Kwangtung Province, a Chinese Government monopoly. which is farmed out by the Salt Commissioner, and by him licenses are granted to the local iron founders on a payment of a heavy fee. Considerable care has to be used in packing the pans for export, in order to prevent breakage, which, however, frequently occurs when any considerable number of pans is shipped to Australia or other distant ports. An attempt was made some years back to cast rice pans in Hong Kong, but the locality chosen—Shau-kiwan—being an unhealthy one, many of the Workmen died, others left the place sickly and fever-stricken, and the concern, from this cause mainly, proved a failure.

PYROMETERS.

Mr. W. R. Browne, writing in *Nature*, gives an interesting bistorical sketch of the advances made in pyrometry :

The accurate measurement of very high temperature, he observes, is a matter of great importance, especially with regard to metallurgical operations; but it is also one of great difficulty. Until recent years the only methods suggested were to measure the expansion of a given fluid of gas, as in the air pyrometer; or to measure the contraction of a come of hard, burnt clay, as in the Wedgewood pyrometer. Neither of these systems were at all reliable or satisfactory. Lately, however, other principles have been introduced with considerable success, and the matter is of so much interest, not only to the practical manufacturer, but also to the physicist, that a sketch of the chief systems now in use will probably be acceptable. He will thus be enabled to select the instrument best suited for the particular purpose he may have in view.

The first real improvement in this direction, as in so many others, is due to the genius of Sir William Siemens. His first attempt was a calorimetric pyrometer, in which a mass of copper at the temperature required to be known is thrown into the water of a calorimeter, and the heat it has absorbed thus determined. This method, however, is not very reliable, and This was superceded by his well known electric pyrometer. rests on the principle that the electric resistance of metal conductors increases with the temperature. In the case of platinum, the metal chosen for the purpose, this increase up to 1400° C. is very nearly in the exact proportion of the rise of temperature. The principle is applied in the following man-ner: A cylinder of fire-clay slides in a metal tube, and has two platinum wires 1-100th inch in diameter wound round it in separate grooves. Their ends are connected at the top to two conductors, which pass down inside the tube and end in a fire-clay plug at the bottom. The other ends of the wires are connected with a small platinum coil, which is kept at a con-stant resistance. A third conductor starting from the top of the tube passes down through it and comes out at the face of the metal plug. The tube is inserted in the medium whose temperature is to be found, and the electric resistance of the coil is measured by a differential voltameter. From this it is easy to deduce the temperature to which the platinum has been raised. This pyrometer is probably the most widely used at the present time.

Tremeschini's pyrometer is based on a different principle, viz., on the expansion of a thin plate of platinum, which is heated by a mass of metal previously raised to the temperature of the medium. The exact arrangements are difficult to describe without the aid of drawings, but the result is to measure the difference of temperature between the medium to be tested and the atmosphere at the position of the instruments The whole apparatus is simple, compact, and easy to manage, and its indications appear to be correct, at least up to 800° C.

The Trampler pyrometer is based upon the difference in the coefficients of dilatation for iron and graphite, that of the latter being about two-thirds that of the former. There is an iron tube containing a stick of hard graphite. This is placed in the medium to be examined, and both lengthen under the heat, but the iron the most of the two. At the top of the stick of graphite is a metal cap, carrying a knife-edge, on which rests a bent lever presed down upon it by a light spring. A fine chain attached to the long arm of this lever is wound upon a small pulley; a larger pulley on the same axis has wound upon it a second chain, which actuates a third pulley on the axis of the indicating needle. In this way the relative dilatation of the graphite is sufficiently magnified to be easily visible.

A somewhat simular instrument is the Gauntlett pyrometer,

which is largely used in the north of England. Here the instrument is partly of iron, partly of fire-clay, and the difference in the expansion of the two materials is caused to act by a system of springs upon a needle revolving upon a dial. The Ducomet pyrometer is on a very different principle, and only applicable to rough determinations. It consists of a series of rings made of alloys which have slightly different melting points. These are strung upon a rod, which is pushed into the medium to be measured, and are pressed together by a spiral spring. As soon as any one of the rings begins to soften under the heat, it is squeezed together by the pressure, and, as it melts, it is completely squeezed out and disappears. The rod is then made to rise by the thickness of the melted ring, and a simple apparatus shows at any moment the number of rings which have melted, and therefore the temperature which has been attained. This instrument cannot be used to follow variations of temperature, but indicates clearly the moment when a particular temperature is attained. It is, of course, entirely dependent on the accuracy with which the melting points of the various alloys have been fixed.

Yet another principle is involved in the instrument called the "thalpotasimeter," which may be used either with ether, water or mercury. It is based on the principle that the pressure of any saturated vapor corresponds to its temperature. The instrument consists of a tube of metal partly filled with liquid, which is exposed to the medium which is to be measured. A metallic pressure gauge is connected with the tube and indicates the pressure existing within it at any moment. By graduating the face of the gauge when the instrument is at known temperatures, the temperature can be read off directly from the position of the needle. From 100° to 200° F. ether is the liquid used; from thence to 680° it is water, and above the latter temperature mercury is employed.

Another class of pyrometers having great promise in the future is based on what may be called the "water-current" principle. Here the temperature is determind by noting the amount of heat communicated to a known current of water circulating in the medium to be observed. The idea, which was due to M. de Saintignon, has been carried out in its most improved form by M. Bouiler. Here the pyrometer itself consists of a set of tubes, one inside the other, and all inclosed for safety in a large tube of fire-clay. The central tube or pipe brings in the water from a tank above, where it is maintained at a constant level. The water descends to the bottom of the instrument and opens into the end of another small tube called the explorer (explorateur). This tube projects from the fireclay casing into the medium to be examined, and can be pushed in or out as required. After circulating through this tube the water rises again in the annular space between the central nine and the second pipe.

central pipe and the second pipe. The similar space between the second pipe and the third pipe is always filled by another and much larger current of water, which keeps the interior cool. The result is that no loss of heat is possible in the instrument, and the water in the central tube merely takes up just so much heat as is conducted into it through the metal of the explorer. This heat it brings back through a short india-rubber pipe to a casing containing a thermometer. This thermometer is immersed in the return. ing current of water and records its temperature. It is graduated by immersing the instrument in known and constant temperatures, and thus the graduations on the thermometer give at once the temperature, not of the current of water, but of the medium from which it has received its heat. In order to render the instrument perfectly reliable, all that is necessary is that the current of water should be always perfectly uniform, and this is easily attained by fixing the size of the outlet once for all, and also the level of water in the tank. So arranged, the pyrometer works with great regularity, indicating the least variations of temperature, requiring no sort of attention, and never suffering injury under the most intense heat; in fact, the tube, when withdrawn from the furnace, is found to be merely warm. If there is any risk of the instrument getting broken from fall of materials or other causes it may be fitted with an ingenious self-acting apparatus shutting off the supply. For this purpose the water which has passed the thermometer is made to fail into a funnel hung on the long arm of a balanced With an ordinary flow the water stands at a certain lever. height in the funnel, and while this is so the lever remains balanced ; but if from any accident the flow is diminished, the level of the water in the funnel descends, the other arm of the lever talls, and in doing so releases two springs, one of which in flying up rings a bell, and the other, by detaching a