnaces for two single acting cylinders which amounts to one double acting one. The same air was used over by Stirling continually. A gentleman in this city, a professor of mathematics and languages, and who is well versed in mechanical inventions, has informed us that Dr. Stirling, while pastor in Kilmarnock, many years before 1827, was to his knowledge blamed by his parishioners, for neglecting his ministerial duties for his hot air hobby. Mr. Steel—called the doctor in this city owing to his extensive acquaintance with science and art—who may be said to be the originator of the New York Mechanics' Institute, exhibited and described a model of Stirling's hot air engine, in his lectures in Glasgow before he came to New York, and that is many years since.

Hebert's history does not give a very clear description of the operation of Stirling's first hot air engine, but we have the words of Dr. Stirling's brother, an engineer of Dundee, Scotland, who was a joint inventor. He, along with his brother, took out a patent for an improvement in 1840, which was described in the "London Times," "London Mechanics' Advocate," Vol. 4, pages 229 and 230, and in the "Dundee Advertiser," Oct. 1841. This latter paper says "it is now working at the Dundee Foundry, is superior to the steam engine, saves a great deal of fuel, and for the purposes of navigation, it is invaluable."—This paper thus states its principle of saving heat:—"Of the heat communicated to the air from the furnaces, a very small portion is lost, for by making *the air, in its way from the hot to the cold end of the air vessel, pass through a chamber divided into a number of small apertures, the great extent of surface with the hot air extracts the heat temporarily, and restores it to the cold again on its passage back from the cold to the hot end of the vessel.*" This paper of 1841 uses the following identical language recently used by some of our papers in reference to the caloric engine. It says again:—"In reference to the purposes of navigation, this invention must lead to extraordinary results, and will render a voyage to India round the Cape, by machinery, a matter of perfectly easy accomplishment."

In 1846, J. Stirling, the engineer, read a paper on Stirling's hot air engine, before the Institution of Civil Engineers, in England. We refer to Vol. 45, page 559, "London Mechanics' Magazine," for an account of the same. The paper elicited a long discussion among such men as Sir George Cayly, Robert Stevenson, C. E., A Gordon, C. E., Smith, of Deanston, J. Jeffreys, &c. Mr. J. Jeffreys said, "the principle of the engine's operation is analogous to that of a respirator. The conducting power of the metals alternately absorb and gives out the caloric." This description is just like that of M. V. Beaumont's, about