out as a garden. Areas adjacent to the Mall and averaging more than 400 feet in width from the Capitol to the Washington Monument are set aside as sites for the great museums and buildings devoted to scientific purposes. Perhaps the feature of this portion of the plans which serves as the greatest cause for congratulation is found in the arrangement whereby the unsightly railway terminal which is now set down in the Mall will be removed to another portion of the city.

Not only will the monument be brought into the Capitol vista, but the Mall will be restored to its original use as a grand setting for the two great buildings of the nation, the Capitol and White House. To the distance of one and a half miles from the Capitol to the monument the reclamation of the Potomac flats adds another mile, giving opportunity for an extension of the treatment accorded the Mall and also a new and great memorial to Abraham Lincoln, to stand on the axis of the Capitol and monument, near the bank of the Potomac. The proposed Lincoln Memorial consists of a portico of Doric columns 250 feet in length by 220 feet broad. The Lincoln Memorial will be the gate of approach to the park system of the District of Columbia. A broad paved quay or landing space will skirt the Potomac; the proposed Memorial Bridge, to be erected at a cost of $15,000,000, will lead directly across the Potomac to the mansion house at Arlington, the national cemetery; and drives up the valley of Rock Creek will afford natural connection to the National Zoological Park.

Connecting the Washington Monument and the Lincoln Memorial will be a canal 200 feet in width and 2,300 feet in length and similar to those at Versailles and Fontainebleau. West of the monument it is planned to place a garden, which will not only add to the impressiveness of the structure, but create an axial relation with the White House, this latter being accomplished by a sunken garden framed in by tree-bearing terraces in the shape of a Greek cross. The center is marked by a great pool, and rectangular basins support this. From the garden a flight of steps 300 feet in width lead to the base of the monument, giving that structure forty additional feet of height. The space south or in the rear of the White House will be left practically undisturbed. Between the monument and the Potomac will be a great place of recreation to be known as Washington Common, and the plan for which contemplates a great stadium bordered by smaller playgrounds.

The south side of Pennsylvania Avenue, now a blot upon the city, is designated as a site for the District Building (which corresponds to a City Hall), the Armory for the District Militia, a Hall of Records and other similar structures. The connection between the Mall system and the Capitol is formed by a rectangle 1,000 feet long and 450 feet wide, relieved by plots of green and flanked by two public buildings which will stand as sentinels to the Capitol. The chief decoration of this area, to be known as "Union Square," will be the Grant Memorial, associated with which will be the figures of his great lieutenants, Sherman and Sheridan, standing independently yet forming a single composition. The grounds at the Capitol will be elaborated by terraces relieved and enriched by basins and fountains, in which the water falling from one level to another is poured finally into a great central basin at the street level. Indeed, the Commission, impelled by the fact that Washington experiences during four months of the year extended periods of intense heat, has provided for a wonderful array of fountains and for an increase in the water supply which will make possible the copious and even lavish use of water in these fountains. In addition to these main features, the plan for the improvement of Washington embraces many minor projects, such as the creation of a magnificent "Cliff Drive" on the Palisades of the Potomac, and the creation of a great boulevard system connecting the various parks.

The most recent application of the electric current is that of taking the place of the old-time bed warmer. The modern implement consists of a coil of wire covered with asbestos, and the electric current passing through the wires heats up the material.

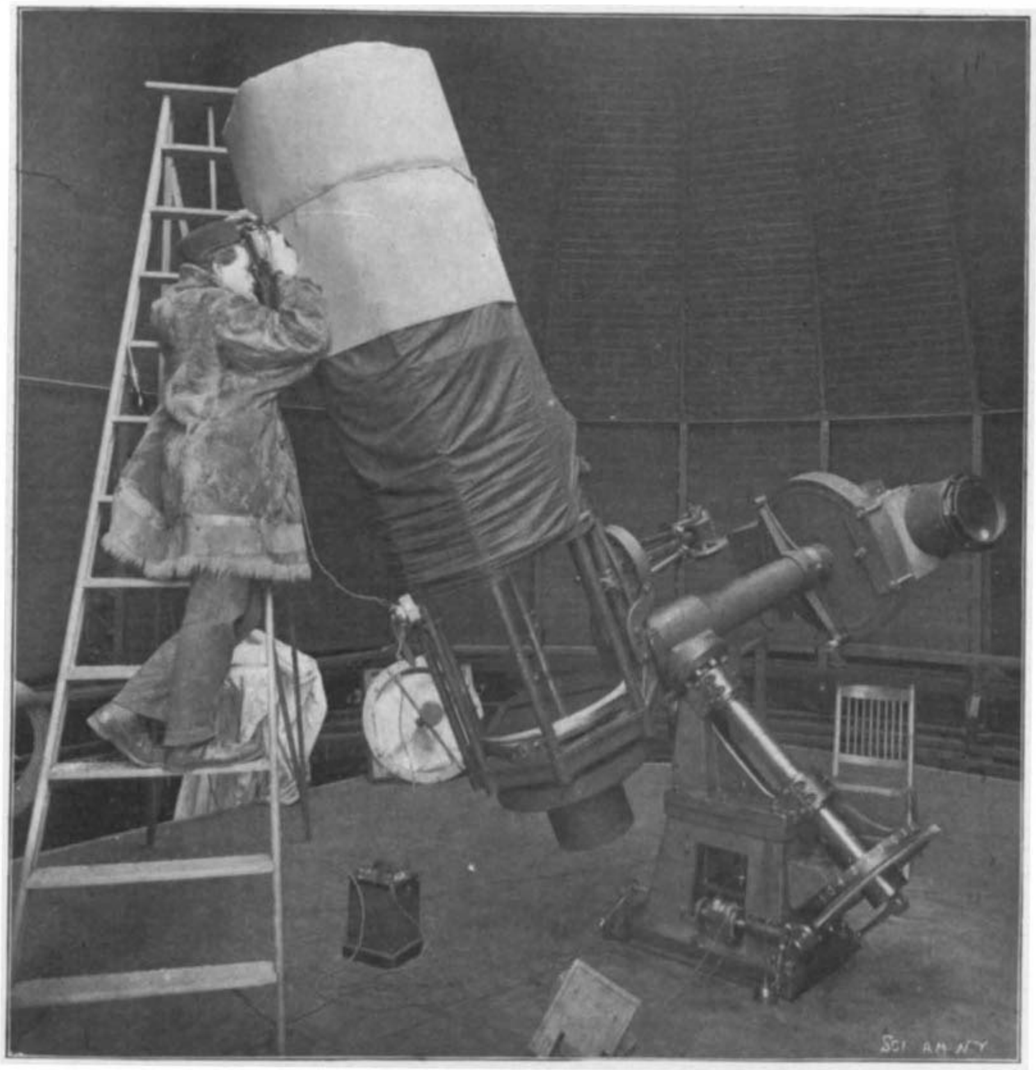
THE YERKES OBSERVATORY TWO-FOOT REFLECTOR.

BY MARY PROCTOR.

Among the many important pieces of work which have been accomplished in the instrument shop of the Yerkes Observatory, has been the mounting of the two-foot reflecting telescope, with which the faint nebula surrounding Nova Persei (referred to in the SCIENTIFIC AMERICAN for December 7, 1901) was photographed.

The telescope is mounted in the southeast dome of the observatory, which was originally intended for a 16-inch refractor. A substantial observing platform or floor, 20 feet in diameter and 12 feet higher than the original floor of the tower, was also built, so that the eyepiece or plate-holder of the telescope is never more than 11 feet above the floor, and is therefore easily accessible with the aid of a suitable observing chair.

While the instrument is generally called the two-foot reflector, the clear aperture of the large mirror is 23½ inches, the focal length being 93 inches. The disk of glass for this mirror was made at the St. Gobain glass works near Paris, for Prof. G. W. Ritchey, who finished the work of grinding, polishing, and figuring it in 1896, at his own laboratory in Chicago.



TWO-FOOT REFLECTOR WITH WHICH PROF. RITCHEY PHOTOGRAPHED THE NEBULA SURROUNDING NOVA PERSEI. HIS ASSISTANT, MR. PEASE, WORKING THE DOUBLE-SLIDE PLATE-HOLDER.

In the case of a reflecting telescope of large angular aperture, such as the present instrument, great rigidity of the tube and extreme stability of support of the optical parts are absolutely essential, in order that the optical parts shall remain in perfect adjustment. And no less important are the perfection of the driving mechanism (by which the telescope is made to follow the apparent motion of the heavenly bodies from east to west across the sky) and of the guiding mechanism, by which the observer corrects any minute irregularities of movement. The parts of the mounting concerned in the four important requirements just mentioned were designed with great care by Prof. Ritchey and constructed under his supervision. The arrangement of the polar and declination axes is similar to that used in the German type of equatorial mounting; but the end of the tube below the declination axis is so short that it will pass the column without obstruction for all declinations, so that reversal of the instrument when passing the meridian is unnecessary. Long-exposure photographs can therefore be started four or five hours east of the meridian, and continued for eight or ten hours when required.

The driving clock, part of which can be seen inside the column in the illustration, is similar in general plan to that of the 40-inch refractor, and is one-fourth the size of the latter, the governor making two revolutions per second instead of one, as in the larger instrument. The governor balls weigh about seven pounds each, and all parts of the clock are proportionately heavy and strong. The winding drum is provided with a maintaining device, the winding at present being done by hand and requiring attention every two hours.

The driving worm and worm-gear, which directly rotate the polar axis, were ground together for 200 hours with fine grades of emery (such as are used in optical work) and oil, and the smoothing was finished with optical rouge and oil. To this grinding the extraordinary smoothness of driving of the instrument is largely due.

The plan of support adopted for the large mirror is as follows: "The mirror rests upon three very rigid cast-iron plates, 10 inches in diameter, the upper surfaces of which are ground to fit the back of the mirror. One thickness of writing paper is placed between each iron plate and the glass. Each plate is supported at its center on a strong ball-and-socket joint. The three balls form the upper ends of the three large adjusting screws which extend through the heavy back casting, and by which the mirror is adjusted for collimation. The edge support adopted consists of four strong steel bands, each of which is in contact with nearly one-half the circumference of the mirror; two opposite bands are just above the middle of the edge of the mirror; the other two, 90 deg. from the first, are just below this plane. In addition, four long rigid arcs of cast-iron are used to give greater stability of position laterally; two of these are bolted down to the large casting behind the mirror; the other two are held against the edge of the mirror by weak springs."

The skeleton tube is about seven feet long, and is constructed of eight two-inch steel tubes, which are connected by three strong light rings of cast aluminium. The rings are driven on the tubes, and each junction is tightly clamped with two strong screws. When the telescope is used with the double-slide plate-holder for direct photography at the first focus, an attachment is used consisting of a strong cast-aluminium ring which carries, by means of four thin wide bands of steel, the diagonal plane mirror and its supports.

The double-slide plate carrier used with the two-foot reflector is the same which was used in Prof. Ritchey's first experiments in photographing with the 40-inch telescope with a color screen. In the latter work a large sliding plate-carrier taking 8 x 10 inch plates is now used. The smaller one takes 3¼ x 4¼ inch plates, and the field photographed is three inches square, which corresponds, in the two-foot reflector, to a portion of the sky about two degrees square.

In regard to the exposures, the telescope is of course always moved by the driving mechanism (the clockwork in the column) during an exposure, but in addition to this the observer watches and "guides" throughout the entire exposure. This is not done in the old-fashioned and clumsy way of moving the entire telescope to make the necessary corrections (by means of "hand slow motions") but by means of what is called the double-slide plate carrier, in which the photographic plate, in its plate-holder, is carried on two very finely made slides, at right angles to each other, which can be moved by two screws held in the observer's fingers. By this means the necessary small corrections can be made with extreme delicacy and quickness.

At the edge of the field a "guiding star" is selected and is brought to the intersection of the spider lines in the "guiding eyepiece," which is carried on the same frame which also carries the photographic plate, so that the two move together. If the observer keeps the "guiding star" exactly bisected on the spider lines, he also keeps all of the stars of the field being photographed immovable on the photographic plate, despite any small errors which may occur in the clock driving.

This guiding is done throughout all exposures, long or short, which accounts for the excellent results obtained. In Prof. Ritchey's best photographic work with the reflector, double stars only 2½ seconds of arc apart are sharply separated. In the illustration showing the two-foot reflector, with which the Nova Persei nebula photographs were taken, Mr. F. G. Pease, Prof. Ritchey's assistant, is represented at the sliding plate carrier, with his fingers on the screws and his eye at the guiding eyepiece. The clockwork is seen in the column, and the two-foot silvered glass speculum is seen at the lower end of the skeleton framework or tube.

The combination of stability of position of mirror, smoothness of clock driving, rigidity of skeleton tube, and delicacy of following made possible by the use of the sliding plate carrier, is so effective that when atmospheric conditions are good the image of the guiding star in the eyepiece of the plate-carrier does not wander by so much as one one-hundredth part of a millimeter during an exposure of three or four hours. The accuracy with which the star images are kept immovable on the photographic plate is nearly as great, as is shown by the photographs.

The results obtained with the two-foot reflector show that very fine atmospheric conditions are necessary for the best results, even in the photography of nebulae. What then would be the results if a properly mounted great reflector were erected in such a climate as that of California.

Prof. Ritchey has given a detailed account of the construction of the two-foot reflector in the Astrophysical Journal for November, 1901, of which the above sketch is a synopsis.

The Changing Use of Gas.

BY ALTON D. ADAMS.

Since the introduction of electric lighting, early in the decade 1880-1890, gas has grown less important as an illuminant and its application to heating has greatly increased. This movement in the use of gas is away from a field where it is less efficient than electricity, to one where its heating qualities can be used to greater advantage. An ordinary gas burner consumes about five cubic feet of gas per hour and yields a light of approximately 16 candle power. Each cubic foot of this gas burnt develops about 650 heat units, or 3,250 units per hour at the burner of 16 candle power. Incandescent electric lamps of 16 candle power regularly consume energy at the rate of 50 watts each. One watt-hour is the equivalent of 3.412 heat units, so that the incandescent lamp of 16 candle power develops 170.6 heat units hourly. It follows that the energy required to maintain the open gas flame for a given illumination is nineteen times as great as that necessary in incandescent lamps for equal service.

If the electrical energy required by the incandescent lamp be supplied to a heater, the amount of heat there produced is exactly the same as the amount that would have been developed in the lamp. If the gas required for a given illumination at an open flame be burned in a gas stove, the development of heat there is fully as great as it would be at the burner. Where the gas is perfectly burned and the products are cooled before they escape the electric heater and the gas stove are equally efficient. In many cases, however, the combustion of the gas is not complete, and even where it is completed the heat is not usually extracted from these products before they escape. In the transformation of electrical energy to heat the efficiency is necessarily exactly 100 per cent, and there are no products of combustion to carry away part of the heat. For the reasons just stated the efficiency of the gas stove may easily drop 75 or even 50 per cent. If the gas stove extracts from the gas passing through it only one-half of the possible amount of heat, the gas is still 9.5 times as effective as a heating as it is as a lighting agent, taking the results attained with electrical energy as unity in each case.

The general tendency is to shift the use of gas to that field where it is under the least disadvantage. This tendency is well illustrated by changes in the number of gas street lamps and of gas stoves used in Massachusetts during the past fourteen years. In the accompanying table the number of gas street lamps and of gas stoves operated in each year from 1887 to 1900 are stated as deduced from the reports of the Gas and Electric Light Commissioners of Massachusetts.

GAS STREET LAMPS AND STOVES IN USE IN MASSACHUSETTS.

Year Ending June 30.	Street Lamps.	Gas Stoves.	Gas Stoves in Boston.
1887	18,990	2,378	
1888	18,335	4,003	
1889	17,260	6,328	
1890	15,493	7,418	
1891	14,107	8,666	
1892	13,324	10,795	
1893	12,971	12,880	
1894	12,700	15,877	
1895	11,701	42,563	23,881
1896	11,693	72,195	49,610
1897	11,9[illegible]8	78,667	53,350
1898	12,407	79,335	47,698
1899	12,876	87,201	47,635
1900	13,308	95,547	48,064

For the fiscal year of 1887 the number of gas street lamps throughout the State was 18,990, but for 1900, thirteen years later, the number of these lamps was only 13,308, a decline of 30 per cent. This decrease in the number of gas street lamps took place in spite of a rapid rise of population during the period under consideration. Figures are not at hand to show the rate of increase for the population of the State since 1887, but from 1890 to 1900 this increase was 25.2 per cent. If the use of gas street lamps had only kept pace with the rise in population, the number of these lamps in 1900 would have been more than 25,000 instead of 13,308. While it is not possible to give the numbers of gas street lamps in years prior to 1887, it seems certain that there was a constant decline during nearly all of the decade from 1880 to 1890. This view is supported by the known increase of electric street lighting during these years. In 1880 the income from electric street lamps in Massachusetts was practically nothing. For the fiscal year of 1890 the value of electric street lighting was $776,986.18, and the sum paid for gas street lighting was only 42.1 per cent of this amount.

The lowest point reached in the number of gas street lamps was in 1896, when it fell to 11,693. Since that date the increase to 13,308 has hardly done more than maintain a constant ratio to the growing population.

Quite different from the declining use of street lamps has been the application of gas stoves. For the year 1887 the number of such stoves reported was only 2,378, while for 1900 the number was 95,547. That is, during thirteen years the number of stoves reported has grown to more than forty times the original magnitude. In the seven years from 1887 to 1894 the number of stoves increased to 15,877, the average yearly addition being nearly equal to the original. During this period the reports seem to be incomplete, as figures for various large companies, notably those in Boston, were omitted. Beginning with the fiscal year of 1895 the returns seem to include nearly all important companies, and the number of gas stoves goes up to 42,563, or more than two and one-half times the reported number for the previous year. Of the stoves included in the report for 1895, 23,881, or a little more than one-half, were at Boston. Near the close of the fiscal year of 1894 one of the Boston companies, under the spur of competition, offered gas stoves to its customers on very favorable terms. This action no doubt had much to do with the large increase of the number of stoves at Boston in 1895 and 1896. How many stoves were put into use at Boston from 1894 to 1895 cannot be stated, but from 1895 to 1896 the number was 25,729, or more than the entire number there in 1895. During the year just considered, the number of stoves throughout the entire State, including those at Boston, increased from 42,563 to 72,195, or 29,632. It follows that the stoves added throughout the State outside of Boston numbered only 3,903, or less than one-sixth of the increase in that city. In 1896 the severe competition at Boston came to an end, and the maximum number of gas stoves there was reached in the fiscal year of 1897, when it stood at 53,350. Since the date just named this number has declined, and stood at 48,064 in 1900. At the time of severe competition stoves were installed at Boston without any charge and under contracts that titles should pass to the users when gas to a certain value had been consumed. The small decrease in the number of gas stoves used at Boston is probably due to failures of some consumers to burn enough gas to earn the stoves. Evidently the number of stoves in Boston had been pushed much beyond the normal demand.

Outside of Boston the increase has been constant and rapid, from 22,585 in 1896 to 47,483 in 1900, thus more than doubling in four years. This increase is the more instructive because it has come about simply through the natural demand. In 1897 Boston had 67 per cent of all the gas stoves in the State, but in 1900 this had fallen to 50 per cent. Boston still has four times as many gas stoves per unit of population as the remainder of the State, since its number of inhabitants is only one-fifth of that for the entire State.

Our Car Shortage.

Reports of car shortage rarely fail to put in an appearance at some time during the season of active shipments, either in the grain or coal producing sections, or wherever there happens to be an extraordinary pressure of traffic. From this fact the inference has frequently been drawn that the railroad companies, despite the additions made in recent years to rolling stock numbers, are far from having brought their equipment up to that condition conducive to the best economy in operating results. Naturally, the lack of cars or engines for tonnage actually offering means loss at some point or other; but still it seems that there must be the periodical outcry of a scarcity of cars. Just now it appears to be the iron and coal interests of Pittsburg and its vicinity which are the main sufferers, the car famine being characterized as the most serious Pennsylvania has ever experienced, says the New York Times.

It is perhaps not to be wondered at that there should be a lack of facilities such as are alluded to, seeing to how great an extent traffic has grown, and how little, apparently, has been done to meet this growth by adequate additions to the number of cars in the railroad service. A recent feature of railroad reports has been the amounts appropriated from earnings or raised by capital issues for the purpose of remedying this state of affairs by the reconstruction and enlarging of old cars and the building or purchasing of new ones, but the work has progressed on a very small scale compared with what traffic conditions indicate should have taken place, and the result is a state of affairs which at times is unsatisfactory to the last degree.

It may be urged, and properly so, that what additions have been made to freight equipments have to a great extent been cars of large capacity, much larger than that of cars destroyed or retired from service.

Take for example the equipment of the Chicago and Northwestern, upon which there have been quite liberal outlays the past few years, and it is shown by the company's reports that while the tons moved since 1898 have increased in the equivalent of 28 per cent, and the ton miles 22 per cent, freight cars of all descriptions have increased only 16 per cent, that is as to number, capacity not being ascertainable. Even this is a much better showing than could be made by the average railroad, large and small, a fact which is clearly brought out in statistics published which cover the country's entire railroad system. These, indeed, indicate really surprising conditions, and anything but adequate attempts to raise car numbers to the level of traffic development, strange as it may seem, after what has been the burden of so much talk of activity in car building, of bringing equipment up to date, and so forth.

Adopting results as set forth in the Interstate Commerce Commission's returns for the fiscal year 1900, and comparing these with results for previous years, the following somewhat striking comparisons are obtained, showing tons of freight carried and the number of cars in the freight service:

	Tons Carried.	Cars in reight Service.
1894	638,186,553	1,205,169
1895	696,761,171	1,196,119
1896	765,891,385	1,221,887
1897	741,705,946	1,221,730
1898	879,006,307	1,248,826
1899	959,763,583	1,295,510
1900	1,101,680,238	1,365,531

The movement in freight is seen to have grown from 638,186,553 tons in 1894 to 1,101,680,238 tons for 1900, indicating that there was an increase of about 463,500,000 tons, or 72 per cent. If the enormous figures relating to the movement of tons one mile, the unit of service, be adopted, the result is quite similar, these showing in round numbers 141,599 million ton miles for 1900 against 81,073 millions for 1894, an increase of 60,526 million ton miles, or 74 per cent. But coming to the freight car equipment, it is to be noticed that 1,365,531 cars in 1900 took the place of 1,205,169 in 1894, the increase being 160,362 cars, or but little more than 13 per cent.

The Interstate Commission has succeeded in introducing into its reports statistics showing the number of tons of freight originating on all the roads, that is, avoiding all duplications owing to much of the tonnage passing over more than one road and being reported by all roads handling the first offerings. These, however, go no further back than 1899, thus limiting comparison to results for 1900 with those for that period. The number of tons given is 593,970,955 for the latter year, and 510,079,200 for the former, from which it can be seen that a net increase of nearly 84 million tons took place, or the equivalent of 16 per cent. Attention may now be directed to the fact, as demonstrated in the table, that 1900 showed a larger increase in cars than any other year, namely, 70,021 cars, but as this is less than a 6 per cent expansion, it will be at once realized that even on this exact basis the disparity between traffic gain and the furnishing of increased facilities is very great. A test of the tonnage movement on the basis reported for the longer series of years shows that between 1899 and 1900 the increase was very similar to that brought out the other way—that is to say, the actual tons without duplications—it being equal to about 15 per cent, so that comparisons are not vitiated by the different methods of making returns. This being the case, some idea may be gained of the increased demand for service put upon car equipment from a glance at the calculations now submitted giving tons carried per car for the past seventeen years:

	Tons per reight Car.		Tons per Freight Car.
1894	529	1898	704
1895	582	1899	741
1896	626	1900	807
1897	607		

After such a showing as this there will perhaps be little wonder expressed that cars should run short when there is a press of traffic.

The Rapid Transit Subway in New York will be equipped with the third-rail system.