THE GREAT TELESCOPE OF THE PARIS EXPOSITION OF 1900.

Among the scientific exhibits at the Paris Exposition of 1900 the great telescope will undoubtedly be the most interesting and important object shown. We have already given a brief description of this telescope, and we are now enabled to present views showing the construction and how the telescope will look upon completion.

It consists of a horizontal tube 197 feet long provided with an objective 4·1 feet in diameter. The image of the moon or stars will be sent through this tube by the aid of a Foucault sidérostat; that is to say, by a movable plane mirror. The focal length of the telescope of the Yerkes Observatory is but 65·6 feet, so that it will be readily seen that with a telescope whose focal length was 197 feet, it would be almost impossible to build a dome and mountings which would carry it. It is estimated that a 210-foot cupola would have been required, so the use of a fixed tube and a movable mirror for gathering the image may be regarded as an excellent solution of a mechanical difficulty. The sidérostat is undoubtedly the most interesting part of the instrument. It consists of a large cast-iron frame and is provided with clockwork and devices for causing the mirror to follow the celestial object which is being viewed. The frame is now under construction at the establishment of M. P. Gautier, a distinguished manufacturer of instruments of precision. It is 26¼ feet long, and the height is the same as its length. It is provided with six leveling screws which enter into sockets fixed upon a stone base 5·57 feet high. The hour axis is actuated by clockwork through the aid of tangent screws. The part of the instrument toward the south carries the mirror which is mounted in a cast steel cell lined with felt in order to prevent any contact of the mirror with the metal. The equilibrium of mirror and cell is obtained by means of levers and counterpoises. The base of this mounting floats in a reservoir 6½ feet in diameter and containing about 16 gallons of mercury. Owing to the application of the principle of Archimedes, the movable parts will be relieved of nine-tenths of its weight. The system of the levers and counterpoises is so well arranged that all of the movable parts can be actuated by hand even without the aid of the mercury. The total weight of the sidérostat is 99,000 pounds; the movable part weighs 33,000 pounds, of which the mirror and its cell weighs 14,740 pounds. A weight of 220 pounds is sufficient to actuate the clockwork.

The mirror has a diameter of 6·56 feet; it is 10·63 inches thick and its weight is 7,920 pounds, and it was, naturally, the most difficult part of the apparatus to construct. The glass was cast at the Jeumont Works, and a special furnace was constructed capable of holding 22·4 tons of glass. When the time for casting arrived, the mould, 6·72 feet in diameter and 12 inches thick, was brought to the furnace upon a truck, and then, after being filled, was introduced into the furnace, which had been raised to a high temperature. It was then walled up in this furnace, and the cooling required a month. Notwithstanding all the precautions, several of the disks that were cast broke in pieces with a loud noise. The transportation of such a huge disk of glass to Paris was a difficult matter, and a special train carried it there without stopping. A crane deposited the gigantic block on a wagon, and it was carried to the optical establishment at night, in order to have a clear roadway.

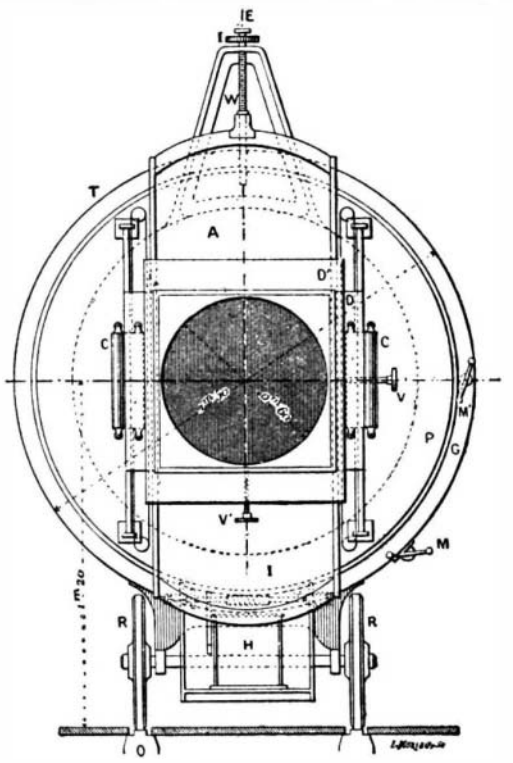
To obtain a fine disk of glass of such dimensions was, of course, difficult, but to give it a perfectly plane surface was a much greater one, and M. Gautier is to be congratulated upon the success which he has attained in performing this difficult operation.

The polishing machine, shown in our general and sectional view, was placed in a special shop protected as much as possible from variations in temperature by a double wooden wall. The grinding apparatus consists essentially of a large cast iron plate, *C*, covered with an inch of flannel, upon which the glass disk, *A*, was carefully laid.

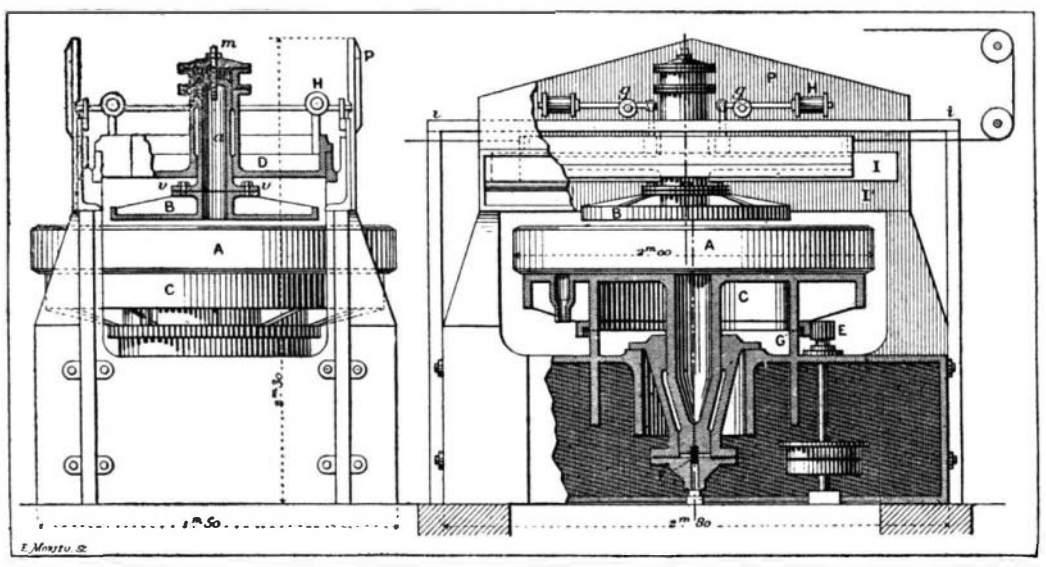
This plate revolves slowly around a vertical axis by gearing, *G*, the whole being stepped in a cone. Above there is a stationary circular bronze rubber, *B*, 47¼ inches in diameter, which is given a reciprocating motion by a slider, *I*, thus passing across the face of the mirror traveling in a circle beneath it. The perfect revolution of the plate and the accurate adjusting of the slides and their parallelism resulted in the production of a perfect mirror. It required three months to adjust the slides alone. The grinding of the mirror was done with a mixture of emery and water. During this operation a workman always stood at a respectful distance from the apparatus so as not to change the temperature of it. From time to time he injected a mixture of emery and water by means of a syringe into a channel running through the grinding plate and ending at the center. This work was carried on generally from 2 to 5 o'clock in the afternoon, the time of day when the temperature does not change perceptibly. The entire morning was devoted to the cleaning of the machine, and to the verification of the parallelism of the grinding plate with the surface of the mirror, an operation which was performed with four scales which were accurate to $\frac{1}{1000}$ of a millimeter.

As the grinding proceeded finer and finer emery was used, and the closer the grinding plate was brought to the surface of the glass. With the finest emery the distance between the plate and the glass was 0·008 inch. The grinding lasted eight months and was followed by the operation of polishing, which required two months. The lower surface of the polishing plate was covered with a sheet of albumenized paper like that used in photography, but unsensitized. The workmen spread upon this paper a small quantity of the finest Venetian tripoli and as much as possible was removed with a soft brush. The distance between the rubber and the surface of the glass was 0·0012 of an inch.

This method of treatment, notwithstanding its delicacy, produces enough heat to render the mirror slightly convex and cause it to draw away more strongly in the center, so that, upon cooling, it was hollowed at this point. In order to surmount this difficulty the slides were given a curve of which the pitch was 0·4 of an inch. The heat was diminished by operating the machine for a minute and then stopping for a quarter of an hour. When the hand is applied to the mirror, there occurs an extension of 0·0012 of an inch, which is sufficient to distort completely for four or five minutes the image of the flame of a lamp placed at one side of the plate and observed from the other with a small telescope arranged for the purpose. The next operation to be performed is the silvering, and, of course, it will have to be silvered anew from time to time. The mirror protrudes 5·4 inches from its tube or cell, which will be made to swing so as to bring the surface to be silvered underneath. The reservoir containing the bath will be lifted by means of a winch until the mirror enters it at a proper depth. When the operation is finished, the reservoir will be lowered and the silvered surface turned upward and the mirror readjusted in its cell.



EYEPIECE HOLDER.



SECTIONAL VIEW OF MIRROR-GRINDING APPARATUS.

The images of the mirror which are transmitted to the focus of the objective may be examined directly by means of an eyepiece or they may be thrown upon a sensitized plate or projected upon a screen placed in a hall set apart for that purpose so that several thousand people will be able to examine the celestial object at the same time. The tube of the telescope is a steel plate ¾ of an inch in thickness and 5 feet in diameter. It is made up of twenty-four sections joined with the aid of bolts. These sections when all mounted will rest upon a cast-iron base supported by stone columns. It is arranged so as to slide to take up the expansion and contraction. The tube plays no part in the formation of the images, nor does it serve for supporting the objectives in the eyepiece, but it prevents dust from introducing itself between the essential parts of the apparatus.

One of the objectives is designed for visual observations, and the other for photographic work. Both are mounted upon a carriage made to roll upon rails so that either of them may be easily placed in position before the tube. The weight of either of these objectives without its mounting is about 1,295 pounds and with the mounting 1,980 pounds. Each of the crown glasses is carried by rollers so that it may be separated from the flint glass in order to render the cleaning of each disk easy. The lenses will cost $120,000.

The disks were cast by Mantois, of Paris. Great attention was paid to the casting of the glass. Specimens of the glass was constantly taken out during the heating and examined with a lens under different conditions of illumination in order to judge of the degree of purity which they have reached. After several specimens have been found to be free from bubbles the temperature is reduced, the glass thickens, the crucible is opened and a certain portion of the surface is skimmed off to get rid of impurities. The glass is then stirred, and the cooling is allowed to proceed rapidly for five or six hours until the surface of the glass emits a well defined sound when it is struck with an iron bar. After this step it is necessary to proceed with annealing. The furnace is walled up and a cooling is allowed to proceed, which requires from four to six weeks. When the crucible is opened the glass is found to have been broken into pieces of varying sizes. In order to obtain a 792 pound flint glass lens it is necessary to find a block which weighs nearly 1,300 pounds, and such a block having been found among those in the furnace it is removed and placed upon a car. Slabs of glass are sawed from two parallel sides in order to obtain polished surfaces that facilitate a perfect examination of it. The striæ in the surface are removed, and if after this the block exhibits any defects situated at such a depth that they cannot be removed, it is submitted to a molding which changes its form and brings the chief defects near the surface. The block is placed in a mold of refractory clay and put into a furnace and heated to 800° to 900° Centigrade. By this means it becomes slowly heated and softened until it assumes the form of the mold, but it must not become fused or the whole operation must be gone over again. If the outcome of the process is successful the glass is slowly annealed and is then taken from the mold and examined anew. If any defects deep in the glass are seen, a second operation is begun with a mold of another form. Finally, when the glass is very pure and perfect another and final molding produces the plano-convex lens. After this comes another heating and cooling which takes two or three weeks.

At this point the glass disks are taken to the establishment of M. Gautier where the surfaces are polished with a device like that used in polishing the mirror, except that the slides have the curve that is to be given to the disk. A long time is required in polishing out the small imperfections, and finally the lens is entirely corrected and ready for mounting.

The tube which carries the eyepiece is supported by four wheels rolling upon rails, *O*. It is attached to the telescope by an adjusting screw, 4·92 feet in length, which serves for putting it in focus. In the interior of this tube another is mounted upon rollers. This inner tube is 3·54 feet in diameter and is moved circularly by means of clockwork through the medium of a tangent screw which fits into the teeth of a circle fixed to its outer extremity. In this first circle which moves upon four rollers is a second circle which carries two guides and in which slides a carriage having a travel equal to a little more than two minutes of time. This is actuated by a screw which causes the motion in another clockwork. This carriage is provided with a system of frames having rectilinear motion that permits of giving the eyepiece different positions. The upper frame is so arranged that it may receive devices for photography, micrometry, spectroscopy or a projecting ap-

paratus. The exact location of the telescope has not yet been determined upon, but it will be at the service of the Exposition, and will probably be placed somewhere where the atmosphere is purer than that of Paris.

We are indebted for most of our engravings and for our particulars to L'Exposition de Paris, 1900, which has had an interesting and scientific series of articles upon the great telescope. The diagrams are from La Nature.

THE "NEW DEPARTURE" AUTOMATIC COASTER.

We have, from time to time, published descriptions of novel forms of bicycle devices. We take pleasure in publishing herewith a new form of coaster hub which possesses novelty of construction in several particulars. It will be noticed from the description given below that in going down hill the wheels may be allowed to run freely with the pedals remaining in a stationary position, while the brake may be applied by simply bringing weight to bear upon the rear pedal.

The coaster uses 36 straight spokes, and can be furnished with any size or thickness of sprocket from 7 teeth by $\frac{3}{16}$ inch up. No fitting or adjusting is necessary; for the hub when it leaves the factory is in perfect order, ready to be placed on the wheel. It has the advantage of being no larger than the regular bicycle hub and has its coasting device assembled compactly and securely within the hub shell. Anyone can apply the coaster in a few moments to any form of wheel.

When the rider desires to coast, the feet are simply held still, thereby releasing the driving mechanism and allowing the wheel to coast freely. By a slight downward pressure on the rear pedal the brake is brought into action and adjusted as required. When it is desired to go ahead, it is necessary simply to pedal forward in the usual manner. There is no back-pedaling; the pedals cannot jump, either forward or backward; and there is no strain or twist whatever upon the machine.

What is probably the greatest advantage, and one peculiar to this device, is the fact that the rider always has a tight pedal under foot, which feature is of itself of paramount importance in any free-wheel device. The best rider will naturally feel nervous and insecure if the pedals hang loosely under foot; but in this improved device there is no point where the pedals are not in thorough contact either with the coasting or driving mechanism.

Second only to this point is the fact that the wheel may be trundled backward or forward, allowing easy racking, whether the coaster be on or off. In walking alongside of the machine the pedals may remain stationary, so that they will not interfere with the limbs or clothing.

The method of obtaining these advantages will be noted by referring to the cuts. Fig. 1 shows the coaster-hub assembled as shipped from the factory. Figs. 2 and 3 show the manner of assembling the interior mechanism.

The chain when pulled forward causes the sprocket, *G*, to rotate. This sprocket being fast upon the driver, *E*, causes it to rotate forward, thereby drawing the cone, *D*, over into contact with the clutch, *F*, which

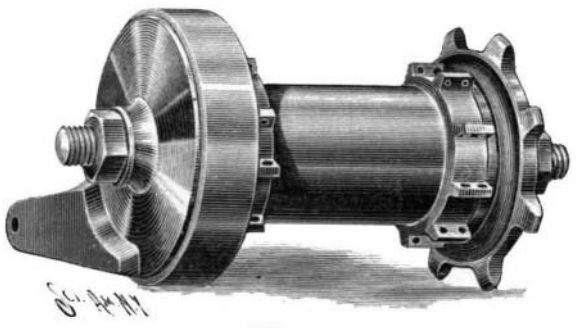


Fig. 1.

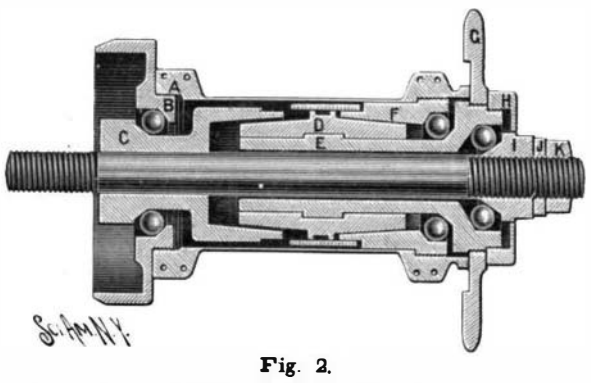


Fig. 2.

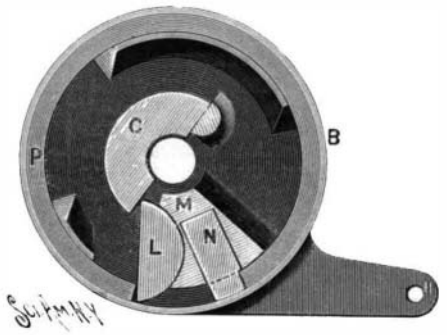


Fig. 3.

"NEW DEPARTURE" COASTER-HUB.

being fast in the hub, causes the hub to rotate and the wheel to move forward.

When the rider holds the feet still upon the pedals, the driver, *E*, stops rotating, thus drawing the cone, *D*, out of engagement with the clutch, *F*, and carrying it across into the brake-clutch, *C*. The brake is not yet applied; but the wheel is free to coast with the feet upon the pedals. If it be desired to brake, simply press lightly upon the rear pedal; and the brake is instantly in operation and can be graduated to any degree desired. When it is required to propel the wheel, merely pedal ahead; the mechanism does all the adjusting. There is no "kick-off."

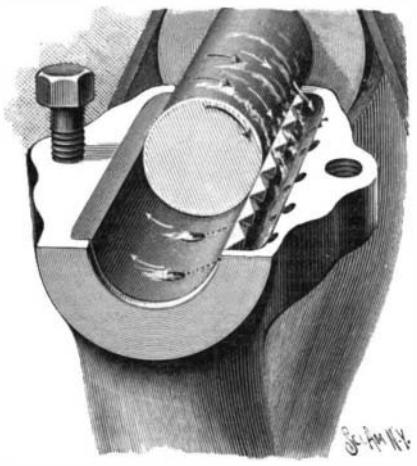
The device is manufactured by the New Departure Bell Company, Bristol, Conn., which is represented by John H Graham & Company, No. 113 Chambers Street, New York, N. Y.

IT is said it will cost nearly $400,000 to bring the great plant of the Schneiders, at Creusot, into working order after the present strike is over.

OIL-RETAINING JOURNAL.

The accompanying cut represents an ingenious device which was recently tried by Mr. Herman Dock upon a troublesome journal with great success, and as we think the "wrinkle" may be new to our readers, we publish it herewith. Mr. Dock is of the opinion that the difficulty in keeping journals well supplied with oil is due to the sharp edges at the joints.

As the shaft rotates, the oil is scraped off on these edges and flows away through the joint. This takes place chiefly on the lower half of the journal. Thus, if the shaft is rotating, as shown in the cut, from left to right the oil collects on the right hand lower half of the bearing and oozes away through the joint at that point. To correct this a channel or small collecting trough is cut in the Babbitt metal parallel with the shaft, and



OIL-RETAINING JOURNAL.

small oil-holes are drilled through obliquely from this trough to the bottom of the bearing. The oil that collects in the joint is thus made to flow to the underside of the shaft, and a continual lubrication is maintained.

A New Lethal Agent.

Prof. Willis G. Johnson, of the Maryland Agricultural Experiment Station, has recently caused some discussion among the governmental scientists at Washington by a brief paper setting forth the claims of hydrocyanic acid gas as a lethal agent, to be used in place of the rope or the electric current in capital punishment. Prof. Johnson's idea is by no means a new one; but some of the arguments, and especially the illustrations, he brings forth are novel. He claims to have been temporarily under the influence of this gas to the extent of a feeling "of pleasant drowsiness, relaxed muscles, a limpness and feeling of indifference as to what happened;" adding that "there was no pain, and the whole sensation was soothing, rather than disagreeable." This description of his experience is far from portraying the experience of the writer, who went to a still further stage toward death, and was with difficulty brought back to life from inhaling these fumes arising from an insect killing jar. Intense intercostal agony, unthinkable mental distress, and a horrible consciousness of all that was going on, without the power to give any sign of life, was the experience in that case.

E. MURRAY-AARON.

Uses for Skim Milk.

An interesting process is reported by the Chief of the Dairy Division of the Department of Agriculture, Major Alvord. This is a new composition somewhat resembling celluloid made from skimmed milk. Paper sizing is now made in considerable quantities in the United States; it is the dry caseine from skimmed milk. It requires considerable skimmed milk to make this product, but at the same time vast quantities of skimmed milk are now wasted or fed to stock which can be utilized in making the new material, which is suitable for the manufacture of oilcloth, book coverings, billiard balls, in fact, for many things for which either celluloid or hard rubber is now used, and it has many advantages of its own, including impermeability to water and non-inflammability. It is thought that it can be used in the manufacture of electrical insulators.

Automobile News.

An automobile omnibus service has been established on the Isle of Man, between the various towns and summer resorts. One vehicle is at present in use seating eight passengers and the driver.

In Texas a wealthy stockman will use an automobile for making inspection trips around the wire fence of his ranch. The country being level and free from brush and other obstructions, it is thought that the automobile will prove practical.

A bicycle factory in Pennsylvania has just completed a number of jinrikshas for China, Japan, South Africa, and the Philippines. The bodies of the carriages are of wood, and some of the wheels are of bicycle finish, with rubber tires. All have tops to protect the riders from the heat of the tropical countries. The American manufacturers have greatly improved the running qualities and appearance of this useful, but queer-looking vehicle.

In Belgium all automobile vehicles must carry, both in front and behind, a number large enough to be seen at a distance, and after sunset each number must be lighted by a lamp. All automobiles and bicycles must be provided with a brake. All self-propelled carriages must also bear the regulation number of the city and also the owner's name and address. Rubber-tired carriages must carry bells, and the maximum speed allowed is 18·64 miles an hour in the open country, and 7·46 miles an hour in town.

According to The Motor Age, Mr. and Mrs. J. D. Davis have reached Chicago with their motor carriage. Very little of the original motor and running gear mechanism with which the couple started from New York was left, the principal remainder being the rear axle, and that broke at the crossing of Seventy-first Street and Bond Avenue, Chicago. After new axles have been fitted, they intend to proceed to San Francisco. Trips of this nature do more harm to the automobile industry than they do good.

Target Practice with Field Howitzers.

Recent tests of the new German field howitzer on the proving-grounds of Doeberitz, near Spandau, have shown how effective the new piece is against resistible targets. Two batteries, armed with 15-centimeter howitzers, fired both shell and shrapnel at targets set up in trenches. According to the Köln Zeitung, a perfect hail of bullets fell upon the trenches and the protection was completely destroyed, so that a body of troops would have been unable to hold their position. Against artificial obstructions made of branches and wire the shell was equally effective.

The Current Supplement.

The current SUPPLEMENT, No. 1244, has a number of articles of great interest. "The Progress of Science and its Results," by Sir Michael Foster, is continued. "Unwatering the Comstock Lode" is a valuable original article by L. P. Gratacap. "The Manufacture of Nitrite of Soda" is by Mr. M. A. Darbon. "Exercises in Horseback Riding Among the Chasseurs of Africa" describes wonderful feats of horsemanship. "The Olfactory Nerve Track" is a most interesting article. "The Replacements of Fluids into the Track of Moving Bodies" gives an important study by Mr. M. F. Mithoff. Dr. Thurston's "Evolution of Technical Education in Economics, Politics and Statecraft" is concluded.

Contents.

(Illustrated articles are marked with an asterisk.)