a crushing strength of 50 tons per square foot. Above low water the cylindrical piers, which are 49 feet in diameter at the top, 55 feet at the bottom, and 36 feet high, consist of the strongest masonry, the hearting being flat bedded Arbroath stone, and the facing, Aberdeen granite. In each cylindrical pier there are 48 steel bolts, 1½ inches in diameter and 24 feet long, to hold down the bed plate and superstructure of the main spans. One of the Fife piers was built by aid of a timber and clay cofferdam, and one by means of a half tide dam. At Inch Garvie much of the work of the shallow piers had to be done at low tide under great difficulties.

The Queensferry Pier consists of a group of four cylindrical caissons 70 feet in diameter at the bottom edge. Owing to the special conditions of the site, the work differs in some respects from ordinary pneumatic caissons. The bed of the Forth at the Queensferry Pier is of very soft mud for a depth of from 20 feet to 35 feet, when the bowlder clay is reached, the surface of both the mud and the clay falling sharply toward the 200 feet deep channel between Queensferry and Inch Garvie. The caissons had to be floated out and sunk about one-third of a mile from shore in an exposed seaway. To facilitate operations, the caissons have double skins, 7 feet 6 inches apart, and vertical bulkheads between the skins. By filling the space between the skins with concrete to varying heights, the irregularity in the level of the bottom, and the hardness of the mud, could be to some extent compensated for, as the weight brought upon the cutting edge of the caisson could be regulated as desired. Iron being cheap, a liberal use was made of it in conjunction with concrete where masonry or brickwork might have been employed. Strong lattice girders and cross girders stiffen to the required extent the roof of the working chamber. These girders are subject to a heavy bending stress upward and downward, owing to the tide, the range of which is about 20 feet. Thus if sufficient concrete were filled over the roof to balance the air pressure at mean tide level, then at high water the excess of air pressure, unbalanced by the weight of concrete, would obviously be that due to the half tide difference of height, and at low water, similarly, the excess weight of concrete would be of the same amount. There would thus be a force of more than 1,100 tons tending to bend the girders downward at low water and upward at high water.

Two shafts 3 feet 6 inches in diameter, with air locks for passing out the excavation, and one shaft with double air lock for the men, are provided, together with ejector pipes for the mud, water pipes, supply pipes for the concrete, and other conveniences.

For the above particulars and our engraving we are indebted to *Engineering*. Further descriptions of the great Forth Bridge and additional engravings will be found in SCIENTIFIC AMERICAN SUPPLEMENTS 354, 457, and 478.

### Toughened Filter Paper.

Mr. E. E. H. Francis recently read a paper at the Chemical Society in which he showed that filter paper, ordinarily so weak, can be rendered tough and at the same time pervious to liquids by immersing it in nitric acid of relative density 1·42, then washing it in water. The product is different from parchment paper made with sulphuric acid, and it can be washed and rubbed like a piece of linen. It contracts in size under the treatment, and undergoes a slight decrease in weight, the nitrogen being removed and the ash diminished; whereas a loop formed of a strip 25 millimeters wide of ordinary Swedish filter paper gave way when weighted with 100 to 150 grammes, a similar loop of toughened paper bore a weight of 1·5 kilogrammes. The toughened paper can be used with a vacuum pump in ordinary funnels without extra support, and fits sufficiently close to prevent undue access of air, which is not the case with parchment paper. A good way to prepare filters for use with the pump is to dip only the apex of the paper into nitric acid, then wash it with water. The weak part is thus effectually toughened. Toughened filter paper will be exceedingly useful, not only to chemists, but to other scientists, both practical and theoretical.

### A New Clock.

A very interesting clock has been fixed opposite the National Provincial Bank in Bishopsgate Street, London. It is on the 24 hour principle, and is remarkable as possessing probably the simplest method which has yet been introduced for indicating time upon the new enumeration. The new clock has only one hand, the long minute hand, and the figures around are placed as heretofore; instead, however, of indicating the hours, they indicate the minutes only, which are marked from 5 to 60. The hours are shown on a sunk dial revolving under the upper dial, a space being left in the upper dial in which the next hour figure comes forward instantaneously upon the minute hand completing its circuit of 60 minutes. In short, the solitary hand marks the minutes, and the sunk space shows the hour.


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### CONCERNING TELESCOPES.

A correspondent in Omaha, Nebraska, asks for information on three points: 1. What would be the cost of the largest telescope with unlimited means?

There are two kinds of telescopes, differing radically in construction, each possessing advantages peculiarly its own. One is known as the refracting telescope, because it depends on the refraction of light through glass lenses. The other is called the reflecting telescope, because it acts by reflecting the light from a concave mirror. Refractors are almost exclusively used in the United States, for they are easily managed, convenient, and have proved themselves to be the best working instruments, while the greater part of the astronomical observations of the present century have been made with them. We therefore infer that our correspondent refers to this kind of telescope. We have no means of estimating the cost of the largest telescope that can be constructed with unlimited means, but we can give the cost of some of the great telescopes now in use.

The telescope of the Naval Observatory in Washington, mounted and ready for use in 1873, cost $50,000. It has an aperture of 26 inches, and was, until 1881, the largest refracting telescope in the world. The great Russian telescope at Pulkowa, a refractor of 30 inches aperture, finished in 1882, now enjoys the distinction of being the greatest refractor in the world. Messrs. Alvan Clark & Sons, of Cambridgeport, made the object glass for this huge instrument, at a cost of about $12,000, the mounting being the work of Messrs. Repsold & Sons, Hamburg, Germany.

The Russian telescope will not long enjoy the supremacy. The Messrs. Clark are now in process of making a refractor for the Lick Observatory on Mt. Hamilton, California, with an aperture of 36 inches, which will, when finished, take the first rank in size and probably in cost.

The reflecting telescope of the Earl of Rosse, in Parsonstown, Ireland, takes the lead in size among reflectors. It cost $250,000. The speculum, or mirror, is 6 feet in diameter, weighing 4 tons, and the focal length is about 54 feet.

M. Flammarion, a French astronomer of renown, was firm in the faith that the moon was inhabited. He determined to prove his position by the construction of a monster telescope with such magnifying power as to reveal the men in the moon to terrestrial observers. He planned an immense refractor, far larger than any in existence, which was to cost $200,000. He earnestly solicited contributions from the whole civilized world to help in his project. For some reason, the plan fell through, and we have heard nothing of it since 1879.

The second question (2) is, How much larger could one probably be made than has ever been made, or now being made to your knowledge?

In the case of refractors, it is almost certain that there is no advantage to be gained by increasing the diameter of the object glass or aperture beyond a limit somewhere between 30 and 36 inches. As the aperture and magnifying power increase, the defects in the instrument become more apparent. The first difficulty telescope makers had to contend with was chromatic aberration. This was obviated by the use of two lenses instead of one, a concave lens of flint glass and a convex lens of crown glass, so arranged that their aberrations destroy each other. Telescopes are now made in this way, and are called achromatic telescopes.

A second difficulty now arose, known as the secondary spectrum. It is due to the fact that flint glass as compared with crown disperses the blue end of the spectrum more than the red, and the result is that the refracting telescope is not perfectly achromatic. The defect is scarcely noticeable in a small telescope, but becomes a serious obstacle in a great telescope, increasing with the diameter of the aperture. Since the trouble is inherent in the glass, there seems to be no possible method of overcoming it.

In the case of reflectors, the trouble lies in keeping the great mirrors in perfect figure in every position, the mirror being liable to bend on account of its own weight and elasticity. Such was the case with the reflector at the Paris Observatory. It has a mirror of silvered glass, the diameter being nearly four feet. It was mounted in 1874, but the glass bent under its own weight, and was rendered useless.

The greatest foe to the mammoth telescopes is, however, the atmosphere. The waving and trembling, the moisture, and the currents so pervade the atmosphere at the sea level, that the most powerful telescopes can be used to advantage during but a small portion of the nights of the year. The remedy or amelioration of this trouble is to establish observatories in elevated positions where the air is dry, clear, and steady. These conditions prevail on the mountains and elevated lands of the western and southwestern portions of North America. When, therefore, the largest refractor in the world is mounted and ready for use in the Lick Observatory, under the serene sky that arches above Mount Hamilton, 4,000 feet above the level of the sea, it is reasonable to hope that important tidings from the star depths will be the result.

The third question (3) is, Would the largest and most powerful one that could be constructed create general interest to the scholars and to the country generally, and, in your opinion, would such a one add materially to our store of information and give us a better knowledge of the heavens?

The largest telescope that could be made cannot fail to awaken a deep interest among scholars and in the whole country, if, through its great eye, some important discovery were made; for the wonders astronomy reveals touch a sympathetic chord in the popular heart. But the largest telescopes are not as available to the ordinary observer as those of more moderate dimensions, They are valuable not so much for their magnifying power as for their light-gathering power.

We have seen Jupiter and Saturn through the great Russian telescope of 30 inches aperture and through a telescope of 8¼ inches aperature. The difference in the two views was not so much in the size as in the brighter light thrown upon the objects in the larger telescope. The great telescope is used principally to bring out objects that are invisible in smaller ones. Thus the Washington telescope won renown by its discovery of the moons of Mars. Herschel discovered Uranus with his reflector of 2 feet aperture. Mr. Lassell discovered two moons of Uranus with his reflector of 2 feet aperture. Lord Rosse's reflector is used chiefly for making drawings of nebulæ and lunar scenery. The reflector of the late Professor Henry Draper was used in photographing the Great Nebula of Orion, bringing out stars of the 14th magnitude. But it takes practiced eyes and the devotion of a lifetime to detect these minute and distant objects. The directors of the great observatories are absorbed in their work. They have little time or inclination to reveal celestial wonders to ordinary observers, who are untrained to see what they see or to comprehend the abstruse calculations by which they reach results.

Astronomy is making its way to the heart of the people. A widespread interest is felt in all that pertains to the heavens. It is, however, popular astronomy that is demanded. The accounts of eclipses, comets, occultations, are eagerly read, and the movements of the bright planets are followed by thousands of observers all over the country.

It would be a noble work for a philanthropist to endow an observatory, furnish it with the best kind of instruments and efficient officers, and devote it under certain restrictions to the use of the people. The telescope is the only instrument that brings nearer to our eyes the mysterious creations of the firmament, and reveals the vastness of the material universe. Those who are familiar with its revelations must necessarily gain a better knowledge of the heavens, and by their influence increase the general interest in the ennobling science by relating what their own eyes have seen.

### PROGRESS OF PNEUMATIC POSTAL TUBES.

In Paris the new extension of the pneumatic postal system is now complete and in operation, ramifying under the streets in every direction. The places for depositing letters are in the various telegraph offices. By payment of fifteen cents, letters may be instantly sent by tube to any part of the city. The tubes also extend from the post offices to the chief railway stations, and letters posted at the last moment may be sent so as to catch the train. Letters from out of town may, if so paid, be sent by postal tube to destination instantly on arrival of the train in the city depot. These pneumatic tubes are a wonderful convenience to the public, and in time will no doubt become an adjunct of the postal service of all large cities. Their use in European cities is already extensive, much more so than in this country, although Americans sometimes pride themselves upon their enterprise and love of doing things quickly. For delivery of local messages our New York telegraphs and telephones are slow coaches compared with the pneumatic postal tubes. The telephone service in this city is poor compared with what it should be.

It takes a good while to halloo to a correspondent, and when he answers it is not more than about half the time one can hear what is said, so mixed up and noisy are the wires, and so bad the connections. As for telegraphing, one can generally send a messenger boy anywhere within a distance of three or four miles and receive reply quicker than to employ the telegraph. In this city the Western Union Telegraph Co. have a line of pneumatic tubes, extending from Broad St. up Broadway to 23d St., a distance of nearly three miles. This is found by the company to be a quicker and cheaper way of sending its own messages than to use its local wires. We wish the post office department could arrange for the connection of these tubes with our city post office. This could easily be done, as the tubes now pass right in front of the building. The department should also extend the line of tubes from 23d St. to the Grand Central Depot at 42d St., and then we might have a continuous line of about five miles, and enjoy to that extent the privilege of Parisians.

The piers from whence nearly all the principal lines of steamships take their departure from New York are within a distance of a mile or a mile and a half from our city post office, or ten to twenty minutes' smart walk by a letter carrier. But so great is this obstacle to our postal officials, that they are obliged to close the foreign mails from two to three hours before the ships leave the docks. To accommodate merchants and late people, they have what is termed a supplementary mail, which is kept open one hour later. For the privilege of dropping letters in this "supplementary" mail, double postage is required to be paid; and in this manner one may get a letter into the foreign mail sometimes up to within one hour prior to the sailing of the ship, but most generally two hours, as the vessels ordinarily do not leave until two hours after the supplementary mail closes. In view of this mode of conducting things, which is the best our postal people think they can do, it is probably too much to ask or expect of them to lay tubes to the docks, or even to employ a one-armed soldier carrier to start a few minutes before the ship goes, and walk to the vessel with a last bag, and thereby give the public the facility of mailing letters up to the last moment.

### Preparation of Large Trees for Moving.

The span of human life in the present era of the world's existence, even in the case of those who live to be old, is of short duration compared with that of trees, the progress of which to a state of maturity is proportionately so much slower than that of man, that those who plant small trees do not live long enough to see much of the effect they produce. In the case of that favorite fruit the pear, it used to be said that those who plant them plant for their heirs, and with the ordinary kind of trees planted to give effect or shelter there is still longer to wait. To shorten time in waiting is the manifest object of those who go to the trouble of planting large trees instead of little ones in the grounds about their dwellings or other conspicuous places, where the presence of such are required. Where work of this kind has to be done, it often happens that enough forethought is not brought to bear on the proceedings. In place of taking the precaution to previously prepare the trees by trenching round them, and severing the roots to within a movable compass, so as to admit of a season's growth before they are taken up, they are at once transferred from where they have been growing for perhaps a score of years or more with their roots unchecked in any way; the result of which is, that the progress made for a year or two afterward is not near so much as it would be if the roots had been previously shortened back in the way named. The omission of this timely preparation of trees that are to be transplanted when much above the ordinary planting size is the less excusable when it is remembered how little labor cutting in the roots as described involves. To the too frequent absence of judgment and reasonable care in moving trees that have attained considerable size is attributable the failures that occur, and that have led many to the conclusion that it is better to plant small trees and wait for them to grow up, even in positions where it is desirable to have such as would give effect at once. In the case of deciduous kinds of a size such as under notice, and that are intended for removal next autumn or winter, the sooner the root shortening preparation is now completed the better, before there is any appreciable movement in the buds. With evergreens it is better to defer this work until the time that the drying March winds are over, especially in cases where the trees are large and in vigorous condition, as with such the root severance necessary is proportionately more felt than with smaller examples.—*T. Baines, in the Gardeners' Chronicle.*

### Progress of the New Orleans Exposition.

Following a custom inaugurated by the managers of the Philadelphia World's Fair, in 1876, the conductors of the New Orleans Exposition have been having a series of State days, on which the exhibits of previously designated States are especially decked out in their most attractive garb, and commemorative exercises are held in honor of the part taken by each in the Exposition. It is perhaps partly owing to the increased attractions thus presented, as well as to the fine weather and the daily concerts and fireworks exhibitions, that the attendance has been largely increased within the past two or three weeks.

The Mexican exhibit at the Fair has at last received its finishing touches, in the completion of a separate building of gorgeous architecture for the display of its minerals, in one part of which is a hillock of block silver worth $144,000. The Mexican display is in every way most excellent, and affords a far more complete representation of the natural resources of the republic, and the life and history of her people, than was ever before offered to the public. In celebrating the entire completion of the Mexican department, however, the announcement was made that the "Mexican day" proper would not come till May 5, the anniversary of the victory of Mexico over the forces of Maximilian, when the latter endeavored to capture the fortress of Guadalupe, near Pueblo; on this date the representatives of Mexico at New Orleans will put forth all their energies to make a display which shall be particularly impressive.

On "Minnesota day," when the ceremonies were somewhat elaborate, tin drums filled with sorghum sugar made in that State were passed around as souvenirs of the occasion, and one of the speakers referred to Minnesota's exhibit in this line as demonstrating that "the sugar line can be removed eighteen degrees of latitude northward." The principal Minnesota exhibit at the Fair is from one of the great Minneapolis flour establishments, where 7,500 barrels are made per day, the flour being held in pyramids of satin sacks. The total production of flour in Minnesota for 1884 was given as 8,800,000 barrels.

The operation of the fiber decorticator which is being exhibited at the Fair is watched with a good deal of interest, as an entirely successful machine of this nature has long been sought in vain. In an experimental way this machine has been used to clean the fiber of henequin leaves, plantain and banana stalks, and Kentucky hemp. all of which have been divested of their woody parts in a single operation. It is claimed that this machine is a universal decorticator.

In accordance with the action of a National Convention of Passenger Agents, the railroad rates of fares were recently reduced to a standard rate of one cent a mile on most of the roads taking passengers to New Orleans, and this action is materially contributing, with other causes, to increase the number of visitors now daily visiting the Exposition.

### A Dinner for Two Cents.

There is an organization in London for furnishing poor children with a dinner for a penny (two cents); and from a recent published report it seems to have proved a successful experiment, in a pecuniary as well as beneficent sense; so much so, in fact, that another society has undertaken to furnish dinners to poor children in the poorest and most populous part of London for half a penny. It is said that the children who take their meals at the penny establishment show a marked improvement in health, are more regular in attendance at school, and accomplish better work in their studies than when they commenced their new regimen. It may interest philanthropists who are engaged in ameliorating the condition of the poor in our large cities, to know the materials of which these dinners are composed. The bulk of the ingredients is, of course, vegetables and bread, potatoes and peas holding a prominent place. Both meat and milk are used in moderate quantity.

From the report just made it is calculated that each child receives about twelve or fifteen ounces of soup or other kind of nutriment each meal, and this quantity contains from one to one and a half ounces of meat. The children enjoy their dinners, and appreciate the kind attention they receive at their meals. When one considers how scanty and unpalatable is the food furnished to many poor children at their homes in the great cities, like London and New York, it is not surprising that the poor neglected children thrive better, learn more at school, and are happier for a hot palatable dinner and a kind word from the attendants.

The last experiment of furnishing a halfpenny dinner for the very poorest children from the most squalid parts of London has not been established long enough to determine if the receipts will meet the expenses, but it promises well, and the supporters of the enterprise are confident that it will nearly pay its way.

As many as 303 children were fed on the first day; the number has to average about 566. A choice within a certain limit is given, and care is taken to make the food agreeable and wholesome. The first course consists of a rich stew or bacon sandwiches, the second of bread and jam or bread and cheese. That the children find the dinner ample to satisfy their hunger is shown by the fact of their continued attendance and the little waste made. It is demonstrated that, with the cook's wages. cost of gas and implements excepted, there is no loss, and that they can be made self-supporting.

The penny and halfpenny dinner associations of London suggest a plan which it seems might be advantageously adopted in our large cities, and, if conducted on the economic scale of the London societies, not only poor children, but unfortunate adults, might be relieved of much suffering without imposing any tax upon our benevolent citizens.

Any one wishing to know more of the penny dinner enterprise may obtain copies of a pamphlet on the subject from Messrs. Alexander and Shepheard, 21 Castle Street, Holborn, London. It is sold for one penny.

### Prize Offered for an Invention.

At the third international conference of the societies of the Red Cross, held in September at Geneva, the Empress of Germany offered 5,000 f. and a gold medal as a prize for the best model of a soldiers' barrack and field hospital. The delegates to the conference from this country have issued a request to American inventors to take part in the contest. The barrack must be large enough to contain 12 beds. It must be easy of transportation and made with interchangeable parts, and capable of being taken down and reconstructed. The designs are to be sent to Antwerp, Belgium, by September 1, 1885, when a committee will decide on their respective merits.