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# The Utilization of the Sun's Energy

**Years Ago Man Endeavored to Make Practical Use of the Energy Contained in the Sun's Rays—Even Tesla, the Electrical Wizard, Has Patented a Sun Motor, While the Shuman-Boy's Engine and Sun Boiler Has Developed 100 H. P. There Is Great Promise Held Forth to Future Engineers Who May Work on This Problem.**

IT has been given to astrophysicists to measure the heat generated by the sun and calculate the force emanating from it. We know that the surface of our luminary gives out a heat estimated to be about 6,000° centigrade, and that its light equals that of 27,000,000,000 candlepower a quarter of a mile away. The heat which the earth receives from the sun in the course of a year would suffice to melt a belt of ice about 55 yards in thickness extending clear around the earth. Only the 2,735-millionth part of the total energy given off by the sun reaches our earth and, if this were lacking, our planet, with all its thousandfold life, its thick forests and fruitful plains, would turn into a dead, rigid ball of rock, for the average annual temperature, which is now one of 13° centigradé of warmth for Europe, would, without the heat of the sun, sink to 73° centigrade of frost, it is calculated.


A Successful 100 H.P. Sun Power Plant Located at Meadi, on the Nile, Egypt.

Every sort of light with which we illuminate our home when the greater light has sunk beneath the horizon, every fire that warms us when the solar rays can no longer do so, is a product originating in the sun. The chip of wood with which the untaught son of nature brightens his hut, the twigs with which he stokes his fire, what are they but pieces of trees that grew in the sunlight? The gas of the city dweller, the coals with which he heats his house and from which the gas has been sucked, what are they but transformed sunbeams? The coal in the grate is the petrified wood of perished forests that covered the earth's surface millions of years ago, and flourished in the rays of the same sun that ripens our corn to-day. Petroleum, that mysterious earth-oil, comes from the bodies of millions of dead and gone animals, chiefly natives of the sea, which lived in the gray ages and fed on things growing in the sun. Alcohol is also a plant product, and the candle our ancestors took to be an ideal light, is won

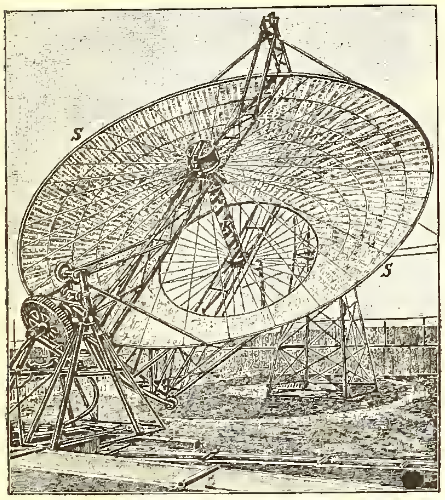

Fig. 1. Common Form of Sun Motor Adopted by Experimenters, Utilizing a Large Number of Mirrors and a Central Boiler.

from the animal and plant kingdom. The smoking fish oil lamps of the Eskimo are indirectly dependent on the sun for their fuel. And what of our own electric light? The dynamo developing the electricity is driven by steam, and the steam engine has to be fed with coal or with other materials gained from the animal and plant kingdoms. How about the waterfall? It would not exist if the sun did not suck up water from the earth's surface, and which is again deposited on the earth in the form of rain.

If it were rendered possible to use the sun's heat itself for the firing of furnaces an ideal state of affairs would be attained. There was a sun motor used for some time on an ostrich farm (see Fig. 1) in South Pasadena, Cal. This consisted of a concave mirror made of single glass planes set together, and measured about 12 yards in diameter. The sun's rays were collected and focussed on to a water tank, let into the mirror in the shape of a cylinder, 2½ yards long, which acted as its axis. When the water tank remained empty on a sunny day its walls grew red hot in less than an hour. The 400 quarts of water it contained was brought to the boiling point in 15 minutes and the steam developed drove a motor of 10 horsepower, which in turn worked a pulley raising 5,600 quarts of water per hour; a decidedly noteworthy performance.

The temperature of the sun, as aforementioned, has been calculated to be about 6,000 degrees centigrade. Several authorities point out that this terrific heat therefore precludes any possibility of the sun being a molten mass in the process of combustion. It has been thought recently by many to be a great mass of matter possessing to a remarkable degree radio-activity akin to radium. Helmholtz proposed that the sun could keep on producing energy at its present rate by accounting for same on the basis of a slight annual shrinkage in its size. From observations and measurements of this heavenly body made from year to year it has been computed that the age of the sun would, on the shrinkage basis, be 17,000,000 years.

The radiant energy received from the sun at the outer surface of the earth's atmosphere is equivalent to 7,300 horsepower per acre. Of this about 70 per cent. or, roughly speaking, 5,000 horsepower per acre, is transmitted through the atmosphere to the land surface proper of the earth, at noon on a clear day. Lesser amounts, of course, are received in the early morning and late afternoon, owing to the greater thickness through which the energy must pass.

Relative to the basis upon which solar energy is calculated for the earth's surface, this is generally made, it may be said, on the "solar constant," as it is termed, ascertained from 696 tests conducted by the Smithsonian Institute of Washington, in various parts of the world, which resulted in accepting 1.93 calories per square centimeter per minute, equal to 7.12 British thermal units per square foot per minute. This is an average value, all things considered.

Only about three-fifths of the solar radiation produce any impression on the earth, and it is only the radiant energy which falls on some material body that is converted into heat. The best body for this conversion having been ascertained to be a dead black one.

Many scientists and philosophers in the past century have tried various methods by which to concentrate the sun's rays, such as schemes utilizing an immense number of lenses built in the form of a huge cone, as previously described and illustrated at Fig. 1. A European experimenter in the year 1820 constructed one similar to this, but on a small scale. This model concentrated the rays sufficiently to melt tin at a distance of 68 yards from the apparatus, and also it was possible to cook food and melt silver instantaneously.

In the year 1882 a Frenchman by the name of M. Pifres devised a solar engine which was built on the roof of a building in Paris to drive a printing press, and the paper so published was called the "Soleil Journal." Capt. John Ericson experimented with solar engines from 1868 to 1886 with more or less success, but nothing remarkable or practical was developed. Another early worker was A. G. Eneas. His solar engines are described in United States patents issued in 1901, bearing the numbers 670,916 and 670,917.

Getting down to basic and simplified apparatus for utilizing such radiant energy as that possessed by the sun's rays, both visible and invisible, we may consider the apparatus of this nature devised by Dr. Nikola Tesla, the well-known electrical scientist. His United States patents on "Apparatus for the Utilization of Radiant Energy" bear the numbers 685,957 and 685,958. This apparatus, intended to absorb and transform such radiant energy as that given forth by the sun, is shown in the illustration at Fig. 2.

Tesla says of this matter that his own experiments and observations have led him to the conclusion that such sources of radiant energy as the sun throws off with great velocity, minute particles of matter which are strongly electrified, and are, therefore, capable of charging an electrical conductor, or, if not so, may at any rate discharge an electrified conductor either by carrying off bodily its charge or otherwise. His patents in this direction are based on alleged discovery by him that when such rays or radiations are permitted to fall upon or impinge against an insulated conducting body P connected to one terminal of a condenser, such as C in Fig. 2, while the other terminal of the condenser is made by independent means to receive or carry away electricity, a current flows into the condenser so long as the insulated body P is exposed to such rays; so that an indefinite, yet measurable, accumulation of electrical energy in the condenser takes place.

This energy, after a suitable time interval, during which the rays are allowed to act in the manner aforementioned, may manifest itself in a powerful discharge, which may be utilized for the operation or control of a mechanical or electrical device consisting of an instrument R, to be operated and a circuit-controlling device d (Fig. 2-A).

Tesla bases his theory on the fact that the earth is negatively charged with electricity and he considers same to act as a vast reservoir of such a current. By the action of the sun's rays on the plate P there is an accumulation of electrical energy in the condenser C. A feeble current is supposed to flow continuously into the condenser and in a short time it is expected to become charged to a relatively high potential, *even to the point of rupturing the dielectric*. This accumulated charge can then, of course, be used to actuate any device desired.

An illustration of a proposed form of apparatus which may be used in carrying out his discovery is referred to in Fig. 2-B. In this figure, which in general arrangement of the elements is identical to Fig. 2-A, the device d is shown as composed of two very thin conducting plates, t t¹, placed in close proximity and very mobile, either by reason of extreme flexibility or owing to the character of their support. To improve their action they may be enclosed in a receptacle from which the air may be exhausted. The plates t t¹ are connected in series with a working circuit, including a suitable receiver, which in this case is shown as consisting of an electromagnet M, a movable armature a, a retractile spring b and a ratchet-wheel w, provided with a spring pawl r, which is pivoted to armature a, as illustrated. When the radiations of the sun or other radiant energy source fall upon plate P a current flows into the condenser, as before explained, until the potential therein rises sufficiently to attract and bring into con-

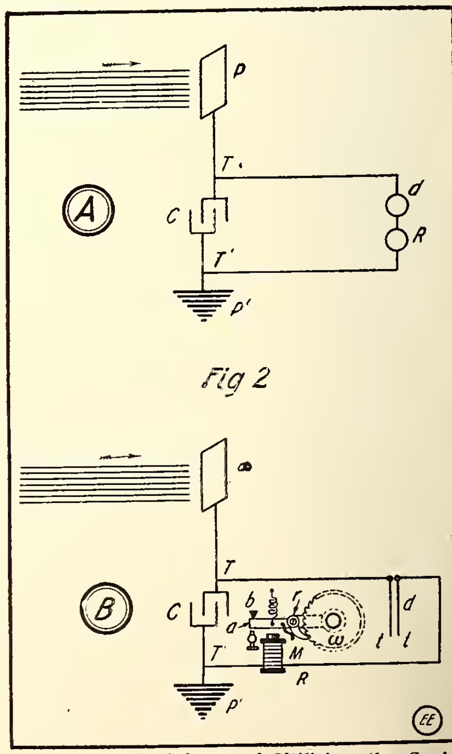


Fig. 2. Tesla's Scheme of Utilizing the Sun's Energy.

tact the two plates t t, thereby closing the circuit connected to the two condenser terminals. This permits a flow of current which energizes the magnet M, causing it to draw down the armature a and impart

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a partial rotation to the ratchet wheel w. As the current ceases the armature is retracted by the spring b, without, however, moving the wheel w. With the stoppage of the current the plates t t cease to be attracted and separate, thus restoring the circuit to its original condition.

Coming now to later developments of a practical nature in the line of solar engines and boilers, we may take up the work of Mr. Shuman, of Philadelphia, Pa., who later collaborated with a Mr. Boys, of England. They were able in their final developments to operate a 100 horsepower engine by means of solar energy. This plant was built at Meadi on the Nile, Egypt, and is shown in the large illustration here reproduced at Fig. 3. Prior to this excellent work, however, we may consider briefly the early solar engines developed and tried out at Philadelphia, Pa., by Frank Shuman, upon which work he started in 1906.

A year later he had running at Tacony, Pa., a practical plant of this type, which developed about 3½ horsepower by using 1,200 square feet of sunshine that was allowed to fall on a fixed, horizontal water box. This box was fitted with a glass top and a series of parallel horizontal black pipes were immersed in the water. These pipes, containing ether, exposed 900 square feet of surface to the solar radiation. The water also became heated and carried the heat to the underside of the pipes, thus realizing a greater efficiency. The ether boiled and its "steam" drove a small vertical, single cylinder engine. The exhaust ether vapor passed into an air surface condenser and the liquid ether from this was pumped back into the tubes of the sun boiler. It was found that this plant worked well even with snow on the ground, which is explainable from the fact that the permeability of the atmosphere is about 20 per cent. greater in winter than in summer.

Further tests and refinements to the Tacony plant by Mr. Shuman resulted in 1911 in an engine and boiler which showed considerable strides forward in their design, the ratio of 245 square feet of sunshine per one brake horsepower having been attained.

It may be mentioned here that the pipes constituting the sun boilers have invariably been *blackened*. For low temperatures lampblack has been used as the absorber, but where high temperatures were required platinum black was used.

The illustration Fig. 3 is that of the solar energy plant built at Meadi on the Nile, Egypt, by Messrs. Shuman and Boys in conjunction with several English scientists, including Mr. A. S. E. Ackerman, B.Sc. This plant made use of a 100 horsepower Shuman engine coupled with suitable auxiliary apparatus, as before mentioned. Five absorbers of the reflection type were utilized, as the illustration portrays. Each one measured 15 feet wide by 205 feet long. These were placed north and south geographically speaking, and were automatically heeled over, by being placed on suitable wheels, from an easterly aspect in the morning to a westerly one in the evening, so as to actually follow the sun. This caused an approximately even absorption of the solar rays all day.

The total area of sunshine so collected at this plant was 13,269 square feet. Cast iron boilers of suitable design were placed at the focus point of the reflectors, as shown in the illustration. They were covered with a single layer of glass which enclosed an air space around the boilers proper. The concentration value of this arrangement was 4½ to 1. The maximum pounds of steam generated was 12 pounds per 100 square feet of sunshine, or the equivalent, to 183 square feet per brake horsepower. The best hours' run developed, at atmospheric pressure, 1,442 pounds of steam. Hence (allowing 22 pounds steam per brake horsepower) the maximum output for an hour was 55.5 horsepower (about ten times better than any previous results). This means 63 brake horsepower per acre of land occupied by the plant. Moreover, no marked reduction in the horsepower produced was noticeable in the early hours of the morning or in the late hours of the afternoon.

The engineers of the concern which made these tests at Meadi recommended that such solar plants were feasible and practical and that undoubtedly they would be a very good thing in such arid regions for irrigation purposes. One argument brought against them, however, was that the power would not be available in cloudy weather, but then the irrigation would not be necessary, was the reply.

Thus the fight goes on between Dame Nature and the scientists. Whether we shall ever have an efficient solar boiler and engine is a problem worth thinking about and a very interesting one at that, as we possess no greater source of natural energy, to be had without taxation or special leases from some money-grabbing coal, oil or other baron, than that of the sun. Some day we may be able to derive all necessary light and power, for our homes at least, by means of a solar-electric plant located on the roof, and who shall say that we must be taxed for utilizing such energy?

## THE TESLA HIGH FREQUENCY OSCILLATOR.

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thousands of horsepower? However, this figures out better than might be expected offhand. With an input of 300 kilowatts at the Tesla coil primary exciting such a structure and considering that this amount of energy is discharged through the earth in six-thousandths (.006) of a second, then the rate of liberation of the energy will be 120,000 horsepower.

Many perhaps would doubt that even with their small experimental high frequency sets, where a high frequency ammeter placed in the high frequency circuit may register but *1 ampere effective current*, yet an average maximum surge for the oscillation passing through the circuit may and often does reach the value of *over 116 amperes*. As the amplitudes of each succeeding high frequency alternation is less than the one preceding it, of course the first oscillations are much higher than the average amplitude just mentioned, and consequently the peak value of the current which flows through the electrode and into a person (who may happen to be connected in series with a 110-volt, 32 candlepower lamp for demonstration purposes) may reach a very much higher figure than 116 amperes.

A tiny electric lamp on the front porch and another on the back porch, left burning all night, will keep night prowlers and burglars away, because no thief cares to take a chance in the light. They need darkness and black shadows for their protection. One two-candlepower lamp for the front porch and another on the rear porch can be turned on all night for a few cents a month, which is certainly cheap burglar insurance.