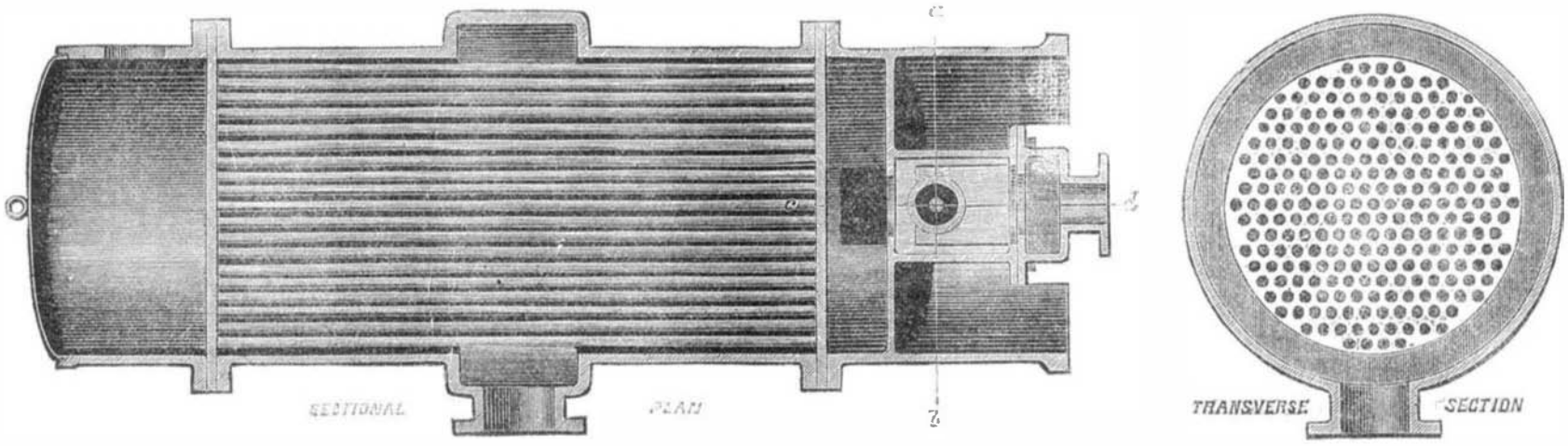
HORIZONTAL COMPOUND ENGINE.

Nearly every day we hear of some novel application of the compound principle in steam engine building; and the interest of the engineering profession in this construction induces us to publish (on the opposite page) a plan and elevation of a horizontal compound engine, recently built by Messrs. Hathorn, Davis & Co., of Leeds, England, for use in a large cement factory on the bank of the Thames. We also give herewith complete details (in section) of the condenser.

The Engineer, to which we are indebted for the engravings, says: The engine is of the fly wheel type; the high pressure cylinder is 12 inches in diameter, the low pressure cylinder is 28 inches in diameter, length of stroke is 3 feet. The valves of the two cylinders are outside. The high pressure cylinder has an ordinary main valve and an expansion valve, with a hand wheel adjustment, so that the cut-off can be altered when the engine is at work; the high pressure valves are actuated by a separate shaft worked by a small fly crank. This engine has both injection and surface condensers.

In the surface condenser the tubes and tube plates are of gun metal; the tubes are packed—as shown in the illustration—simply with india rubber rings. This engine has been working for upwards of nine months, with an average consumption of 2½ lbs. of coal per horse power per hour. The boiler is a 50 horse power Howard, and supplies plenty of steam to drive the engine when indicating 150 horse power.



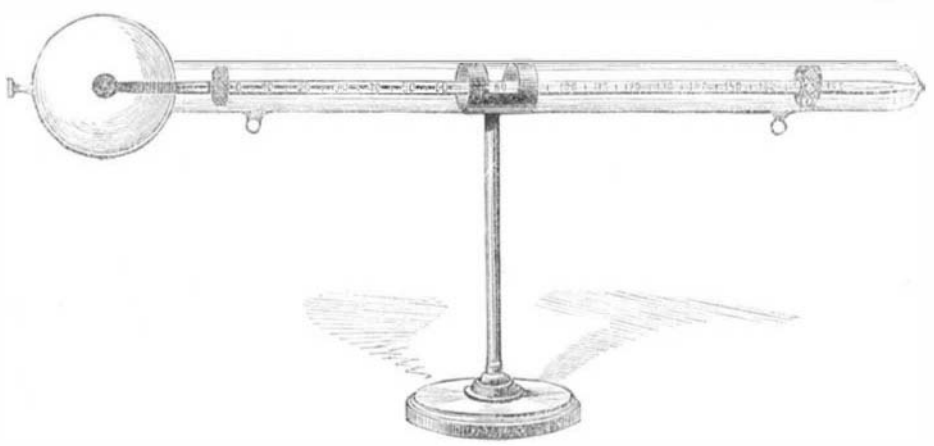
HATHORN & CO.'S COMPOUND ENGINE—THE CONDENSER.

SOLAR RADIATION THERMOMETER.

For the purpose of measuring the intensity of sunshine, various kinds of thermometers have been, and are still, employed by meteorologists. The thermometric fluid is always mercury for these instruments, because spirit is too volatile at great heat. An ordinary thermometer would merely indicate the intensity of solar heat at the instant of observation; hence, self-registering maximum thermometers, which show the highest degree of heat during the interval of exposure, are generally used.

Notwithstanding the progressive modifications made in solar radiation thermometers, even those *in vacuo* frequently give discordant indications in the same conditions of exposure as regards time and place.

In 1873, Messrs. Negretti and Zambra invented a special contrivance, shown in our engraving, taken from *Engineering*, for depriving the instrument of all uncertainty regarding the extent of the vacuum. It consists of a small mercurial tube and cistern gage (a miniature barometer) inserted in the jacket. This gage shows at any time the pressure of any air or vapor which may be left inclosed. As its tube is very small, the mercury will be depressed a certain extent by capillary action, and so it will indicate too little rather than otherwise. Possibly the presence of mercurial vapor in the vacuum may prove objectionable; for, by continual heatings, the mercury will vaporize out of the cistern, and may condense in some other parts of the jacket. Instruments fitted with these gages show, however, that, as the best makers have always affirmed, the pressure is reduced to $\frac{1}{120}$ part of an atmosphere, that is, to a quarter of an inch of mercury, and even less. It is possible to reduce the pressure within one fiftieth of an inch, without resorting to the Torricellian mode of producing a vacuum, which, excepting the presence of mercurial vapor, may be regarded as perfect.



NEGRETTI AND ZAMBRA'S SOLAR THERMOMETER.

The Lights of the Heavens.

The spectroscope has explored the far-off space of heaven. The light of hundreds of stars has been analyzed, and nebulæ, scarcely visible, have had the quality of their radiations revealed by its aid. The light, in some cases very feeble, with which a number of stars shine, gives a spectrum with dark lines like the solar spectrum, and this fact proves to us that the constitution of these stars is like that of our sun. Aldebaran sends us records of hydrogen, magnesium, and calcium, which abound in solar light, but also those of metals which are rare or absent, as tellurium, antimony, and mercury.

Nebulæ, twenty thousand times less brilliant than a candle at a distance of 13,000 feet, have still given a spectrum; for their light, although feeble, is very simple in its constitution, and the spectrum which it gives consists only of two or three bright bands, one of hydrogen, the other of nitrogen. These nebulæ, which give a spectrum of bright lines, are those which the most powerful telescopes cannot resolve; there is an "abyss" between them and resolvable nebulæ, which, like ordinary stars, give a spectrum with dark lines.

What an effort of the human mind! To discover the constitution of stars of which the distances are unknown, of nebulæ which are not yet worlds; to establish a classification of all the stars, and still more to guess their ages—ah, tell me, is not this a triumph for Science? Yes, we have classed them according to their ages. Stars colored, stars yellow, stars white; the white are the hottest and the youngest; their spectrum is composed of a few lines only, and these lines are dark. Hydrogen predominates. Traces of magnesium are also met with, of iron, and perhaps of sodium; and if it is true that Sirius was a red star in the time of the ancients, it owed perhaps its tint to the greater abundance of hydrogen at that epoch. Our sun, Aldebaran Arcturus, are among the yellow stars. In their spectra the hydrogen lines are less developed, but the metallic lines are fine and numerous. The colored stars are not so hot and are older. In consequence of their age, they emit less vivid light. In them there is little or no hydrogen. Metallic lines abound, but one also finds channelled spaces like the lines of compounds. The temperature being lower, these latter can exist whether they consist of atoms joined to others of the same kind, or whether they contain groups of heterogeneous atoms.

As to matter, it is everywhere the same, and the hydrogen of water we meet with in our sun, in Sirius, and in the nebulæ, everywhere it moves, everywhere it vibrates; and these movements which appear to us inseparable from atoms are also the origin of all physical and chemical force.—*M Wurtz.—Proceedings of French Association.*

White Opaque Glass.

One of the most interesting and important kinds of colored glass, says Philip Fischer, in the *Glashutte*, is the so-called "bone glass," and yet very little has been said about it in glass literature. Its name hints at its composition and nothing more, especially since cryolite has come to be used in the manufacture of glass. This kind of glass is used for lamp shades and globes to protect the most important organ of the human body, the eye; and formerly it was both rare and expensive. Cryolite, however, has effected as great revolution in the manufacture of white glass as petroleum has in the means of illumination. What part the chief constituent of the bone, the phosphate of lime, played in the manufacture of the bone glass was not exactly understood, and a still thicker veil is drawn over the action of the fluoride of lime, soda, and alumina, known as cryolite. It is to offer some explanation of this action that Fischer takes up this interesting branch of the glass industry. Phosphoric acid is, at high temperatures, a very powerful acid—so much so that no other acid is able to displace it. Hence we may reasonably suppose that the phosphate of lime remains suspended, as such, in the molten mass of glass. This, too, is indicated by the fact that when an excess of bone dust is added to the glass, or on suddenly cooling it, it is rough on the surface; but if the glass has the proper constitution, it remains perfectly smooth. How may the action of cryolite be explained? The power of hydrofluoric acid to etch glass and render it matt is well known, and depends on the decomposition of the silicates, taking from them a part of the silica, and the soda or potash, so as to form a compound known as fluosilicate of soda or potash, and then flying off in form of a vapor. We all know that this takes place, to a greater or less extent, in every cold, completely formed glass; how much easier and better would this process take place under the ægis of heat? Thus the phenomenon appears to a greater degree in the process of fusion.