*Surface Condenser.*—A three-horse power high-pressure steam-engine was procured for our experiments. Wishing to give it equal power with a lower pressure, we caused the steam from the eduction port to pass downwards through a perpendicular iron gas-pipe, ten feet long and an inch and a half in diameter, placed within a larger pipe through which water was made to ascend. The lower end of the gas-pipe was connected with the feed-pump of the boiler, a small orifice being contrived in the pump cover in order to allow the escape of air before it could pass, along with the condensed water, into the boiler. This simple arrangement constituted a "surface condenser" of a very efficient kind, giving a vacuum of 23 inches, although considerable leakage of air took place, and the apparatus generally was not so perfect as subsequent experience would have enabled us to make it. Besides the ordinary well-known advantages of the "surface condenser," such as the prevention of incrustation of the boiler, there is one which may be especially remarked as appertaining to the system we have adopted, of causing the current of steam to move in an opposite direction to that of the water employed to condense it. The refrigerating water may thus be made to pass out of the condenser at a high temperature, while the vacuum is that due to a low temperature; and hence the quantity of water used for the purpose of condensation may be materially reduced. We find that our system does not require an amount of surface so great as to involve a cumbrousness or cost which would prevent its general adoption, and have no doubt that it will shortly supersede that at the present time almost universally used.

## IV. "On the Stability of Loose Earth." By W. J. Macquorn Rankine, Esq., C.E., F.R.SS. L & E., Regius Professor of Civil Engineering and Mechanics in the University of Glasgow.

(Abstract.)

The object of this paper is to deduce the mathematical theory of that kind of stability which depends on the mutual friction of the parts of a granular mass devoid of tenacity, from the known laws of friction, unaided by any hypothesis.

The fundamental principle of the internal stability of such a mass has already been published in the 'Proceedings of the Royal Society' for the 6th of March, 1856, viz. that the ratio of the difference to the sum of the greatest and least pressures at each point of the mass must not exceed the sine of the angle of repose.

The principles of the general theory of the internal equilibrium of a solid mass are expressed in a form suited to the special subject of the paper. For the purpose of determining the conditions of equilibrium under its own weight, of a solid mass whose upper surface is that generated by the motion of a horizontal straight line along a line of any figure described on a vertical plane at right angles to the generating line, the mass is supposed to be divided into *layers of equal horizontal thrust* by a series of surfaces, which layers are subdivided into elementary horizontal prisms by vertical planes normal to the vertical plane first mentioned. For independent variables there are taken the horizontal coordinate in this plane, and the total horizontal thrust from the upper surface down to a given surface of equal thrust. The condition of equilibrium of any one of the before-mentioned elementary prisms being expressed by a differential equation in terms of those variables, the integration of that equation gives the vertical coordinate of any surface of equal thrust in terms of the total thrust down to that surface and of the horizontal coordinate. The integral obtained belongs to a class first investigated by Fourier.

An approximation to the forms of the surfaces of equal thrust is obtained by a simple graphic process, first employed by Prof. William Thomson in connexion with the theory of electricity.

It is shown incidentally how the same integral may be applied to determine the intrados from the extrados of any arched rib, loaded only with its own weight.

The pressure on a surface of equal thrust is vertical; the pressure on a vertical plane at a given point is parallel to the surface of equal thrust traversing that point. When the upper surface of the mass of earth is one plane, horizontal or inclined, the surfaces of equal thrust are planes parallel to it. When the upper surface presents elevations and depressions, the surfaces of equal thrust have corresponding elevations and depressions, gradually vanishing as the depth increases.

The principles of the paper are applied to the determination of the pressure of earth against walls, and the power of earth to sustain buildings. The weight of the building which a horizontal bed of earth will sustain, exceeds the weight of the earth displaced by the foundation, in a ratio which is a function of the angle of repose.

V. "On the Geometrical Isomorphism of Crystals." By Henry James Brooke, Esq., F.R.S., Hon. M.C.P.S. &c. Received June 11, 1856.

(Abstract.)

The author commences by remarking that all the crystals at present known have been divided into the six following groups or systems:—the cubic, pyramidal, rhombohedral, prismatic, oblique, anorthic.

He then states that he has constructed tables which accompany this paper of the minerals comprised in each of these systems, except the cubic, in a manner new, as he believes, to crystallography; and that the unexpected facts exhibited by the tables present that science under a new aspect.

The author explains briefly the language and notation he employs in discussing the results of the new tables.

It appears that the crystals in each system, except the cubic, are distinguished from each other by what are termed their elementary angles, that is by angles between particular faces of what may be termed elementary forms.

It is next observed that there is not in crystals any natural character which indicates an elementary or primary form, and it is shown that cleavage which Hauy regarded as such an indication, is only a physical character depending upon the degree of force with which the crystalline particles cohere at the surfaces of particular faces.

The question of high indices is also considered with reference to their influence on the choice of an elementary or primary form, and a general explanation is given of the nature of such indices.

The author then states that the most important of the facts presented by these tables, are the horizontal ranges of nearly equal