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 crossconnected 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 energy is economized as one would economize the energy of a locomotive, and his legs and feet are saved from an enormous amount of battering, which proves so fatal on all conditions of road.

In an experiment tried before his audience with his invention, which was exhibited at the World's Fair, at Chicago, Mr. Brigg used a two-seated wagon with ordinary shafts. From the latter a line was carried back seven feet to a small platform bearing a chair on which was seated a man of middle weight. Two people climbed into the seats of the wagon. A strong, heavy man now tried to haul the affair, but failed. The automatic appliance was then attached to the shafts and the wagon was hauled easily, notwithstanding a second man had taken his position on the platform drag. The hauler had been relieved of part of his weight, and the strength in his pull had been added to that much.

PROGRESS AND INVENTION.

In the course of his remarks recently upon the part that had been played by the American inventor in the development of the country, the Hon. Thomas Reed among other things said: "To hear the discussions in Congress you would suppose that invention dropped from Heaven like manna to the Jews. You would suppose that James Watt reached out into the darkness and pulled back a steam engine. It was not so. All invention is the product of necessities and of pressure. When the boy who wanted to go off to play, so rigged the stop-cocks that the engine went itself, he was not only a true inventor, but he had the same motive—his personal advantage—that all inventors have, and, like them, it was urged on him by business necessities. What originated Bessemer steel? Sir Henry Bessemer? No; but the necessities of railroads, which would, every one of them, have been bankrupt without steel rails. If Sir Henry had not invented the process, somebody else would. It detracts not one iota from the fame of Alexander Bell that a dozen men were close on his track. It has been so in every great invention. I say, therefore, that it was the diversification of our industries that stimulated inventions. Otherwise all the inventive power of America would have run to waste; and when a man calculates the wonders of American inventive genius, he knows where some of our wealth comes from.

"As a further proof that invention is born of necessity, tell me why great inventions never come until the world is in such shape as to enjoy them? What would the Crusaders have done with railroads? There was not money enough in the world, or travel, or merchandise to keep them going a week."

A New Sanitary Building.

Dr. W. Van der Heyden, of Yokohama, Japan, in a recently published pamphlet, describes a sanitary building devised by him, which he has occupied for a year, and in which he believes that he has solved the twofold problem of the construction of a dwelling for use in both arctic and tropical climates. The new structure is composed of glass boxes filled with a solution of alum and made air and water tight. The application of glass for building purposes is not altogether new, however, since hollow glass bricks have already been made and houses built of them.

The boxes employed by Dr. Van der Heyden are formed of two panes of 4·10 inch thick glass, fixed in cast iron frames that are screwed together. These boxes, which have thus far resisted the influence of cold and heat, shocks and earthquakes, rest upon cast iron supports. The necessary gaps between two rows are filled with felt and then covered with boards. The series of boxes above each other and next to one another, with as little space between them as possible, and such space filled with felt, form the external walls of the house. The roof, which is flat and is supported by the cast iron pillars that carry the boxes, can be made in exactly the same mould.

In the house under consideration, glass panes pressed against each other, but with strips of rubber between them, form the horizontal ceiling. Above this there rests a thick layer of ashes, upon which there is a light framework of wood, covered over with cement. This, of course, renders the roof non-translucent, but it defends the room well against the radiant heat, and, being made of bad conducting material, the heat of the interior is not lost. As the four walls are totally translucent, there is more light than in any other description of dwelling.

A house built in such a way is an entirely closed hollow space, without windows or doors. As there are no openings and no fissures, it is practically impermeable to air, moisture, heat, cold, dust, microbes and insects. Since the panes are of rough plate glass, objects within the inclosure cannot be seen from the outside. At convenient places, some may be replaced by transparent glass to serve as windows giving a view of the exterior. Doors are not needed, since the entrance can be made through the floor by means of a staircase from an underground room, which receives no direct light from the sun. The walls of this room are made of ordinary bricks, plastered inside and protected outside by a thick layer of clay to exclude moisture. The light is admitted through glass boxes set into the four corners of the ceiling, which forms the floor of the room above. This floor is made of double planks, with a thick layer of sawdust between them. The planks facing the upper room are painted and varnished, but may be saturated with paraffine. Those facing the under room are plastered, as are also the walls. There is a mild, diffused light in the lower room, sufficient to read by. At night, both compartments are lighted by electric lamps.

As in winter the solution in the glass boxes might freeze, and would certainly do so in cold countries when the temperature falls to —18° C., a covering of ordinary glass set in wooden frames surrounds the whole building, so as to form an envelope of air, which is a very bad conductor of heat. This air space can be easily warmed if required. In the summer of moderate climates, and all the year round in tropical ones, the same glass window frames are put within the house, so as to shut off the heat by means of these badly conducting air cushions. The dwelling is entered from the exterior through a staircase leading to a corridor that communicates with the subterranean room, and that can be closed by doors, so as to let in as little cold or heat as possible while a person is entering.

Between the walls and the ceiling, there is a space leading outside to a belt covered with window glass and partially surrounding the building. From this external air space a tube leads to a stove (which stands out of doors) and conveys the air directly under the grate. There is thus a constant withdrawal of air from the house as long as the fire burns. This vitiated air is replaced by pure air that has been warmed in passing through tubes placed around the pipes that carry the heated gases from the furnace to the chimney. This air, before entering the heating space, comes from the lower room, where it has already taken the temperature of the surrounding earth. The heated air rises in a tube laid under the ceiling of the lower room and escapes through openings in the floor of the upper room. The temperature of the air is controlled by valves.

In the summer of moderate climates, and always in the tropics, the renewal of the air is effected in a different way. The vitiated part escapes, as in winter, near the ceiling. From there it enters a prismatic chamber of wood and glass, which is carefully closed in winter by a wooden cover, but is left open in summer. This apparatus, which Dr. Van der Heyden calls a "sun belt," performs the functions of a stove, in causing a useful draught, through the heating of the inclosed air by the solar rays. The expanded air, in rising and escaping freely at the top, is followed by the denser air from the room. The arrangement acts automatically when the sun shines. When it rains, the more the rain and the harder it falls, the greater the draught, while every slight movement in the external air promotes the withdrawal of air from the sun belt and house.

In a hygienic building, it is of great importance to have the fresh air constantly entering the apartments free from dust and microbes. This result is obtained as follows: Both in winter and summer, the air for ventilation is taken from the cellar room. The air to replace this enters through a large glazed earthenware pipe or a plaster-lined brick tunnel extending underground to a distance from the house, and then rising vertically to some height above the surface and opening in the free air. It is here covered with wire gauze to filter the air from insects and rough particles, and is sheltered from direct sunshine by a wooden roof. In the opening that communicates with the lower part of the cellar room there is placed a wire cage filled with loose cotton, which filters the air from the finest particles of dust and from microbes. In front of this cage is placed a pane of glass covered with glycerine or moist glue. The air coming from the pipe strikes this surface, leaves thereon the microbes that may have passed through the cotton, and then expands in the interior of the room. The rooms of such a building are thus made as aseptic as a wound-dressing of Lister.

Dr. Van der Heyden, believing that the air of one's neighbors ought not to be vitiated by allowing the air leaving the house to carry with it bacteria, or poisonous gases due to the expiration of the inmates, purifies the air of his building more fully by having curtains stretched under the ceiling with woolen tassels attached to them by hooks and eyes. Into some of these tassels a strong alkali and into others Nestle's reagent is drawn by capillarity. The air, striking along the ceiling before it leaves the cornice openings, deposits there its carbonic acid and its organic alkaloids, besides the greater part of the dust that may have collected. In this manner an endeavor is made to have the air that leaves the house as pure as it was forced to be on entering.

The wash and kitchen water is rendered innocuous, before it is allowed to enter the drains, by passing it through an unglazed chinaware filter, on the principle of that of Chamberland, but differing in construction. On the same principle of not allowing any matter containing infection to remain in the house or to leave it undestroyed, the water closet used is so constructed as to permit of the quick oxidation of the urine, fæces, sputa and other refuse through the action of sulphuric acid and nitrate of soda. Different organic salts are the result, all the organic matter is destroyed, and nothing that is of great value as a fertilizer is lost.

Railroad Development.

To complete the Transandine Railway, which would give uninterrupted communication between points in Chile and Buenos Ayres, the capital of the Argentine Republic, it is necessary to build only 33 kilometers (20½ miles), as trains can now run over 1,189 kilometers out of a total of 1,222 miles. The Argentine section is nearly completed as far as Puenta del Inca, so that in 1894 there will remain to be constructed 15 kilometers, including two tunnels at the summit. Work on this remnant of the Argentine section will be commenced as soon as the line on the Chilean side is sufficiently far advanced to permit the work being prosecuted in such a manner that the two sections—the Argentine and the Chilean—shall be finished at the same time. Thus, the only obstacle to the completion of the road has been the lack of satisfactory arrangements for constructing the Chilean section. The contractors, John and Matthew Clark, having found it impossible to raise money for this link under the guarantee of the Chilean government, asked the Chilean congress to increase the guarantee from 4 to 5 per cent, and this having been done, it is said there will be no difficulty in completing the road.

The Chilean congress has granted a concession for a railway to connect the Southern Line of Chile with the Argentine Great Western, at La Paz. The road will be mostly in Argentine territory, namely, 175 miles from La Paz to the Andine pass of Tinquiririca and 75 miles further to a point on the main trunk Southern Railway, between San Fernando and Curico. The road is expected to be of special use for the valuable cattle trade across the southern passes of the Andes into Chile.

From a report by Mr. C. C. Mallet, British consul at Panama, it appears that steady progress is being made in the construction of the important railway from Cartagena to Calamar, on the Magdalena River, in Colombia. The concession for this road was obtained in 1889 by Mr. S. B. McConnico, representing some American capitalists. The funds for the enterprise were raised in the United States, but work was delayed for nearly three years, because of the difficulty experienced in securing an amount sufficient to complete the road. Construction was commenced in June, 1892, and one year later, June 15, 1893, the first section of the railway, from Cartagena to Turbaco, a distance of 14 miles, was formally opened. The next section, to Arjona, 8 miles, was to have been opened in October, and it is expected that the road will be completed to Calamar by June, 1894. At the time of Consul Mallet's report, in September last, 1,800 men were at work on the road. The road is being built with care and is equipped with the best American cars and locomotives. The distance from Cartagena to Calamar is 65 miles. Most of the land adjacent to the line is suitable for fruit culture and cacao. The trade from the upper Magdalena, a large part of which, it is hoped, will be diverted to the port of Cartagena, is expected to give the road substantial profits.

A Fish with a Rubber Corset.

Forest and Stream speaks of a curious find in the Cape Ann fish market, at Gloucester, Mass. It was nothing less than a mackerel with a rubber band around the body. The band had been put on the fish when quite small, and stayed there in spite of the rapid growth of the wearer. The fish's body under the band did not grow, which caused a depression in the full-grown body of about three inches in depth. The depression was covered with a healthy skin in no way unlike that on the rest of the body. The fish measured in length fourteen inches, diameter of body each side of the depression, seven and three-fourths inches, diameter of depression, five inches. The fish was undoubtedly in a healthy condition, and the band was sound and could be stretched like any other band.

Cleveland's Portable Engine Brake.

In describing this improvement, in our issue of December 16 last, it was inadvertently stated that the brake might be applied to a portable engine "for braking purposes on reaching a down grade." The brake is not intended for such use, but to prevent oscillation of the engine when driving machinery. The illustration clearly indicated its thorough effectiveness for the latter purpose, the simplicity of its application, and the readiness with which the chains could be tightened to lock the wheels immovably, no matter how severe might be the work the engine was called upon to do. The device is strong and durable, and may be stored on the engine when not in use. The improvement was recently patented by Mr. E. W. Cleveland, of Rounthwaite, Manitoba, Canada.