ERICSSON'S SOLAR ENGINE.
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ERICSSON'S SOLAR ENGINE.

He Believes It to Be Now Complete and Ready for Great Uses.

The Work with Which the Inventor of the Monitor Has Been Occupied for Forty Years.

The Means by Which a Steamless Engine May Pull a Train Across Sahara.

New York Sun.

When Capt. John Ericsson towed the Admiralty-barge from Somerset House down the Thames, at the rate of ten miles an hour, with his screw-propeller steam-launch, in 1837, the watermen that lined the river banks were amazed. Ericsson waited impatiently for the verdict of the Board of Admiralty, who were to give an opinion on his substitution of the oblique principal for the direct action. The Board rejected the propeller on the ground that its position in the stern would interfere with the steering of the vessel. This verdict induced Ericsson to come to this country.

During his residence in England, Ericsson had been much impressed with the question which, even at that time, agitated the minds of English scientific men: "What will mankind do for motive power when the supply of coal is exhausted?" Numerous experiments have been made by him with the view of discovering a method whereby solar heat could be utilized, and on his arrival in New York these experiments were continued with increased industry. Now, after nearly forty years of constant application and study, in which time he invented the Monitor, which revolutionized naval warfare, the steam fire-engine, and the caloric engine. Ericsson claims to have at last perfected

HIS LONG-SOUGHT-FOR SOLAR ENGINE.

If erected near the seaboard, where water is to be had, the solar engine will, he claims, generate steam, and that where water is not procurable atmospheric air may be made the medium for transmitting the solar energy to the motor. Ericsson says that in recent experiments, under a clear sun, the engine worked with perfect uniformity, at a velocity of more than 300 revolutions per minute, and that it consumed, at the stated rate, only a part of the steam furnished by a solar steam generator intended for a larger engine.

Capt. Ericsson, during a recent interview, stated that he is ready to build solar engines of any power. A beautifully-finished model occupies a table in the front parlor of his house in Beach street. He intends to offer the principle of the solar engine as a free gift to the world, and he will apply for a patent only for the purpose of protecting the public. It is a gift for the future, he says, for he does not expect that his invention can be made available in competition with machinery using combustibles. When, however, artificial fuel is not to be had, his solar engine will, he believes, open new possibilities to human achievement.

To give some idea of

THE FUTURE POSSIBILITIES OF THE SOLAR ENGINE,

Ericsson says: "There is a rainless region extending from the northwest coast of Africa to Mongolia, 9,000 miles in length, and nearly 1,000 miles wide. Besides the North African deserts, this region includes the southern coast of the Mediterranean, east of the Gulf of Cabes, Upper Egypt, the eastern and part of the western coast of the Red Sea, part of Syria, the eastern part of the countries watered by the Euphrates and Tigris, Eastern Arabia, the greater part of Persia, the extreme western part of China, Thibet, and lastly Mongolia. In the Western Hemisphere, Lower California, the table land of Mexico and Guatemala, and the west coast of South America, for a distance of more than 2,000 miles, suffer from continuous and intense radiant heat.

"Computations of the solar energy wasted on the vast areas thus specified would present an inconceivable amount of dynamic force. Estimate the mechanical power that would result from utilizing the solar heat on a strip of land a single mile in width, along the rainless western coast of America, the southern coast of the Mediterranean, both sides of the alluvial plain of the Nile in Upper Egypt, both sides of the Euphrates and Tigris for a distance of 400 miles above the Persian Gulf; and, finally, a strip one mile wide along the rainless portions of the shores of the Red Sea, before pointed out. The aggregate length of these strips of land, selected on account of being accessible by water communication, far exceeds 8,000 miles. Adopting the stated length and a width of one mile as a basis for computation, it will be seen that this very narrow belt covers 223,000,000,000 square feet. Dividing the latter by the area of 100 square feet, necessary to produce one horse-power, it will be seen that 22,300,000 solar engines, each of 100 horse-power, could be kept in constant operation nine hours a day

BY UTILIZING THAT HEAT

which is now wasted on the comparatively small areas of land extending along some of the water-fronts of the sunburnt regions of the earth.

"The experience of the past shows that the exhaustion of the European coal-fields must at some time cause great changes in favor of those countries which are in possession of continuous sun-power. Upper Egypt, for instance, will, in the course of a few centuries, derive signal advantages and attain a high political position on account of her perpetual sunshine, and the consequent command of an unlimited motive force. The time will come when Europe must stop her mills for want of coal. Upper Egypt, then, with her never-ceasing sun-power, will invite the European manufacturer to remove his machinery and erect mills on the firm grounds along the sides of the alluvial plain of the Nile, where an amount of motive-power may be obtained many times greater than that now employed in all the manufactories of Europe.

"By means of the solar engine, locomotives may be run across arid wastes where neither water nor fuel of any kind is to be had. Not that the solar engine can be elevated upon wheels, for the constantly changing angle the sun makes with the earth would prevent this; but locomotives may be fed from reservoirs of air compressed by stationary solar engines placed at regular intervals along the routes."

This much has been given to the public through an interesting article on Capt. Ericsson in *Scribner's Monthly*, some months since. Further investigations reveal important facts connected with the present condition of the engine and with Capt. Ericsson's purposes.

Few subjects connected with physics are so little understood as the

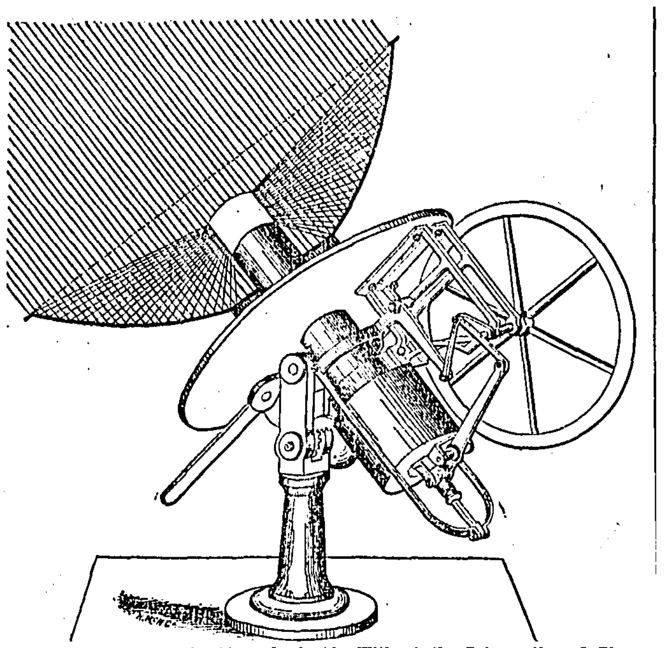
PROPAGATION OF RADIANT HEAT.

The recognized law that the temperature diminishes in the inverse ratio for the square of the distance from the radiating body, Ericsson says, is true only of a sphere of perfectly uniform temperature at the surface when the distance is reckoned from the centre of the sphere. Sir Isaac Newton, referring to the intensity of the sun's radiant heat at different distances, thus defines the law: "The heat of the sun (at various distances) is as the density of its rays." He also said that the densities of the diverging rays are reciprocally as the square of the distance from the centre of the sun. This fact evidently has nothing to do with the main proposition, as it simply resulted from certain geometrical relations, viz.: that the areas of transverse sections of a cone are as the square of the distance from the apex.

Besides ascertaining the dynamic energy of solar radiation by measuring the units of heat developed in a given time under various conditions, Capt. Ericsson extended his labors to the determination of the true intensity of the sun's radiant heat. By a series of observations, he says, he was able to estimate the loss of intensity by the passage of the rays through the earth's atmosphere. By adding this to the ascertained intensity of the radiant heat on reaching the surface of the earth, and before being affected by terrestrial radiation, he determined the actual heat at the point where the rays entered the earth's atmosphere. His attention was originally called to the important subject of actual intensity of solar radiation by reflecting on the limited amount of dynamic energy, —about five units of heat per minute, upon an area of 142 square inches exposed perpendicularly to the sun's rays, while the thermometer indicated 150 deg. above Fahrenheit's zero, or 610 deg. above absolute zero. Preliminary experiments, carefully conducted, disclosed

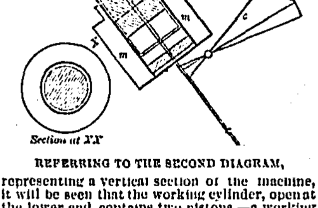
THE STARTLING FACT

that the real intensity of solar radiation marks a point on the thermometric scale several hundred degrees below the freezing point of water. Ericsson resorted to the expedient of concentrating the sun's rays by such a method that the degree of concentration could be accurately measured. Investigation, conducted in conformity with this method of determining the true intensity of the radiant heat, proved the temperature to be nearly identical with that shown by the preliminary experiments. Thus he established the extraordinary fact that the sun's rays, before [illegible] by terrestrial influences, are so feeble that fluid mercury, contained in a shallow vessel from which the air is exhausted, and covered with a thin lens of about fifty inches focus, and exposed to the full powers of a clear sun, will soon become solid, provided the vessel is prevented from receiving heat from surrounding substances. The above experiments are interesting, as forming a part of the work performed by Ericsson in seeking a solution of the problem of the utilization of solar heat.



Solar Engine Actuated by Atmospheric Air Without the Intervention of Steam.

The engraving at the head of this article represents a perspective view of Capt. Ericsson's solar engine, in which the concentrated energy of the sun's rays is communicated to the motor by means of heated atmospheric air, instead of being communicated by water heated under pressure and expanded into steam. The upper end of the working cylinder is heated by the sun's rays reflected by a curved mirror. It will be seen that the solar rays converge at a point beyond the axis of the reflector; hence that the form of the latter is not parabolic, but is of irregular curvature. The object is to spread the converging rays over a greater length of the cylinder than possible with the divergence which would result from employing a reflector of true parabolic curvature. The upper end of the cylinder will be subjected to a concentration of heat many times greater than the concentration at the lower end.



Section at XX

REFERRING TO THE SECOND DIAGRAM,

representing a vertical section of the machine, it will be seen that the working cylinder, open at the lower end, contains two pistons,—a working piston (a) and an exchange piston (b). The working piston is connected with the crank shaft (d) by the beam (c) and the connecting rod (g). The exchange piston (b) is connected with the crank shaft by the bell crank (ff) and connecting rod (h). An annular space is formed round the exchange piston, admitting a free passage of the air from end to end of the cylinder during the motion of this piston. During the downward motion of the exchange piston, the cold air from the lower end of the cylinder will be transferred to the upper end, heated by the concentrated solar rays; hence internal pressure will be produced, tending to force the working piston down. The working piston is actuated by the confined air, heated and cooled alternately by the peculiar motion of the exchange piston. The large surface presented by the outside of the exchange piston and inside of the cylinder will cause a rapid change of temperature of the air while circulating from end to end of the latter. The upper end of the cylinder being heated by the concentrated solar rays, the cold air from the lower end will, during its transfer to the upper end, caused by the downward motion of the exchange piston, become heated and expanded; while, during the upward motion of this piston, the air, in being transferred to the lower end of the cylinder, becomes cool and contracted. The exchange piston thus performs the office of a regenerator. The engine, it is claimed, is, therefore, capable of operating for a considerable time by exposing the upper end of the cylinder to the reflected solar heat during a few minutes while starting. By continuous exposure to the concentrated solar rays, Ericsson claims that the engine will make fully 400 revolutions per minute. Concentrated solar radiation supplies heat with

SUCH EXTRAORDINARY RAPIDITY

that the apparently insufficient amount of heating surface presented by the cylinder has proved adequate, notwithstanding the great speed of the engine. It only remains to be stated that the body (mm) represents a radiator carrying off the heat that is not taken up by the circulating air during the motion of the exchange piston. The amount of heat carried off by the radiator furnishes a nearly correct measure of the solar energy not converted into mechanical work. The form of the solar engine thus described is applicable only for purposes requiring moderate power. In the largest class of solar engines actuated by atmospheric air, in which the radiator is incapable of abstracting the superfluous heat, valves are employed that take in fresh air at each stroke of the machine, as in the caloric-engine.

Capt. Ericsson says that the mechanism which he has adopted for concentrating the sun's radiant heat abstracts, on an average, during nine hours a day, for all latitudes between the equator and 45 deg., fully 8.5 units of heat per minute for each square foot of area presented perpendicularly to the sun's rays. A unit of heat being equivalent to 772 foot-pounds, a dynamic energy of 2,702 foot-pounds is, theoretically, transmitted by the radiant heat, per minute for each square foot; hence, 270,200 foot-pounds for an area of 10 feet square. Dividing this sum by the adopted standard, 33,000, the result is reached that 100 square feet of surface exposed to the solar rays develop continuously 8.2 horse power during nine hours a day within the limits of latitude before mentioned. It is well known, however, that the whole dynamic energy of heat cannot be utilized in practice by any engine or mechanical combination, nor even approached; hence Ericsson has assumed, in order not to overrate the capability of the new system, that a solar engine of one-horse power demands the concentration of solar heat from an area of ten feet square.

The solar engine, when steam is employed as the medium for transmitting the radiant energy, is composed of

THREE DISTINCT PARTS,—

the engine, the steam generator, and the mechanism by means of which the inadequate energy of the sun's rays is increased to such a degree that the resulting temperature will exceed that corresponding with the steam pressure necessary in an efficient engine. The motor itself, when steam is employed, resembles in all essential points a modern steam-engine, utilizing to the fullest possible extent the mechanical energy of the steam admitted to the working cylinder. But when atmospheric air is employed as the medium for transmitting the solar energy to the motor, an entirely different combination of mechanism is called for. No fuel being used, the steam generator is not exposed to the action of fire or soot, and can suffer only from the slow action of ordinary oxidation. The cost of the concentration apparatus will be moderate. The weight will be light,—indeed, lightness will be the characteristic feature of the apparatus. It will be composed of parts readily adjusted. It is well known that certain metals, however thin, if kept dry, may be exposed to the sun's rays during an indefinit time without appreciable deterioration. The concentration apparatus, which is to be constructed of thin metallic plates, must be extremely durable. The maximum size of the solar engine, Ericsson says, should be sufficient to utilize the radiant heat of a pencil of rays of thirty-five square feet section. The employment of an increased number of such structures will, therefore, in most cases, be resorted to when greater power is needed. The motor itself, the steam cylinder, and the working parts must be proportioned in accordance with the pressure of steam employed and the work to be done.

Capt. Ericsson wishes it understood that he does not recommend the erection of solar engines in localities where there is not steady sunshine until proper means shall have been devised for storing up the radiant energy in such a manner that regular power may be obtained from irregular radiation. Formidable difficulties often present themselves in storing up mechanical energy; yet, when coal can no longer be obtained,

NECESSITY, INGENUITY, AND INCREASED EXPERIENCE

will, Ericsson thinks, find means of overcoming obstacles which now appear insurmountable.

Mouchot, of Tours, formerly of the Lycee of Alencon, claims to have anticipated Ericsson in employing solar heat for the production of motive power. Mouchot bases his claim on some experiments, made in 1866, intended to show that, by the accumulation of heat which takes place when a blackened surface is surrounded by glass bells, steam may be generated for actuating machinery. Sir John Herschel elaborated the old idea of concentrating solar radiation, and conducted a series of experiments at Cape Town in 1838, showing that not only was it possible to produce boiling heat by accumulating solar heat as described, but he succeeded in elevating the temperature sufficiently for roasting meat. About 1870 Mouchot made a small model engine, a mere toy, actuated by steam generated on the plan of accumulation by glass bells; but, finding the heat insufficient, he added a polished metallic reflector. The increase of temperature resulting from this expedient rendered his steam generator more effective, and it was found that, under favorable circumstances, sufficient steam could be produced to work his small model. The Conseil-General of Indreet-Loire having subsequently provided Mouchot with necessary means, he put up a steam generator at Tours in 1872, which he deemed a perfect machine, its action being based on the results of his previous experiments. M. L. Simonin, in describing this machine in *Revue des Deux Mondes*, says that on occasions when the sun has been exceptionally clear, the solar generator at Tours has evaporated five litres of water per hour, which he assumes to be equal to a half-horse power. This result is produced by the reflector, a truncated cone eight feet six inches in diameter. It was found, however, that in order to double the reflective arch necessary to generate steam for an engine of one-horse power, a truncated cone of eleven feet nine inches aperture would be required. Practical engineers say that an inverted conical body whose base is nearly twelve feet in diameter swinging round an inclined axle at least sixty degrees on each side of the vertical line, will present a structure so formidable, even if counterpoised, that it would not be prudent to increase its size. Accordingly, it would take 100 of Mouchot's solar generators to furnish steam for an engine of 100-horse power, which, if placed side by side, would occupy a front space of 2,000 feet from east to west.

Although 76 years of age,

CAPT. ERICSSON

has the appearance of a strong, healthy man of 50. A visitor at his home will see two long loaves of coarse brown bread standing on end upon the mantel of his dining-room and resting against the wall. "These have stood in this position for forty-eight hours," said his Secretary, as he took one from the mantel, "and they are not yet dry enough for the Captain!" This is his favorit food, and he eats large quantities of it during his two meals. Each morning Ericsson passes two hours in gymnastic exercise, bath, and dressing. He seldom goes out of the house in the daytime, but after 10 o'clock he may be seen walking briskly toward the Battery or Central Park. The rooms over the parlors are his workshop. There, working for years, with hardly a day's release, he has perfected that which he calls his masterpiece,—the solar engine.