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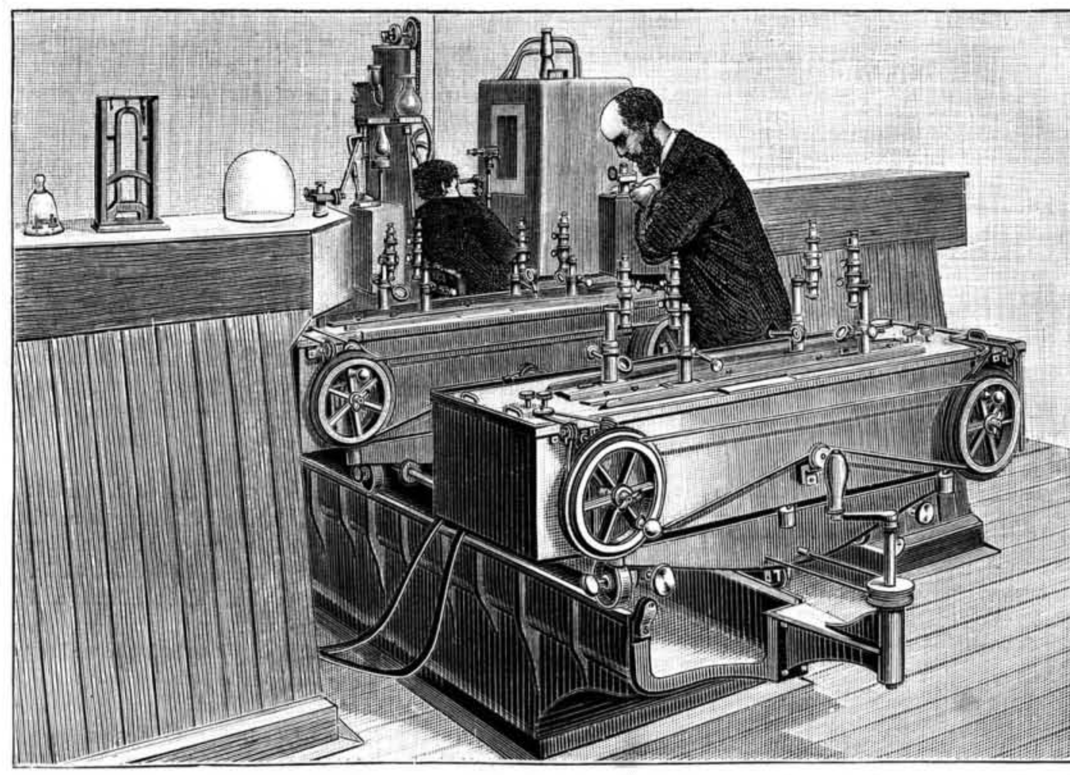
BLAKE'S COMPOUND STEAM PUMPS.

We illustrate one of Blake's compound high and low pressure steam pumps, manufactured by Messrs. S. Owens & Co., of White Friars Street, London, E. C. It has been constructed for the Southwestern Railway Company of Russia, and is capable of forcing 4,500 gallons of water per hour to a height of 500 feet through 10,000 feet of piping, with a boiler pressure of 80 pounds to the square inch. Our cuts and description are from *Engineering*. As will be seen from the perspective view below, the two steam cylinders are arranged tandem wise, their diameters being 8 inches and 16 inches respectively, while their stroke is 24 inches. The low pressure cylinder has two piston rods, which pass through long passages cast on each side of the high pressure cylinder, so that all the glands are close together. The three rods take hold of a common crosshead to which the piston rod of the pump cylinder is connected. This cylinder is 5½ inches in diameter and is brass lined. Its valves are of gun metal and have spindles projecting upward and working in heavy gun metal caps, each of which contains a spring. The valves are faced with the best oil dressed hydraulic leather secured by a central screw, and they bear on flat faces five-eighths of an inch wide. The steam valves are operated from the crosshead through a rock shaft worked by a vibrating arm. Upon the rock shaft is a lever, which by means of a connecting rod moves a sliding block backward and forward between two tappets on the rod of the auxiliary valve. The office of this valve, as is well understood, is to control the admission and exhaustion of steam to and from the double pistons above it, which move the two main valves of the steam cylinders. The steam from the boiler is admitted to the interior of the valve of the high pressure cylinder, and after expansion it exhausts into the valve box and proceeds to the larger cylinder, which has an ordinary D valve. The piston, which is shown nearly at the end of its stroke toward the right, is prevented from striking the covers by the use of supplementary exhaust passages, which can be more or less throttled at will. When the piston has covered the main exhaust



INSTRUMENTS FOR MEASURING EXPANSION.—INTERNATIONAL OBSERVATORY FOR WEIGHTS AND MEASURES.

, the remainder of the steam is confined and a cushion luced.

he pump is provided with an independent air pump and lenser, which are shown beside it in the perspective 7, while the condenser is to be seen in section in Fig. 3 7e. The connections are very clearly shown in the 7s; in the interior of the condenser hangs a copper float, 1ected by a rod to an air valve above it. When the in- of water to the condenser exceeds the amount removed he pump the ball rises and, opening the valve, destroys vacuum.

y the use of this separately driven condenser a vacuum be obtained before the pump is started, and the speed of air pump can be varied according to the temperature.

EORGIA's manufactured products will aggregate almost),000,000 this year.

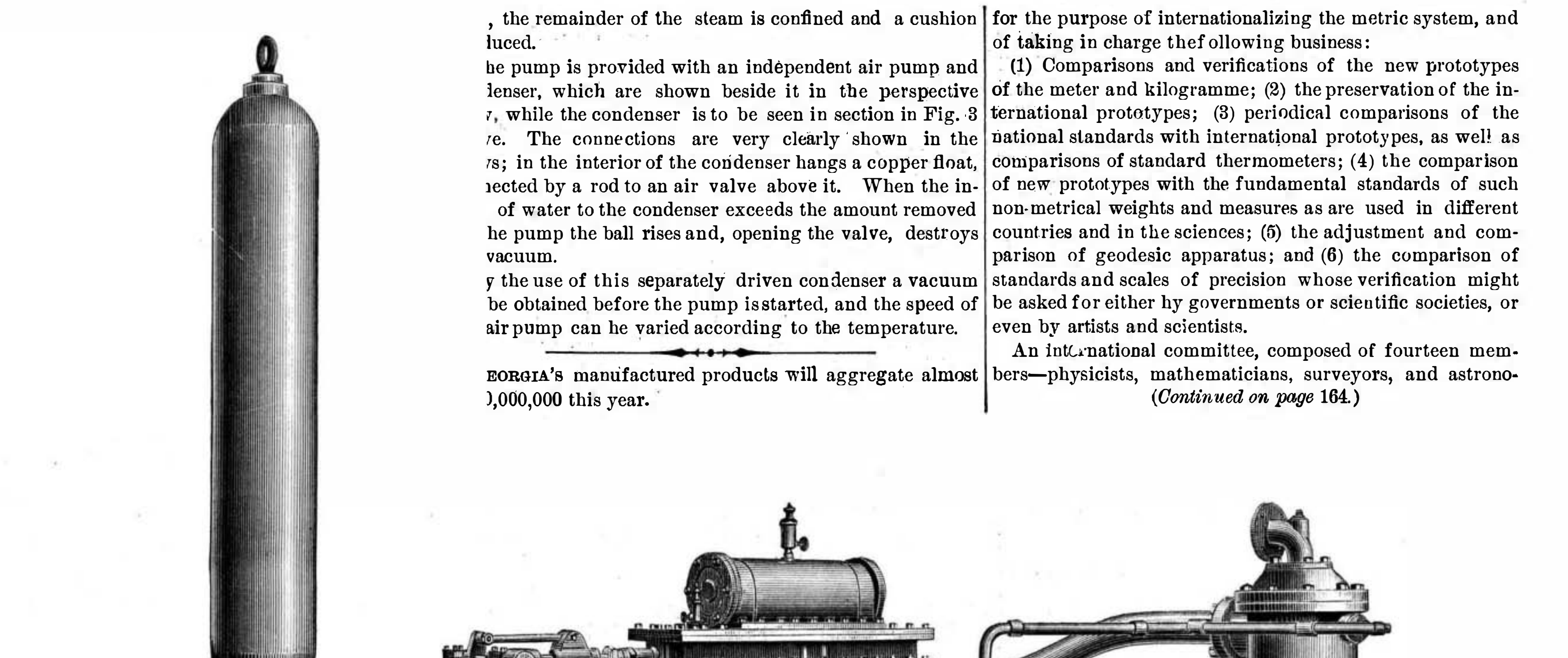
THE OBSERVATORY OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

As a consequence of an international convention held on the 20th of May, 1875, there has been created at Paris, says *La Nature*, an international bureau of weights and measures for the purpose of internationalizing the metric system, and of taking in charge the following business:

(1) Comparisons and verifications of the new prototypes of the meter and kilogramme; (2) the preservation of the international prototypes; (3) periodical comparisons of the national standards with international prototypes, as well as comparisons of standard thermometers; (4) the comparison of new prototypes with the fundamental standards of such non-metrical weights and measures as are used in different countries and in the sciences; (5) the adjustment and comparison of geodesic apparatus; and (6) the comparison of standards and scales of precision whose verification might be asked for either by governments or scientific societies, or even by artists and scientists.

An international committee, composed of fourteen members—physicists, mathematicians, surveyors, and astrono-

(*Continued on page* 164.)



COMPOUND BLAKE STEAM PUMP WITH CONDENSER.

THE OBSERVATORY OF THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

(Continued from first page.)

mers—belonging to different nationalities has been charged with the direction of the bureau.

The president of this committee is General Ibañez, the Director-General of the Geographical and Statistical Institute of Spain, and its secretary is Dr. Hirsch, the Director of the Observatory of Neuchatel. The committee meets once a year at Paris.

Twenty countries (twenty-two if Austria and Hungary and Sweden and Norway be counted separately) were represented at the preliminary diplomatic conference of 1875, and seventeen (or nineteen) of these signed the international convention that was a consequence of it. A single one of these states not having ratified it, the expenses of founding and keeping up the bureau have been borne by the sixteen (or eighteen) following countries: Germany, Austria, Belgium, the Argentine Confederation, Denmark, Spain, the United States of America, France, Italy, Peru, Portugal, Russia, Sweden and Norway, Switzerland, Turkey, and Venezuela. This represents about 351,000,000 of inhabitants that have already contributed more than a million to the founding of the international bureau. More recently the government of Servia has joined the association.

In order that the necessary structures might be erected where no vibrations of the earth were to be apprehended, such as might occur from the passing of vehicles or the running of engines in the heart of a large city, France conceded the land that was formerly occupied in the Saint Cloud Park by the Breteuil Pavilion.

We have recently visited this new establishment—one of the most remarkable of modern scientific installations—and shall give a description of it.

In the front part of the bureau are the laboratories, and back of these are the large halls, through which are distributed the various instruments of precision that are employed in metrological operations. These halls have very thick walls, and receive their light from skylights above, which are arranged in such a way as to prevent the rays of the sun from entering. They are surrounded by a passageway that isolates them from the exterior. The object of these arrangements is to secure as nearly as possible a perfectly uniform temperature, this being a condition necessary for the success of certain operations.

The labors of the bureau are naturally divided into two sections, one of them having to do with standards of length, and the other with those of mass or weight. The first of these occupies itself principally with the establishing of the *equations* of the different standards; that is to say, with their lengths with respect to the prototype which is the universal starting point, the measurement of their expansions, and the study of their subdivisions. The section of weights determines how kilogrammes of the first order agree with the prototype kilogramme, graduates their subdivisions, adjusts specific weights, etc. These different labors are distributed among a certain number of observers, who constitute the *personnel* of the bureau.

We shall take a hasty glance at the principal instruments that belong to each section. These apparatus, which were constructed by one of the most skillful makers in Europe, realize in general the extremest limits of perfection that can be reached by the mechanics of precision.

The instruments of the section of lengths are called *comparers*. A comparer for meter rules consists essentially of two microscopes, which are firmly and immovably fixed, and which are provided with micrometers under which may be successively slid, by an appropriate mechanism, the two rules that it is desired to compare with each other. The bureau possesses several of these instruments, each of which has its special purpose and is consequently distinguished by characteristic peculiarities of construction. The first is the *Brunner comparer*, so called after the skillful makers who constructed it. This is designed for comparing meter rules in the air. The two microscopes are fixed by means of strong cramps to pillars composed of a single stone mounted upon a masonry foundation. The micrometers with which they are provided exhibit the general arrangement usual in astronomical instruments.

Each of them consists of a sort of rectangular, elongated, flat box fixed to the body of the microscope beneath the eyepiece. In this box slides from right to left a frame on which is stretched two very fine, parallel cobweb threads, which are placed very near each other. The sliding of this frame is effected very slowly by means of a micrometer screw, which is actuated by a nut whose circumference is divided into a hundred equal parts. When this nut is revolved by the observer it moves the screw, and this latter in turn moves the frame, along with the cobweb threads visible in the field and the microscope. The image of the division marks traced upon the rule, given by the objective, occurs in the plane of the threads.

To "point" a division is to cause the micrometer threads to coincide with the image of such division; that is to say, to bring the threads, through a play of the nut, into such a position that the division mark shall appear exactly between them; the position occupied by the threads is then given by a reading of the nut. If a second division mark happens to present itself under the microscope in a different position it is necessary, in order to "point" this in its turn, to move the threads; that is to say, to revolve the nut a certain number of divisions. Knowing the distance that corresponds to the moving of one division, the distance between any two marks may be deduced from such measurement. Beneath the microscope is situated the comparer, which consists, in the first place, of a strong cast iron frame, exceedingly strong and massive, forming through its upper edges a sort of railway, upon which runs a heavy carriage that is moved along at will, by means of a winch that actuates a system of gearings. Upon this carriage there is mounted a long metallic box having double sides, that is to say, two boxes, one set within the other. This box receives the two rules that are to be compared, these being placed, one near the other, in its axis, upon supports of an appropriate form. It contains the different mechanisms by means of which the observer, while having his eye at the microscope, can manipulate the rules, cause them to rise or descend, put them in focus at the two extremities and move them longitudinally or transversely as need be. It is capable of receiving, in addition, a certain number of thermometers, which are observed by the aid of special spy glasses carried by the lid that covers the whole and prevents rapid variations of temperature from occurring in the interior of the apparatus. The observer, through a motion of the carriage, brings successively under the microscope the two meter rules whose difference he desires to know, and "points" upon the division marks of each, and this operation, performed at the two extremities, furnishes the equation sought between the two rules.

A second comparer is one designed for measuring expansions, and this is the kind that is represented in the accompanying cut. As in the preceding instrument, we find here two microscopes with fixed micrometers, and a carriage running upon a railway, but carrying in this case two distinct boxes or troughs at a distance of about one meter apart. The two rules to be compared are each placed in one of the troughs, so that they are in a measure independent of each other and may consequently be raised to different temperatures. In order to measure the expansion of a rule, the latter is placed in one of the troughs, while in the other trough there is placed what is called a "comparison rule." This latter is kept, while the determination is being made, at an unvarying temperature, while the other is alternately heated and cooled, in a consecutive series of experiments, between quite wide limits. The rule to be tested, then, alternately contracts and elongates, and, in each experiment a comparison is made of the length that it assumed at the temperature to which it was carried with the constant length of the comparing rule. One of the great difficulties of such measurements is to maintain very constant temperatures for a sufficient length of time, especially when they are notably different from the surrounding temperature. To succeed in doing this the rules to be compared have to be immersed in a liquid, which latter is heated by means of a continuous circulation of water between the double sides of the trough. The rubber tubes seen in the cut are designed for this purpose. The water is supplied by a large metallic reservoir (outside of the hall) in which it is heated by means of a regulating system that causes it to issue at an invariable temperature. From thence it reaches the comparer through pipes, traverses the troughs in a continuous manner, and flows out afterward, through properly arranged waste pipes, into a drain. There may thus be maintained, to within a few hundredths of a degree, a constant thermic state up to 40°, for hours at a time.

The cut shows the principal details of the mechanism. There will be seen in front the winch which, through the intermedium of an endless cord, actuates the carriage and permits of one of the troughs being substituted for the other under the microscopes. On the sides will be observed long rods provided with buttons, which the observer finds always within his reach, whatever be the position that he occupies around the instrument, and which are likewise capable of acting upon the carriage, through a gearing underneath it, and moving it along with a slow and micrometric motion. Upon the covers will be seen the heads of the different keys that permit of rectifying all adjustments, as well as the spy-glasses by means of which the thermometers are read. The hand wheels placed in front of the trough serve to give a rapid rotary motion to the agitators, through the intermedium of cords and pulleys, so as to mix the layers of liquid in the troughs and secure a uniformity of temperature in all parts of the bath.

With these apparatus may be determined, to within *some ten-thousandths of a millimeter*, the difference that exists between two meter rules at a given temperature; it being necessary for this purpose, be it understood, that the division marks of such rules shall be traced with sufficient sharpness to allow of their supporting the magnifications employed.

The two preceding instruments compare only meter rules, but the *Universal Comparer* permits of comparing any lengths less than one meter or up to two meters. This instrument is entirely different in appearance from the others. The microscopes, which are always its essential members, instead of being fixed, are mounted upon carriages that run upon a sort of bridge placed horizontally between two stone pillars. This bridge is a large casting trimmed with steel planes upon its upper edges, which latter serve as a support and guide to the microscopes in their motions. It is perfectly rectilinear and horizontal. When, on rolling the carriages, the microscopes have been brought to occupy the position that they are to have for a given operation, they are fixed by tightening a clamp by the aid of a screw. Beneath there is, as in the preceding comparers, a heavy carriage carrying supports upon which are placed the rules to be studied. These supports are likewise provided with all the rectifying parts necessary, these being maneuvered by means of a mechanism that is so complicated that no idea can be given of it without the aid of figures.

This comparer contains, besides, a standard two meter rule, divided into centimeters throughout its length; two supplementary microscopes mounted upon a special carriage, and designed for graduating subdivisions of a meter; and different accessory pieces serving to compare rules of the same kind with each other or with other kinds. The instrument is wholly inclosed in a large mahogany box provided with the necessary apertures for lighting the different parts and for the transmission of motions to the outside, etc., and having the appearance of an elegant piece of furniture.

This beautiful collection is to be completed in a few months by the acquisition of a *Geodesic Comparer* for four-meter rules.

Origin of Nitrogen.

The authors, A. Muntz and E. Aubin, show that the only noteworthy agent for the production of nitric or nitrous acid from the free nitrogen of the atmosphere is the electric discharge. They consider that unless the supply of the oxides of nitrogen thus generated is greater in tropical regions than it has been found to be in Europe, it will be difficult to explain, by electricity alone, the compensation of the nitrogen which is incessantly wasted, and especially the accumulation of combined nitrogen which exists on the surface of the globe. Hence another cause must be sought for the production of nitrogenous compounds. It has been proved by the experiments of M. Boussingault upon plants, and those of M. Schloesing upon the soil, that neither of these is able to assimilate free nitrogen. Hence the authors are inclined to seek the source of combined nitrogen in the violent combustions which must have ensued at a certain stage of the earth's existence, when the elements which had been dissociated by an elevated temperature recombined in presence of oxygen and nitrogen, involving the formation of nitrous compounds. It is known, indeed, that large quantities of nitrous acid are formed whenever any body is burnt in air.

According to the authors' experiments, 1 grm. of hydrogen burning in air yields as much as 0·001 grm. nitric acid, while 1 grm. yielded as much as 0·100 grm. Hence at the first appearance of organic beings upon the earth, there existed a large stock of nitrogenous compounds in the air and the soil upon which we are still subsisting, and which is decreasing under the influence of the causes which effect the escape of free nitrogen, unless the supply is kept up by the action of atmospheric electricity.

Malarial Fever.

In the *New England Medical Monthly* is a communication from Dr. Rufus W. Griswold, of Rocky Hill, Conn., in relation to a case of litigation in Berkshire County, Mass., in which he was a witness. He sums up the facts and their conclusion in an abstract of the testimony to the effect that the flowing of land, and thereby creating a pond of water by a dam, the water being drawn continuously, is not a source of malaria—bad air—or a cause of unusual ill health. One of his best arguments was that the flowing of low lands for ponds to afford water power for manufacturing purposes is almost coeval with our existence as a nation, when we first began manufacturing, and when water power was the only power known for driving machinery. Whereas the low and tertiary fevers known now as "malaria" are of only recent importance. Dr. Griswold says:

"The verdict of the jury in favor of the defendants was the only one that the facts could allow. The best expert testimony the States can afford was brought into use to sustain the prosecution—not simply medical, but sanitary. But before a critical and caustic, but perfectly fair and honest, defense, also conducted by eminent and able counsel who demanded reasons for opinions, and did not allow opinions to go before the jury without reasons—the case of the prosecution, which sought to prove the sanitary and economic evils of the flowage, was a signal failure. The verdict will not be without its lesson to the medical mind, since it will help to enforce the thought that while it is perfectly easy to evolve theories out of coincident conditions, it is not so easy to present reasons for them that will carry conviction to the skeptical intelligence."

Photography of Love.

A Madrid photographer has, according to the *Archiv*, had a strange sitter to deal with lately. A young lady came to his studio to have her portrait taken. Having placed her in position, he turned to arrange his camera, when, casting a last glance at the posing belle before removing the cap from the lens, he was horrified to see that she was holding the muzzle of a revolver to her temple. "Stop! stop!" he cried; "you surely do not mean to kill yourself! You would ruin my business! and, besides, it would be a pity to spoil that pretty face!" The lady laughingly replied: "It gives me no pleasure to spoil one of your most beautiful productions, but I will tell you what I mean. My betrothed has deserted me, and I intend to send him a copy of my photograph in this position, with the remark that if he does not return immediately I shall pull the trigger." This astonishing intention was duly carried out, and a few weeks later the photographer had the pleasure of taking the newly married couple without the revolver, which apparently had done its work harmlessly.