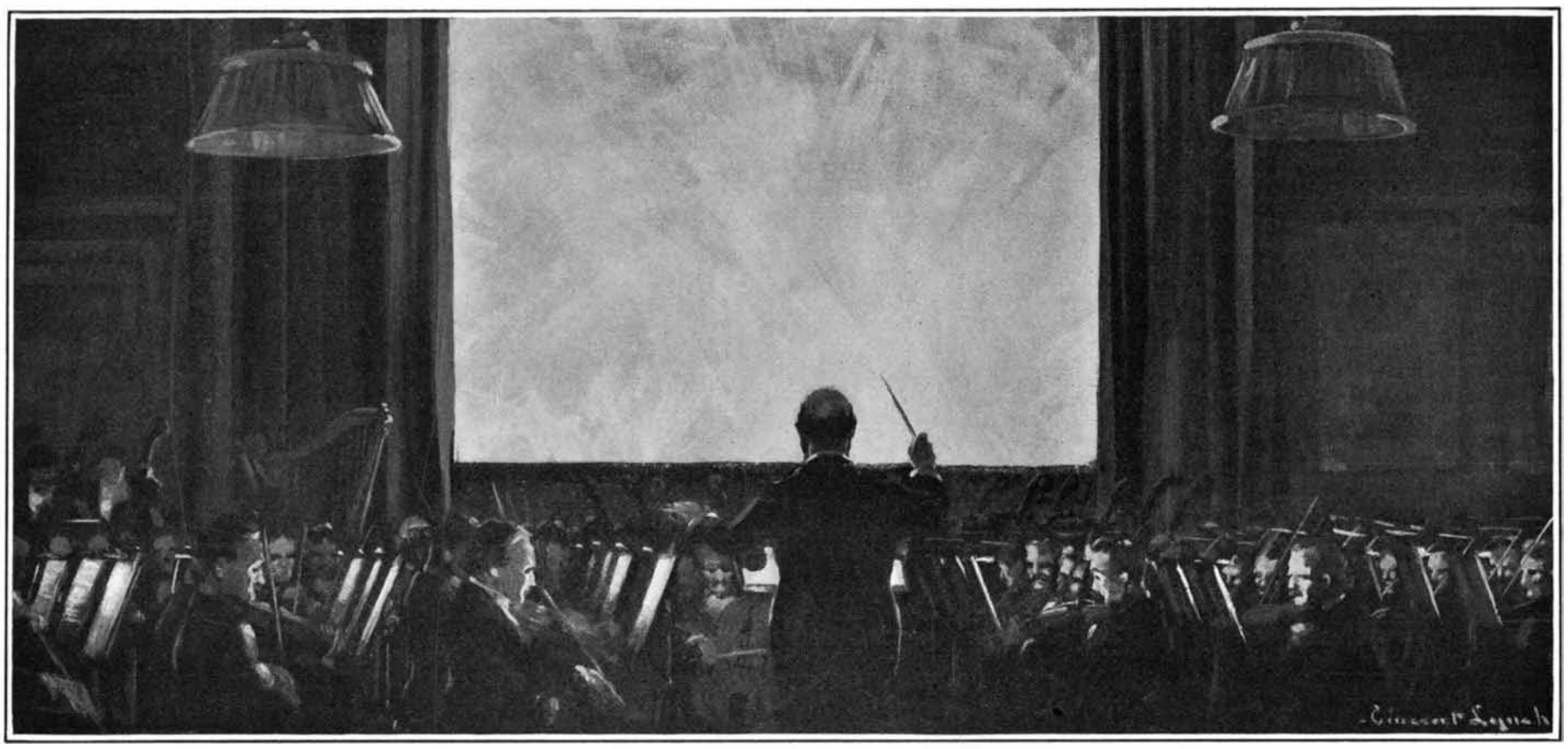


As the orchestra played, lights of changing hue illumined the screen.

Color Music—A New Art Created With the Aid of Science

The Color Organ Used in Scriabine's Symphony "Prometheus"

By Harry Chapin Plummer

NEW YORK concert-goers, on Saturday evening, March 20, witnessed a novel departure from the conventional symphonic programme when the Russian Symphony Orchestra presented the tone-poem "Prometheus," of the Russian composer Alexander Scriabine, with the employment for the first time, as an "orchestral unit," of an instrument for producing colors, designated by the composer the "tastiera per luce" or "clavier lumière" (color-light keyboard).

The colors appeared, simultaneously with the rendition of the music, filtering through a mesh of fine gauze within a square framework at the back of the stage, above the orchestra, and were controlled from a keyboard, not unlike that of an ordinary piano. The player, or operator, sat at the keyboard in the body of the orchestra and, of course, facing the conductor. He was so located that he saw both conductor and screens. He followed the conductor's beat and the "music," which in appearance differed little from that of the "orchestral voices." As in the conductor's score, which had the part for the "tastiera per luce" at the top of the page in the position usually accorded the part for the first violins, the "music" for the color-light keyboard expressed the color requirements not in color terms, as "red" or "blue" or "green," but in musical notations, as "C," "F-sharp," "A," etc.

An arbitrary color-scale was employed by the composer of "Prometheus," corresponding with a musical scale upon which the tone-poem was built and which is equally arbitrary in the "new" tonal standards which it imposes. His tone-scale, with its color equivalents, follows:

C	Red
D	Yellow
E	Pearly Blue
F-sharp	Blue
A	Green
B-flat	Steely Gray

Harmonic combinations of these tones naturally demanded corresponding combinations of the various hues in the mesh upon which the gaze of the audience was centered, and, so, many variations of the primary hues and many tints were effected. With the drift of the music, the colors changed and dissolved by superposition, by juxtaposition and otherwise.

It is here that the peculiar nature of the composition which was the medium for the experiment should be pointed out. "Prometheus" is styled by Scriabine the embodiment of the creative energy of the universe—the creative principle of light, heat, life, energy, conflict, and physical and mental activity. Musically, it is what is known as a "programmatic" work, in that it affects to suggest more or less definite subject matter. It belongs in the category of what a sister art would term "futurist" music, principally because of the arbitrary tonal scale established and the striving of the author after a sequence of dissonance and cacophony, rather than the more absolute harmonies of earlier and "orthodox" composers.

In marked contrast to the complexity of the tonal scheme, the color scheme, as finally evolved, proved to be somewhat simple in its operation and in its results. The disadvantage of a fixed location for the colors was quickly discerned, as the illusionary and mystic effect so much to be desired in such a case was lacking.

The splendid resources of the Electrical Testing Laboratories of New York were placed at the disposal of Jacob Altschuler, conductor of the Russian Symphony Orchestra, for the preparations for the music-and-light concert. Preston S. Millar, general manager and secretary of the Laboratories, and past president of the Illuminating Engineering Society, personally supervised the building and installation of the apparatus, and he was assisted in the planning and construction by W. F. Little and in the production of color filters by William McKay, and others of the Laboratories staff.

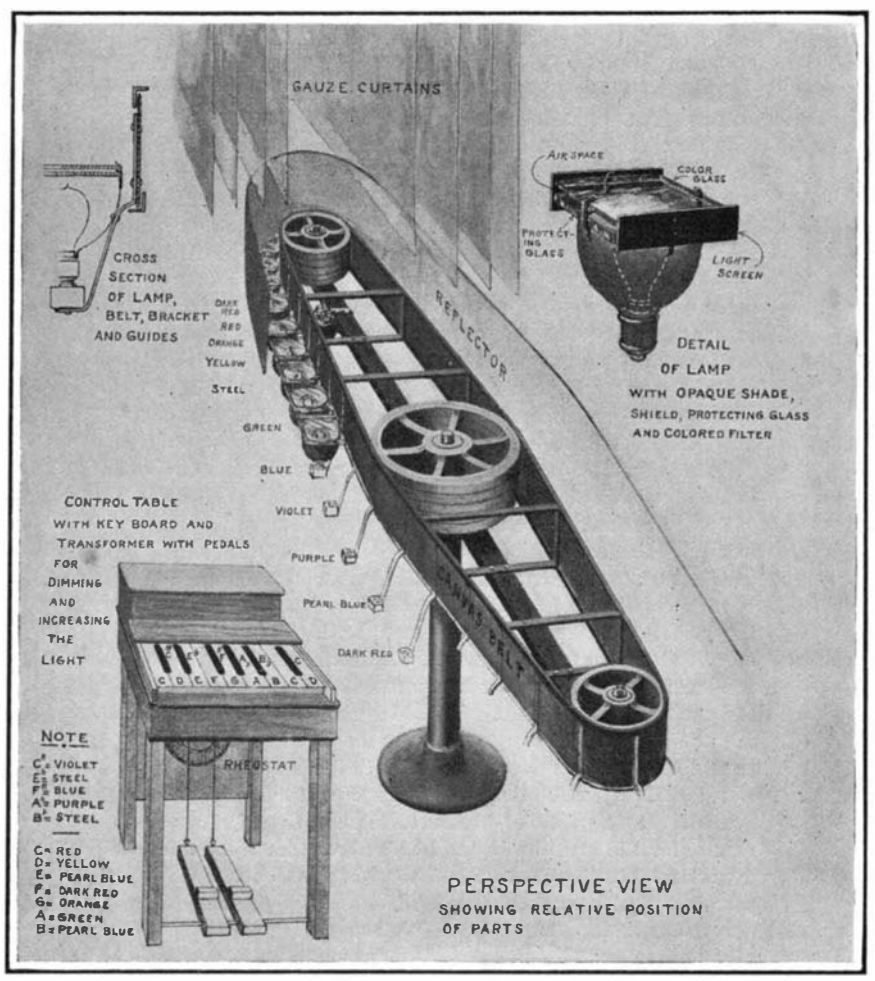
To operate the color apparatus the player presses a key and that makes contact in the direct-current circuit, which actuates a relay, closing the alternating current circuit on the lamp or lamps, which are connected. There is one relay for each hue of light called for by the composer; the number of lamps varies from one to six.

The light of tungsten lamps is so largely yellow that one lamp suffices to produce the yellow hue, but little of this light having to be suppressed. On the other hand, when deep red or violet light is desired, it is necessary to suppress a large part of the light, leaving so little of the desired hue that a number of these lamps is necessary to give the requisite intensity. The lamps range in size from 100-watt vacuum tungsten to 400-watt gas-filled tungsten, and all were specially made for this purpose in unusually small bulbs, and supplied by courtesy of the General Electric Company.

The required regulation of the lamps to vary the intensity of the hues is obtained by employing the reactance in the common circuit feeding all of the lamps. This is operated by pedals, just as intensity of sound is controlled in a pianoforte or organ, the reactance being mounted directly beneath the keyboard and directly connected with the pedals. Whereas, in a piano the hammer is brought into immediate contact with the string, in this instrument the hammer is replaced by a carbon contact; depression of the key brings this contact into abrupt connection with a corresponding fixed contact, closing the circuit and actuating the relay.

Each lamp is inclosed in an opaque concentrating reflector, which gathers a large part of the light and projects it upward and over the mouth of which are placed color filters. These consist usually of three or four glass plates. The first is of crystal glass and is separated by about three eighths inch from the others for ventilation purposes, it being obvious that a great amount of heat is generated and

(Concluded on page 350.)



The mechanism of the color piano.

nevertheless, such stations as Nauen, Germany, and stations of similar distances are heard very clearly and at all times of the day.

The operator in charge of the station at Hoboken is Mr. Gillon, a man who has had great experience in radio work.

An Important Development in Color Photography

(*Concluded from page 341.*)

fitted, carrying the two filters and plate holders, so that first one picture can be taken, then the back slid along and the other picture taken at once. This camera enables the two exposures necessary to be given very rapidly one after the other, the total exposure, using the powerful artificial light which has been adopted, being only about three seconds. Great attention to detail is necessary in the process, if the best results are to be obtained.

Portraits produced by this process are in the form of transparencies and are intended to be viewed in a special illuminator which lights them evenly from behind by electric light, this illuminator being attachable to any electric light fitting. Finished portraits illuminated in this manner add to the attractiveness of library or living-room.

The process cannot be used for the production of paper prints, and in most cases it is convenient to transform the original negatives into the finished positive, but, if desired, duplicates can be made by making contact positives from the original negatives, from which new negatives are printed which are then transformed into the color images. This duplication process enables retouching, both of the negative and positive, to be employed if desired.

The new process, according to its inventors, is not well adapted, in its present form, to outdoor subjects, especially where blue sky is included in the picture. The limitation of the process to transparencies must also be remembered. It represents, however, a highly satisfactory and practical method of obtaining beautiful color portraits having first-rate photographic quality and giving a pleasing reproduction of the colors to the original.

Color Music

(*Concluded from page 343.*)

must be disposed of for the protection of the filters. The filters differ for the several hues. In some cases they consist of two thicknesses of colored glass bound together. In others, of one clear glass, a thickness of theatrical colored gelatine and one colored glass, and in still others, the colored gelatine is employed between two clear glasses.

As examples, to effect the hue of green, two thicknesses of imported green glass are used, between which two different kinds of green gelatine are placed; but to effect the hue of red, a single thickness of red glass is employed.

In all cases, the principal desideratum in the construction of the filters is approximately mono-chromatic light, with a minimum of absorption in the filter. The light units are equipped with thin metal closing strips, with a view to the avoidance of leakage of white light through the openings left for the ventilation of the color filters.

The light units, with the filters, were mounted for this concert on a horizontal belt revolving on pulleys in turn mounted upon a rigid steel frame. A small motor mounted upon this frame drove one of the pulleys through a worm gear and revolved the belt. To avoid the numerous moving electrical contacts which would be required by a continuous revolution of the belt, arrangements were made for the automatic reversal of the motor field; in this way, with each half-revolution of the lamps, the motor was reversed, each lamp moving through an arc of 180 degrees and returning over the same path.

To conform to the limitations of the space available on the stage of Carnegie Hall, the belt was arranged in an ellipse thus bringing one row of lamps behind the other and removing it by about thirty inches.

The hues thus provided were thrown

upon diaphanous materials, which, in sheets of about 8 feet by 10 feet each, were mounted vertically directly over the light sources. The materials in the front of the group were most diaphanous, the others being graduated until the last was reached, which consisted of a rather heavy mesh net, presenting a large surface for reflection purposes. The whole body of gauzes was mounted within a black square inclosure, thus preventing the play of light upon the surrounding surfaces and distracting from the colors as displayed on the gauzes. The effect of this arrangement was that the observer saw the light of one hue displayed upon the rear gauzes and the light of a different hue displayed upon the front gauzes, the one being visible through the other.

The final result of this was a beautiful combination of hues not precisely identical in any two portions of the screen and varying in appearance, as does changeable silk in dress materials, when shown under strong light. This arrangement avoided a difficulty which would otherwise have been experienced had the colors been juxtaposed or superimposed upon one surface. At the same time the slight appearance of animation obtained by moving the light sources slowly around as the belt revolved operated to avoid the monotony which would have been consequent upon the employment of a given hue uniformly in a given portion of the screen. It produced, also, much more interesting blends of color, and any combination of two colors which was displayed for a number of measures of the music changed its precise appearance continually and at no time became monotonous.

The space occupied by the color apparatus, outside of the keyboard, was about 10 feet by 5 feet. The apparatus was 16 feet high, from the floor to the top of the gauze.

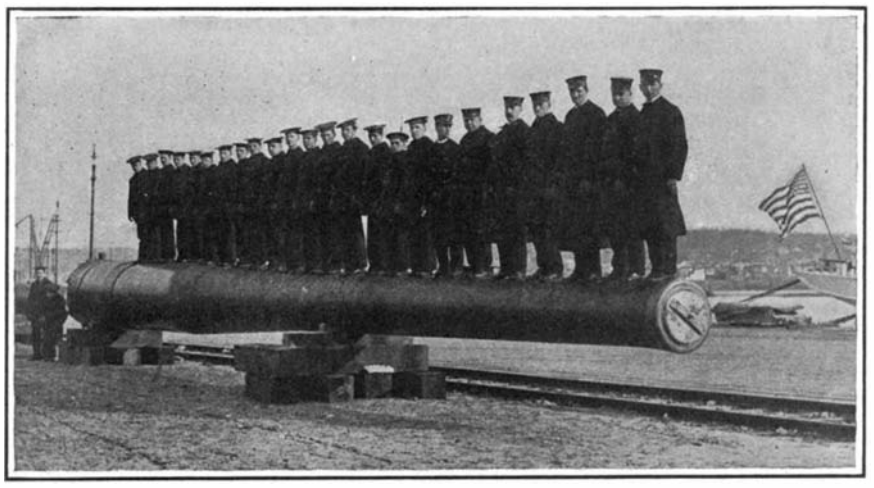
It must not be supposed that this is the first attempt to treat color musically. Readers of the SCIENTIFIC AMERICAN will recall that Prof. Rimington of London devised what he calls a color organ which was to do for light what a symphony orchestra does for musical sounds. So far as we are aware, Prof. Rimington's scheme was never carried out in practice on a large scale, so that the performance of Scriabine's "Prometheus" may probably be regarded as the first successful experiment of its kind that has ever been made.

Bricks Without Clay

MAKING bricks without straw is a familiar quotation, but making them without clay, or its equivalent, which from time immemorial has been the essential ingredient, is a novel suggestion. This, however, is what is now proposed, and a plant is being built in Illinois. According to the *Railway Age Gazette*, the process consists in chemically combining any coarse material containing silica with a binder of finely divided particles of silica, alumina, potassium, or sodium in suitable proportions to insure a binder with a low fusing point, as compared with the coarse body material. The bricks are molded under high pressure, preferably in a dry state, and are fired in a manner similar to that used in making ordinary brick, but the time required is not nearly as long. Bricks made by this process have been tested and have shown very satisfactory absorption qualities, and have withstood a temperature of 2,900 deg. Fahr. without cracking or showing damage. They have undergone crushing tests of 20,000 pounds per square inch without failure. The samples examined show a texture capable of taking a high polish, and the grain is so fine that clean-cut carving is possible, but these qualities evidently depend on the character of the material of which bricks are made. It is proposed to use the tailings from coal mines at the new Illinois plant, and it is stated that, on account of the wide variety of materials that can be used in the new process, including many waste products, these bricks can be profitably made in localities where ordinary brick cannot be produced on account of the absence of suitable clay.

The 14-inch Guns of the United States Navy

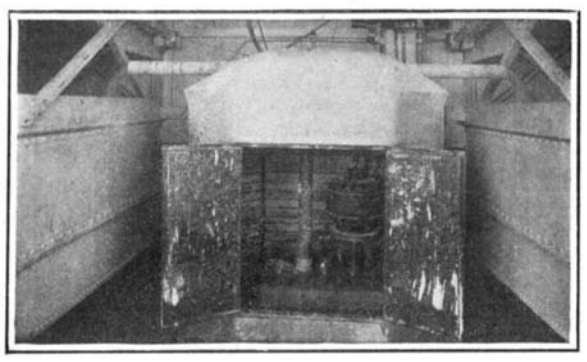
THE accompanying photograph shows one of the 14-inch guns of the new dreadnought "Pennsylvania." In order to give some conception of the size of this gun, twenty-four members of the crew of the President's yacht "Mayflower" lined up on the gun to have their photographs taken with the big engine of destruction. This gun was built at the Washington Navy Yard. It has a total length of 54 feet, and weighs 63.3 tons. It throws a shell of 1,400 pounds weight to an extreme distance of 21,000 yards, in other words about twelve miles. This range could be increased materially did the ship mountings allow for a greater angle of elevation. To be sure the gun is entirely outclassed by the 15-inch guns of the British navy, which fire a projectile weighing 1,950 pounds with a muzzle velocity of 2,500 foot-seconds, as compared to 2,600 foot-seconds of our 14-inch guns. This gives the British gun, with its higher maximum elevation, an extreme range of about 24,000 yards. At the same time the 14-inch gun is not to be scorned. The powder charge it requires weighs 370 pounds, and at 10,000 yards its shell will penetrate 15.9 inches of Krupp armor.



One of the big guns of the new dreadnought "Pennsylvania."

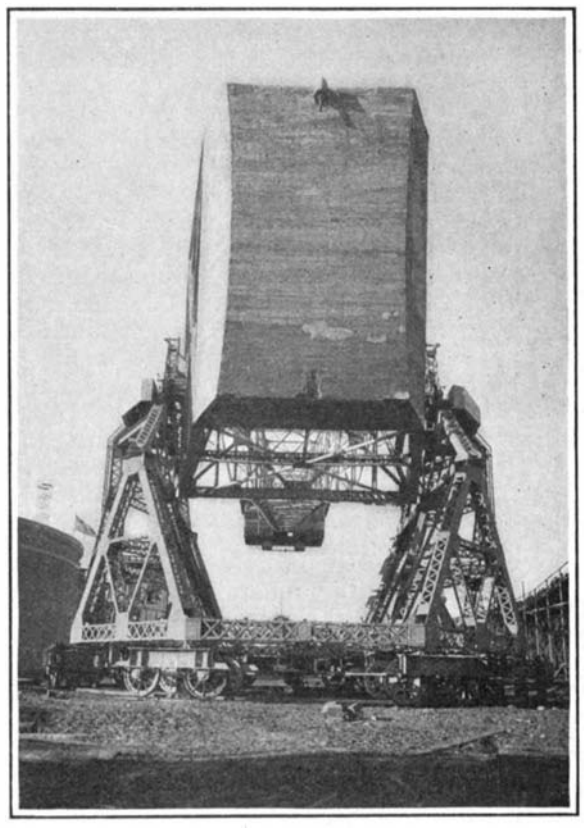
Joy Riding in the Sky

ONE of the prominent features of the "Zone," the amusement section of the Panama-Pacific Exposition, at San Francisco, is a device designed by a Chicago bridge builder which is called an aeroscope, and which will enable sensation seekers to experience some of the pleasures of an aeroplane ride with perfect safety. This contrivance consists really of a bascule bridge 250 feet long, which carries an inclosed passenger car at its free end. While the bridge arm is gradually raised, carrying with it the observation car, the entire apparatus is slowly rotated on a turntable, which results in a gentle spiral course being given to the car, simulating the gliding flight of an aeroplane and giving the passengers views in every direction over the surrounding country.



The passenger car on the aeroscope is provided with two water ballast tanks which provide an even balance for the lifting arm on each trip.

The weight scheduled to be carried in the car is 15,000 pounds and the filling device adds enough weight in water each trip to make up the scheduled weight. If there is too much ballast, automatic emptying valves permit water to escape to the required amount. The pumping device is shown here filling the tanks.



A view of the towers which support the lifting arm of the aeroscope.

They are built in two portions to permit the counterbalance weight to swing between as the upper portion of the lighting arm assumes a vertical position. The towers are 49 feet tall and each merges at the top in a trunnion bearing on which the lifting arm pivots.

The entire structure is of steel, and the mechanism is operated by electric power, a heavy concrete platform forming the foundation for the device. On this foundation is a double circular track of railroad rails 61 feet in outside diameter. Eight four-wheel trucks on the rails carry the entire structure, which revolves about a vertical axis set in the center of the platform. Power for this purpose is furnished by four electric motors mounted on, and geared to alternate trucks. Upon the framework supported by the trucks stand two pyramidal towers that carry the trunnions upon which the elevating arm turns when lifting the observation car. This arm is about 215 feet long, while the overhanging counter-balance lever is about 30 feet long, and carries an immense block of concrete, weighing in the neighborhood of 600,000 pounds, which balances the lifting arm, car and its load of passengers so nicely that the only power necessary to raise the car is just sufficient to overcome the friction of the trunnions. Hence two electric motors of eleven horse-power each move the mass.

The observation car is a two-story structure, attached to the lifting arm by trunnions and links so designed as to keep the car vertical no matter in what position the lifting arm may be. The load for which the car is designed is 15,000 pounds, or one hundred people of an average weight of 150 pounds, but there is actually room to accommodate comfortably about 120 passengers, provided they do not exceed the prescribed weight. In order to ascertain this fact quickly and accurately, and also to enable a suitable adjustment of weight to be made when the full number of passengers is not carried, an ingenious construction has been devised. Two ballast tanks are hung below the floor of the car, and when it is in its depressed position these tanks dip into a reservoir of water below the loading platform, and the depth to which they sink constantly weighs and indicates the load. If this load is below the normal an automatic switch is closed, and an electric motor operates a rotary pump to run water into the ballast tanks until the proper balance is attained. If on the other hand the weight indicated is too great, another automatic device opens an escape valve that lets the required weight of water run out of the tanks.

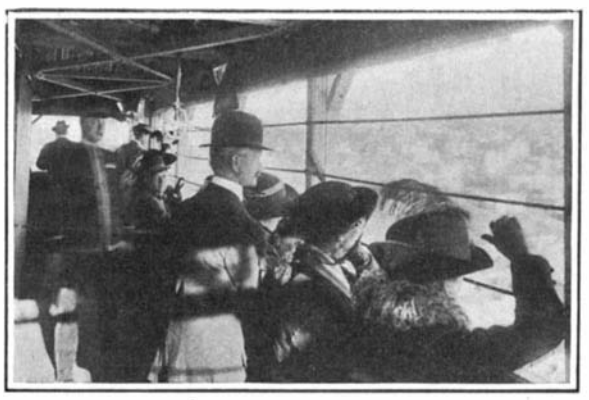
To carry out the idea of flying two electrically driven aeroplane propellers are located on the lifting arm, just under the observation car; but these do not furnish enough power to be of any assistance in lifting, and their effect is purely psychological. They probably mislead the passengers in a harmless way, and as an advertising feature serve to attract attention.

It is impossible to start the lifting or turning motors until the doors have been properly closed and locked. Then the cut-outs are closed, and the operating switches put into connection with the current. First the long arm carrying the car rises vertically, but as soon as it is high enough so that the car will clear the surrounding structures, the motors connected with the turntable trucks start, and the structure begins to revolve. As the arm rises it also swings around. In its ascent the car describes a great spiral. It requires about four minutes to lift the car to its extreme height, and the turntable makes one complete revolution in the same time; and in descending the same operations are repeated. It is possible, however, to vary these movements, for the arm can be stopped before it has reached a vertical position, and then swung around either in complete circles or back and forth through a portion of a revolution, while the passengers enjoy the panoramic view through the plate glass windows which entirely inclose the car.

Effect of Tarred Roads upon Trees

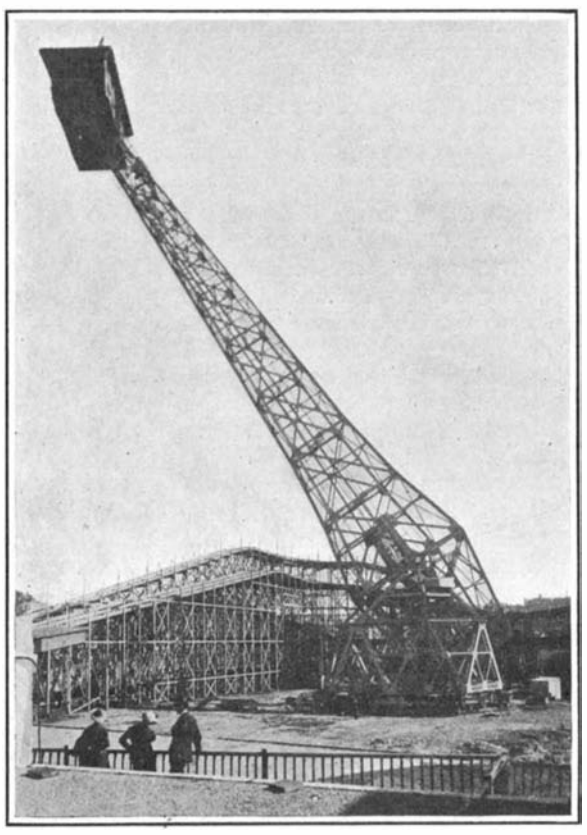
A PARIS engineer, M. Hickel, gave the following report about the effects of tarring of roads upon trees and shrubs which border the roads. Dust which comes from the wear of the road, when it falls continually upon the leaves of plants, is often seen to cause lesions and burned places, starting from a simple spot and extending farther, even to a perforation of the leaf, according to Griffon and Mirande's observations. Vapors produced at the time of putting on the tar on the road have also a bad effect, though it is less. Damage is seen to depend also on the amount of traffic on the road and, too, upon the sunlight, and this latter favors the production of lesions. Ornamental plants, such as the begonia, are found to suffer much from the tar dust in these cases. Besides the lesions seen in leaves of trees, such leaves do not grow to full size, but are dwarfed, and in general the tree tends to perish. Different varieties of trees suffer less than others, for instance the sycamore is noticed to suffer less damage. Perishing of trees occurs only after several years. Tarring of roads is usually done because of automobile traffic, and the author recommends the following precautions so as to conciliate the two opposing interests:

Instead of a surface tarring, it is preferable to relay the road with the use of tar combined with the road material, so as to avoid frequent tarring operation and formation of dust. Where plants are found to suffer greatly from the effects of tar, another material should be used instead, and tests are now being carried on which give promise of finding what is needed in the class of bituminous and asphaltic substances. A radical solution would be the use of concrete roads.



Looking out from the passenger car of the aeroscope at a height of 250 feet above ground.

The capacity of the car is 120 passengers. Plate glass windows are used on all sides so as to give an uninterrupted view. It is possible to look out over the Exposition, the bay and a large portion of San Francisco as the structure is revolved.



The lifting arm of the aeroscope is here at an angle of about 75 degrees.

The car is lifted vertically from the landing station until clear of the surrounding structures, then the structure is revolved in a circle. Aeroplane propellers placed on the arm just below the car give an impression of flying.