SCIENTIFIC AMERICAN

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A CITY UNDER ONE ROOF—THE MASONIC TEMPLE.

The World's Columbian Exhibition may justly be said to have commemorated the quadricentennial of America, not only by the exhibition of the arts and industries of the globe, as brought together in the White city by the Lakes, not only by the lovely architecture and land- and water-scape there created, but by the city of Chicago proper, the worthy exponent of American progress and growth, the typical American metropolis. Of all the buildings of our Western sister Chicago, none is more remarkable than the Masonic Temple, a structure which, in its functions, dimensions and construction, is one of the unique buildings of the world. In spite of its name, it is proudly claimed to be the "highest commercial building in the world." In it we find exemplified the union of Freemasonry and commerce, a four and one-half million dollar building supplying beautiful halls and parlors for Masonic rites, as well as an unequaled collection of business offices.

The building is situated on the corner of Randolph and State Streets, in the heart of Chicago. It is constructed of granite, marble, steel and terra cotta as the principal materials of construction, and is fireproof throughout. From street level to apex it measures three hundred and two feet; this in absolute height of structure, not in the mere elevation of a lantern surmounting a dome. For one of the peculiar features of the building is its plainness and uniformity of design, the main features being repeated story after story until the sloping roof is reached. There is no tower or dome added simply to break the record. The building is just what it claims to be and no more.

The architects were Messrs. Burnham & Root, of Chicago, Mr. Burnham being widely known as Director General of Works of the Columbian Exposition. The street fronts are of dressed granite up to the sills of the fourth floor windows; above that they are of terra cotta and brick, matching in color the granite. The foundations are of concrete and steel, the latter being horizontal beams arranged to distribute the column loads, so that a uniform pressure of 3,500 lb. to the foot on the clay is produced. The building is of steel frame type, a method of construction now generally followed in large buildings.

The floor loads are sustained by steel columns; all of the building above the fourth floor is carried by steel columns, except for six piers, which are self-sustaining and support no additional load. Even the great arch in front has but a small load, a twenty-five ton girder running across it at the fourth floor level. Tension bracing, consisting of heavy steel rods, extends in two systems from top to bottom of the building in the direction of least width. The vertical columns are two stories in height, and alternate columns break joints.

The general dimensions are one hundred and seventy feet front and one hundred and thirteen feet depth. It is the front which appears in our illustration. The entrance is beneath a granite arch forty feet high and thirty-eight feet wide, and opens into a great rotunda, lined with Italian marble, and opening upward, through twenty stories. Ornamental iron staircases lead up from either side. Back of this great

Masonic Temple. Trinity Church, N. Y. Statue of Liberty, N. Y. Capitol, Washington. Ferris Wheel.

A CITY UNDER ONE ROOF—THE MASONIC TEMPLE, CHICAGO.

court is a sort of semicircle of elevators arranged like lights in a bay window. There are fourteen of these, lining an arc fifty feet deep and of seventy feet chord. The court is seventy feet each way, square in front and semicircular in the rear, the rear lines being determined by the elevator fronts.

The elevator plant is one of the features. Of the fourteen passenger elevators, seven are for express service only, not stopping below the tenth floor. The others stop at any floor desired. Owing to the great height of the building, the weight of the steel suspension cables became a serious problem, and was dealt with by counterweight chains attached to the bottom of each elevator and drawn up by it. These prevent any irregularity in the weight to be raised, due to difference of elevation, which, otherwise, would have been very great. The elevators run at a speed of nearly nine miles an hour, and ascend 258 feet. Allowing continuous ten hour service for each, their aggregate travel in one year would be over 123,000 miles. Thirty seconds is ample time for the full ascent. There are also two freight elevators. The wire ropes of the elevators aggregate sixteen miles in length.

The rotunda is surmounted by a glass roof 302 feet above its mosaic floor. The windows and balconies of the twenty stories open upon this shaft. The twenty-first story is properly the roof. It is a roof garden, and is devoted to purposes of observation, and may be used for commemorative or festival occasions. It forms a great platform, inclosed by walls and ceiling of glass, with oak panels, steam heated, and capable of accommodating 2,000 people at one time. It is the highest point of observation in the city, and gives grand views in all directions.

Around the rotunda galleries are carried for the first ten stories. Shops open on these galleries, with show windows, exactly as in a street. The stories from eleventh to sixteenth inclusive are for offices; the remainder are for Masonic uses. The general features of the court and balconies include mosaic floors, marble soffits or under surface of the balconies, alabaster-cased columns, bronze-finished hand rails and metal work, and marble-lined walls.

The water supply plant comprises pumps with a combined capacity of 2,000 to 3,800 gallons per minute. The pumping machinery circulates each day, if reckoned in gallons passed through the pipes, enough water to fill a reservoir 240 feet long, 100 feet wide and 50 feet deep. The roof tanks alone provide storage for 7,000 gallons. The cellar has still larger tanks of 18,500 gallons capacity.

Wrought iron pipes with screw joints are used for water supply and for sewage, all taking vertical courses and placed in special pipe chambers or pockets. Part of the drainage goes directly to the sewers; part is delivered to a tank in the basement, whence it is forced by steam ejector into the sewers.

For heating about 40,000 square feet of steam radiator surface on the overhead system is provided, and a sixteen inch steam pipe is used for their supply.

The electric light plant includes some 7,000 16 c. p. incandescent lamps, operated by six 1,000 lamp dynamos, the latter driven by high speed engines. Two sets of electric mains are carried through the building, all cross connected and of large size, to prevent any danger from heating. It is estimated that there are 53 miles of electric wires, and the weight of the rest of the electric plant has been put at 50 tons.

To allow for settling, the building was started a little above the proper street level. The settling was so accurately calculated that it is now at the proper level.

Our illustration is designed to show the great size of the building. On the right of the cut is seen the great Ferris wheel, 265 feet high, next comes the Capitol at Washington, 288 feet high, the Statue of Liberty in New York harbor, 301¼ feet from water level to the torch, then Trinity Church spire, 284 feet high, and then the Masonic Temple. To bring it within every day comparisons we show adjoining it a typical New York City fireproof, first-class office building, and next to that, on the extreme left, a four-story "brownstone front." It will be seen that the mammoth pile dwarfs everything shown.

The Silk-Spinning Spider.

The silk spider of Madagascar forms the subject of an interesting article in *Die Natur*, by Dr. Karl Muller. Its native name is Halabe, meaning great spider. This Halabe, or *Nephila Madagascariensis*, spins threads of a golden color and strong enough, according to Maindron, to hang a cork helmet by. The female spider may attain a length of 15 cm., while the male does not exceed 3 cm. A single female individual, at the breeding season, gave M. Camboue, a French missionary, some 3,000 m. of a fine silken thread during a period of about 27 days. The thread was examined with a view to creating a new industry. Specimens tested at a temperature of 17° C. showed an elongation of 12·48 per cent under a weight of 3·27 gr. Small textures woven of these threads are actually used by the natives for fastening flowers on sunshades and for other purposes.

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HAULAGE BY HORSES.

Mr. T. H. Brigg, who has spent the better years of his life in the investigation of the fundamental principles of economic haulage by horses, read an instructive paper on this subject at the World's Engineering Congress, in Chicago, last July. The question discussed by Mr. Brigg is one which, from a financial, humane, scientific or civilized point of view, affects the commercial interests, comfort and well-being of every civilized country in the world, and which, notwithstanding its apparent simplicity, must be approached by scientific methods. While man, says the author, is continually devising methods to lighten his own labors by substituting the forces of nature for his own strength, the horse is required to bear his burdens and haul his loads under the same disadvantages that have hampered him in the past. Much attention has been paid to the development of speed in horses, and the result has been a vast improvement in their strength, beauty and speed; but the animals are still so handicapped by the unscientific methods under which they are required to labor that there is an absolute loss, in many cases, of fifty per cent of their strength.

The amount of resistance that a horse can overcome depends upon his own weight, his grip, his height and length, the direction of the trace and his muscular development, which determines the power to straighten the bent lever represented by his body and hind legs against the two resistances—the vehicle, through the trace attached to the shoulder, and the hind feet against the ground. Many erroneous notions exist as to the best inclination of the trace for the horse. For instance, if a horse can haul a given load up a given hill with a deep inclination of trace and cannot do so with a horizontal one, it is generally thought that the former is the better angle. It is, indeed, for that particular hill, but when once the latter is surmounted it becomes a very bad angle, inasmuch as it involves a great loss of power. To pull through a low trace, or to have a man, or even two or three men, on a horse's back, is advisable, and even necessary, if a horse is expected to haul a load requiring the full force of his muscles at any particular moment, and for the moment, under such conditions, he would be able to draw a much greater load than without the added weight; but any one can see that the animal could not travel far with any vehicle if he had to carry three men on his back in addition to hauling his load. It is utterly impossible, says Mr. Brigg, for a horse to pull through a permanently oblique trace, or through shafts, such as are so commonly used in America, without the animal being compelled to carry a part of the vehicle, just as effectually and with the same extravagant and painful result as sedan chair carriers experience in carrying their loads.

The question has been asked, Should the horse support the vehicle, or the vehicle the horse? The lighter the load, says Mr. Brigg, the more the vehicle ought to support the horse. When, however, the load increases, the horse ought gradually to lose that support until, with a very excessive load, he ought to support a part of the vehicle itself. If the load is heavy and difficult to move and the horse is compelled to make a horizontal thrust, without increasing his grip and mechanical conditions, it fails. But, if the conditions remove some of the weight from the load and place that on the horse, it is equal to allowing the thrust to be an obliquely upper one. Again, a load that a horse can draw up any ordinary gradient should never require the horse to support either any part of the vehicle or the load on a hard level road.

Human beings are constantly moving, resting first on one foot and then on the other in search of relief. Generally, they can sit down, but horses cannot do so without being smartly beaten for their effort to relieve themselves. For generation after generation, we have kept on yoking horses by methods that compel them, in the shafts of a four-wheeled wagon, to rest their entire weight on their feet. It is not realized that a horse exerts from ten to a hundred times more force and expends that much more energy in transporting himself from place to place than in hauling a two ton load on fairly good roads. The horse is compelled, absolutely unnecessarily, to exert himself under conditions such as no engineer in the world would for a moment think of applying to the steam horse, under which to waste its energies and knock itself to pieces in practically no time.

The result of Mr. Brigg's investigations is that, having ascertained the fundamental and economic principles involved in the haulage of vehicles, and the transportation of living or inanimate matter, he has devised a special contrivance applicable to all kinds of four-wheeled vehicles or sleighs, which he claims will, at all times, automatically afford the horse all possible assistance. It does not matter whether he be traveling on smooth, level roads, up hill or down, with a heavy or a light load, he cannot fail to receive a direct advantage from the very moment he is attached to the moment he is detached. The relief is afforded while he is walking, running or even standing. The percussion on his feet is reduced at every stride during the day. His muscles are less strained, his