is particularly noticeable in thin films of mica and selenite, and it serves as an excellent means for selecting eighth and quarter wave plates, which are useful in the study of circular and elliptical polarization.

As stated in a former article, the writer intends to deal sparingly with the theoretical part of the subject, that having been treated extensively in many physical works and in books especially devoted to light and optics. "Ganot's Physics" is prominent among works of its class, and "Light," by Lewis Wright, and "Polarization of Light," by William Spottiswoode, are excellent books bearing directly on the subject. The writer knows of no better means of securing a good knowledge of polarized light than by reading these three books.*

Returning to the matter of the thin films: It is quite difficult to produce a perfectly uniform thin film of selenite, owing to the brittleness of the material. For this reason, mica is generally used, as it possesses considerable flexibility and toughness. The common method of cleaving off thin films of mica is to split off a moderately thin plate and then separate the laminæ at one of the corners by bending it between the thumb and fingers. A medium sized sewing needle secured point outward in a slender handle is probably the best instrument for teasing the laminæ apart; but after the separation begins, the thin end of the ivory handle of an ink eraser seems to serve the purpose exceedingly well.

A score or so of plates are split, and examined one by one in the Norremberg doubler, by laying them on the mirror and turning them in their own planes, while the polarizer and analyzer are parallel. Should the plates exhibit any unevenness under the test, they should be at once rejected. Such as exhibit an even tint should be preserved carefully, and examined further to determine which, if any, possess the required qualities. Not every piece of mica will split evenly, therefore it may be necessary to make several trials before success is attained.

Should the film, when placed on the stage, exhibit a dull plum color, slightly inclined toward red, when the polarizer and analyzer are parallel, it produces a difference of phase of half a wave length, and is called a half wave film. As a matter of course, if two films of like thickness, superposed and arranged with their axes in the same direction, produce the same color under the same circumstances, they are one-fourth wave films; and if a pair of films exhibit the same color when similarly arranged on the mirror of the doubler, they may be regarded as eighth wave films, as the polarized beam passes twice through the film to produce the same tint. These films should be carefully mounted between glass plates, either dry or in benzole balsam, the latter being preferable.

The practical application of the eighth and quarter wave films will be treated in a future paper. Beautiful and instructive designs made from thin films are described and illustrated in Wright's "Light," to which reference has been made.

* These books may be had at this office at publishers' prices.—ED.

WINDING ENGINE FOR AUSTRALIA.

The winding engine illustrated by the accompanying engraving, which we take from *The Engineer*, was

GERBOZ'S ALARM THERMOMETER.

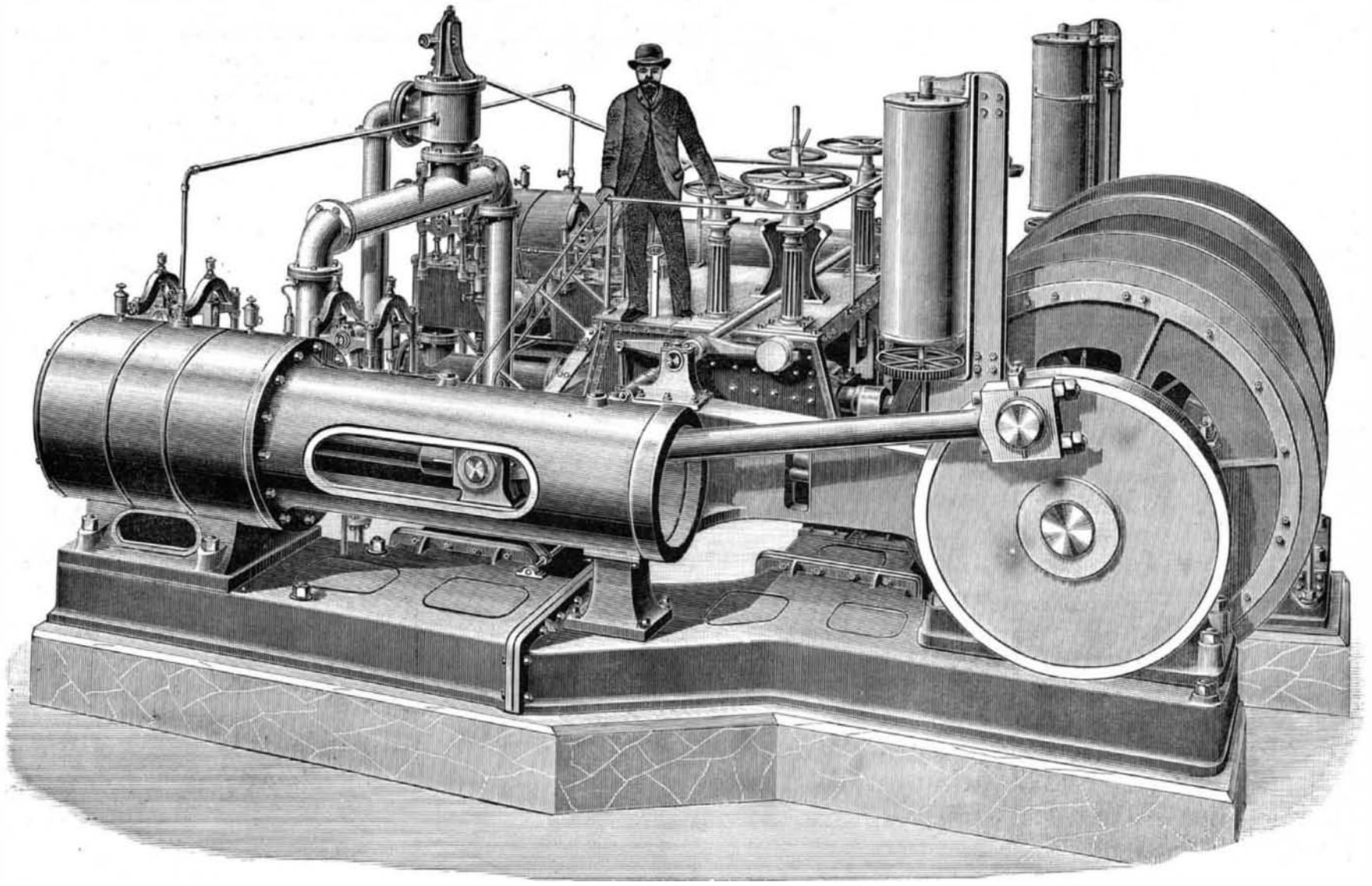
made by Messrs. Tangye, of Birmingham, England, under the instructions of Mr. J. D. Baldry, M.I.C.E., for use in the extensive coal mines of the Australian Agricultural Company, of New South Wales. This design, which, in some respects, is a departure from general practice, has proved satisfactory in all respects, and has met with special approval from mining engineers in the colonies. The cylinders are 32 inches in diameter by 48 inches stroke, and are steam-jacketed, with separate steam pipes and valves for supplying the jackets direct from the main supply pipe. The steam and exhaust valves are of the Cornish type, double beat equilibrium, two separate nozzle boxes being fitted to each cylinder containing the valves.

The crank shaft is of Siemens-Martin steel, 10½ inches in diameter at the journals. The bearings are in three parts, of gun metal, with wedges and screws for adjustment, and arranged so that they can be removed without taking out the shaft.

The hauling drums are 6 feet in diameter by 3 feet wide, are loose on the shaft, and are driven by steel clutches. Each drum is provided with a brake, fitted with oak blocks. Between the engines is a raised platform, on which are placed the clutches, brakes, wheels, reversing lever, steam valve handle, and rods for working the condenser steam cocks. The engines, platform, etc., are mounted on a strong cast-iron bed plate.

As these engines are to haul about 2,000 yards, they are fitted with an arrangement for accurately indicating the position of the tubs at any point in their journey. This consists of a vertical drum rotated by gearing, and having traced upon it a spiral line, along which the positions of the various stations are marked. A pointer moving on a screwed shaft, driven by worm gearing from the main drum, traverses the spiral, and so indicates the position of the truck.

The speed of hauling is 9 miles per hour, and about eighty skips, of 10 cwt. each, make up a load.



COLLIERY WINDING ENGINE FOR AUSTRALIA.

THERMOMETER WITH ELECTRIC ALARM.

The thermometer figured herewith is designed for giving indications as to the temperature of silos, grain depositories, piles of coal, or certain fabrics that are apt to burst into flame spontaneously and set fire to factories or ships.

The thermometer used is a metal one, of the Bourdon type, inclosed in a strong cast iron box, provided with a cover of the same nature. This latter is omitted in the figure, so that the internal arrangement may be seen. This box is everywhere perforated, so that the thermometer may be in contact with the surrounding air. The apertures, however, are small enough to prevent the entrance of particles of coal or fragments of seeds, etc.

The apparatus, when placed in a coal bunker or a silo, is connected with the exterior by means of conductors that traverse the surrounding substance, and that serve to indicate, at every moment, that the temperature has or has not reached a dangerous height. As soon as the needle of the thermometer strikes an index, placed at the degree of temperature that it is important to know (50°, for example, showing that there is danger of fire), a bell rings.

We shall now give a few details of construction: As the rotary axis of the needle and that of the index are on the same line, contact between these two pieces takes place at the same point, whatever be the respective angular position of these two parts. Instead of being a simple rod, making one piece with the maneuvering button, the index is composed of a barrel that forms one piece with the button, and upon which is mounted (1) the index needle properly so called, (2) a spring for holding the index in a constant position with respect to the barrel, and (3) a toothed pinion. This latter gears with a cog wheel upon the same axis with the polarized armature of an electro-