physical charts, and which was here named the Japanese Current, from its analogous relation to Florida and the Atlantic Gulf Stream. This Gulf Stream of the Pacific was then traced by direct observation and inference, from numerous authorities who were quoted, across the entire breadth of the Pacific, to the N.W. coast of America. Its effect on the climate of Sitka and Prince William's Sound were shown to be similar to that on the coast of Norway. The temperature and the wrecks of Japanese junks, the drift of timber to the Sandwich Islands, &c., proved the circulation of the waters around the lat. of 30°, to be the same as in the other thermal systems described. The ocean waters flow southward, down the American coast toward the Bay of Panama or the Great Bight, formed by the American Isthmus; and the new and very important current was then described, and the numerous authorities on which it might be established were quoted. It is a zone of *easterly* drift, between lat. 50° and 60° N., extending all across the Pacific, from the Pellew Islands, nearly to the Bay of Panama, and was named the Equinoctial Counter Current. This singular current has an exact relationship to the Guinea Current, on the opposite side. The origin of this was supposed to be due to the action of the N. N. E. and S. E. trade winds, forcing the waters up to these latitudes, cause them to reverse their normal action; and thus the waters appear all to flow toward that one point, of such great interest at the present time. The navigation about Panama was shown to be very critical and difficult. Respecting the question of the level of the two oceans, if it were not for the counter current it might be reasonably supposed that the Atlantic would be several feet higher than the Pacific, from the waters in each ocean being drifted to their western sides, but which are thus almost exactly balanced. After some complimentary remarks from the President, the meeting was adjourned.

On Ericsson's Hot Air, or Caloric Engine; by William A. Norton, Professor of Civil Engineering in Yale College.*

The engines of the Caloric Ship Ericsson consist of four large double cylinders, "standing in a fore-and-aft line; two before and two abaft the shaft of the paddle wheels, and working in pairs upon it." Each cylinder is double, the two cylinders being placed one above the other. The lower one, which is the larger of the two, is called the working cylinder, and the other the supply cylinder. The working cylinder is entirely open at the top, and the supply cylinder at the bottom. The pistons which play in the two cylinders are connected by eight strong iron columns, and move up and down together; the length of the stroke is therefore, of necessity, the same for each, viz: 6 feet. For the sake of distinction, the piston in the working cylinder is called the working piston, and the piston in the supply cylinder the supply piston. Underneath each working cylinder is a furnace, which heats the air in this cylinder beneath the piston, and by thus increasing its expansive force, furnishes the motive power of the engine. The expansive force of this heated air drives the working piston up, and with it the supply piston. During the ascent the air above the supply piston which is compressed before it passes through a communicating pipe into the working cylinder, and receiving an accession of heat keeps up the ascensional force. When the pistons have reached their highest point, a valve is opened by the machine, which establishes a free communication between the compressed and heated air under the working piston and the external air; it flows out, and the two connected pistons descend by their own weight. It is to be observed, however, that the mechanical effect of this descending weight is but a compensation for the diminution of mechanical effect produced by the same weight in the ascent, and that the weight of the pistons therefore forms no part of the real motive power of the engine.

Confining our attention to the pair of double cylinders posited on either side of the main shaft, in the vacant space between the working and supply cylinders is placed a horizontal working beam, turning upon a shaft lying between the two double cylinders. One of the supply pistons is connected with one end of this working beam and the other with the other end; by means of links and connecting rods: and so, by the alternate action of the two working pistons, a reciprocating movement is communicated to the working beam. It will be seen therefore, that *one double cylinder*, with the necessary appurtenances, *constitutes a single acting engine*, and that *each contiguous pair of double cylinders*, standing on either side of the main shaft, by the connection of their pistons with the opposite ends of a working beam, *form a double acting engine;* that they accomplish the same end as one double acting steam engine.

The shaft of the paddle wheels of the Ericsson is, accordingly driven by two double acting engines; one before and the other abaft the shaft. Each of these engines has its separate working beam. The power is transferred from each of these working beams to the shaft, (which, it is to be observed, is considerably elevated,) by means of a connecting rod passing from the nearer end to the crank of the paddle-shaft. The two connecting rods are attached to the same crank-pin; and the relative position of the shaft and working beams is such that each of the connecting rods has a mean deviation of about 45° from the vertical position, and when one rod is passing the dead centre the other is acting upon the shaft with the maximum leverage.

From what has been stated, it will be seen that in studying the essential theory of the new engine, we may confine our attention to one of the double cylinders with its accompanying mechanical arrangements, which taken together form one single acting engine. The essential parts of this engine are shown in the annexed diagram, which is a copy of Ericsson's representation of the stationary engine. These are, respectively, the double cylinder, with the pistons and piston rods; the furnace, a large vessel communicating by pipes with the top of the supply cylinder and the bottom of the working cylinder, called the *Receiver*; and a piece of apparatus placed in the lowermost of these pipes, called the *Regenerator*. The working piston in the engines of the Ericsson, has a diameter of 14 feet, and the supply piston a diameter of 11 feet 5 inches. The ratio of the areas of these pistons, and therefore also the ratio of the volumes of the two cylinders is as 3 to 2. The working piston is six feet deep, and concave underneath to fit the cylinder-bottom. The top and bottom, as well as the sides, are of iron, but the space between them is filled with gypsum and charcoal, non-conductors of heat. The packing of the piston is at the top. The working cylinder is of necessity prolonged six feet below the position of the top of the piston when at its lowest point, thus forming a large vessel called the heater, or heating chamber, into which the air passes from the receiver. By this arrangement the packing at the top of the piston never comes into contact with any portion of the cylinder that is touched by the hot air. The grate of the furnace is five feet below the apex of the dome-shaped cylinder-bottom. Anthracite coal is used, and acts by radiant heat alone. The supply cylinder is merely a great condensing air-pump, which forces fresh air into the receiver, to be thence transmitted to the heating chamber under the working piston. The supply piston is furnished with thirty-six self-acting valves, which open upwards and through which the air is admitted into the cylinder, in the descending stroke of the piston. During the ascending stroke these valves remain closed, and the compressed air opens another set of valves at the top of the cylinder, and flows along the connecting pipe into the receiver. These two set of valves may be called respectively, the *outlet* and the *inlet* vales. The valve arrangement represented in the diagram is a little different: both

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