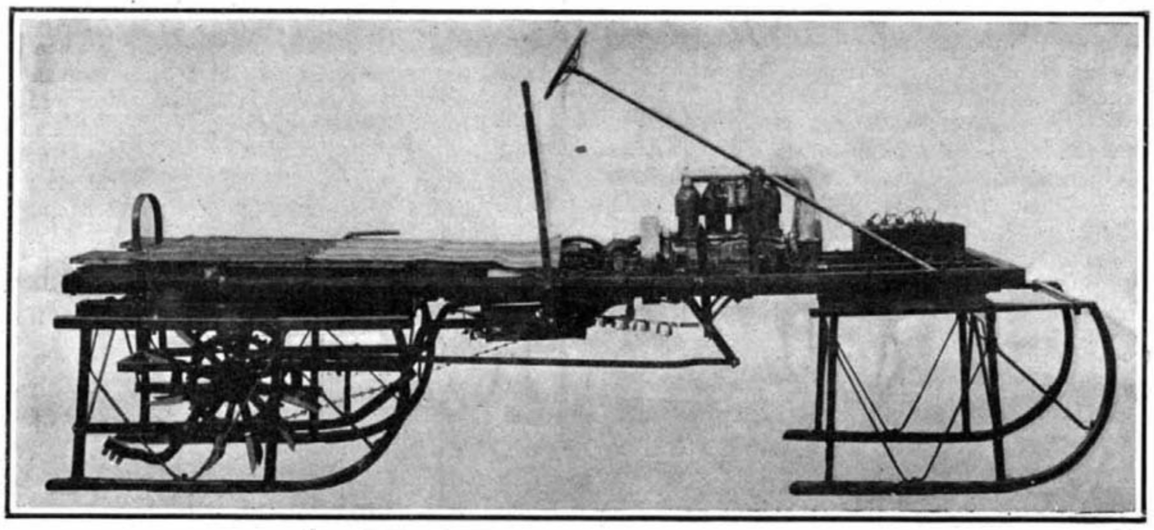
a receiving instrument just as his hearers do in the next block or miles away.

One of the striking features of the electrical music, as heard in the Cahill laboratory in Holyoke, is the performer's perfect control of the expression. The volume of sound seems to respond absolutely to his touch—in fact, the hearer soon becomes conscious that the soul of the musician is in his music. By the touch of the hand the performer controls the attack and



CHASSIS OF SLEIGH, SHOWING 12-HORSE-POWER, 4-CYLINDER, AIR-COOLED MOTOR CONNECTED THROUGH A CHAIN AND TWO SPEED GEAR TO THE SPIKED DRIVE WHEEL AT THE REAR.

sostenuto and varies the note at every instant. The musicians at the Cahill laboratory produced very good vibrato effects, and crescendos and diminuendos not inferior to those produced by a good violin.

The singularly pure quality of the tones and the remarkable control over them which the performer possesses take the listener by surprise. It is a curious system in which a battery of powerful alternators at a central station may be used to vibrate diaphragms all over a great city, producing music in thousands of homes, while the electrical forces are so perfectly under the control of the performer's fingers that they respond to their musical feelings more perfectly than any existing instrument, saving the violin, viola, and 'cello. It is said to be as easy for a musician to recognize a friend's touch a mile or fifty miles away, as if he were playing a violin in the next room.

Perhaps one of the most remarkable features of this new art is the "tone mixing" or "tone building." Physicists have known for some time that most musical sounds were composed of several parts or elements and that the different tone qualities or tone colors resulted from the presence of different overtones or harmonics in combination with the fundamental or ground tone. Thus, when a single key is struck on the piano, the tone is composed of several different sets of vibrations, from the lowest of which it receives its pitch-designation. This is called the ground tone, fundamental, or first partial, while the other elements are called overtones or harmonics, and it is well known that if the ground tone is represented by n, the overtones for the lower notes of a piano will be $2n$, $3n$, $4n$, $5n$, etc. The timbre or quality of the note, then, depends upon the harmonics which enter into it and their respective strengths. Now, in the musical instruments of the past the tone-color or quality is dependent upon many things. In the piano, for instance, the kind of wire used, the manner in which it was drawn and tempered, the tightness with which it is strung, the manner of attaching to the soundboard, the shape, material, and nature of the soundboard, the weight and hardness of the hammer with which it is struck, the place where it is struck, etc., each plays its part in, and has an effect upon, the sound produced. The same general principle applies to other musical instruments. In Dr. Cahill's electrical music system, however, the different elements of a tone are generated separately and blended at the will of the performer in such combinations as he may desire. A number of inductoriums or tone mixers serve to build up from the simple or sinusoidal waves of the alternators complex resultant vibrations. Thus, several alternators contribute their waves to produce a single note, when that is of a rich or string quality. Several such notes on a single keyboard are combined electrically into more highly composite vibrations, which, when they reach the ear, appeal to it as musical chords of great beauty. In some cases the complex vibrations from different keyboards are further combined into still more highly composite vibrations, so as to produce several voices or parts, as a violin and a 'cello, or a clarinet and flute, in the same receiver at the same instant. Some of these superpositions of vibrations are produced conductively and some magnetically.

This system of building up the quality of tone desired by mixing with the ground tone one or many harmonics, with any strength desired, opens up a new field of timbre control. The wood-wind, brass, and stringed tones of the orchestra are easily produced by mixing the required harmonics in the required proportions. A musician in Dr. Cahill's laboratory showed a staff correspondent that a mere ground tone produces a clear, pure flute note, a ground tone with the third and fourth harmonics of suitable strength produces the sound of a clarinet, while to imitate the violin all the harmonics up to the eighth were useful. Another combination of harmonics, in which the seventh and eighth are strong, gives the characteristic blare of brass. In addition to reproducing the leading orchestral tones, a skillful performer can mix the harmonics so as to produce musical timbres unknown before. These new qualities are a striking feature of the electrical music.

It is impossible within the limits of this article to enter upon any elaborate description of these tone-mixing or tone-building devices. Suffice it to say that there are special forms of inductoriums, having usually a plurality of primary circuits into which vibrations from different alternators are fed, and a combining secondary circuit in which resultant vibrations are produced, equivalent musically and electrically to the several series of vibrations in the several primary circuits. Some of these inductoriums have iron circuits almost closed; others have open iron circuits; while still others are air-core transformers—entirely without iron. One of the illustrations shows a "tone-mixer" in which the electrical vibrations are combined magnetically.

One thing that is to be emphasized in connection with this new music is that while the telephone is employed as a receiver it is not held to the ear. It would be bad for the ear if it were, when a loud note is sounded. The current in the receiver is literally thousands and at times millions of times stronger, measured in watts, than those to which an ordinary telephone receiver responds. Thus, Sir William Preece, superintendent of the British telegraph and telephone system, found that a telephone receiver would respond to a current of six ten-millionths of a millionth (6/10,000,000,000,000) of an ampere, and Continental electricians have found even a weaker current sufficient. In the Cahill system, for loud tones, a current of an ampere is sometimes used for an instant in the receiver.

In consequence, instead of a feeble sound in a telephone held to the ear, feebler often than the slight inductive noises of the line, a musical tone, as loud and clear as it is sweet and pure, fills the whole room, and the inductive noises of the line, which can be heard when a common telephone is pressed to the ear, cannot be discovered even by the closest listening. The sound, on the contrary, is absolutely sweet and pure.

The electrical music is characterized by the following points: Perfect tuning; pure, clear tones that fill the room; qualities so closely resembling the principal orchestral instruments that they would be mistaken for them; new qualities, also, which it is impossible to describe, and which must be heard to be appreciated—a singular attack, which is controlled by the performer's touch, and which seems at one instant to be that of a bow, at another that of a hammer on a string, at another that of a wood-wind, according to the effect which the performer desires to produce on the instrument that he wishes to imitate; and last, and most important, the fact that the music, produced in the form of electrical vibrations, is divisible and distributable and can be produced at a thousand places simultaneously, with as much power in each as if an orchestra were on the spot.

A SIMPLE AND SPEEDY MOTOR SLEIGH.

What appears to be a very promising solution of the motor sleigh problem is a machine of this sort constructed recently by two residents of Springfield, Ohio—Messrs. Temple and Redmond. The inventor of the sleigh appears in the photograph seated in the front on the left. As can be seen from the chassis view, power for driving the sleigh is obtained from a four-cylinder air-cooled motor of about 12 horse-power. The cylinders of this engine are provided with air jackets through which a blower mounted on the crankshaft sends a forced draft for the purpose of keeping them cool. The engine drives a countershaft placed behind it, by means of bevel gears; and pinions on this countershaft mesh with spur gears on a second parallel countershaft. The spur gears may be locked to their shaft by friction clutches, and thus two different speeds are obtained, since the driving sprocket is keyed on this shaft and connected by chain with the snow

MOTOR SLEIGH SAID TO BE CAPABLE OF MAKING 35 MILES AN HOUR ON SNOW AND 90 MILES AN HOUR ON ICE.

paddle. This wheel has double rows of strong, sharp, steel blades which successfully grip the snow or cut into the ice beneath. The wheel is spring-pressed against the ground. It can rise 12 inches above its normal level and can drop still further, so that it has a vertical play of something like 2½ feet. The curved bar with teeth on the end, which is seen beside the drive wheel, acts as a brake when pressed against the ground. The long horizontal rod connecting this bar with the brake pedal in front is seen beneath the sleigh, as is also a string of bells for the purpose of simulating the music of a similar horse-drawn vehicle. The long lever at the side operates the clutches fc, obtaining the different speeds. The sleigh is 14 feet in length and has runners 22 inches high. Its weight is 1,400 pounds. Its inventors claim for it that it has carried twenty people eight miles an hour through the snow. Its normal speed is from 20 to 35 miles an hour over good, well-packed roads, and carrying a load of from four to eight people. On ice, when fitted with a special wheel for speed, it will travel around 90 miles an hour, and the inventors claim that it has pulled two tons at a rate of speed of 36 miles an hour on ice. On account of the light weight and great carrying power, it should be of use at some places in the Arctic regions and in all countries where it is possible to travel many months of the year on snow or ice.

THE NEW CUNARDERS.

The Cunard Steamship Company are building their new twenty-five-knot transatlantic liners with the expressed intention, among other things, of bringing back to that line the "blue ribbon of the Atlantic"; and that they will succeed in doing this is generally considered to be a foregone conclusion. The fastest average time for the eastward passage is 23.58 knots per hour. This record is at present held by the "Kaiser Wilhelm II." of the North German Lloyd line, which ship also holds the distinction of being the longest, broadest, and deepest of the fast transatlantic liners, her length being 706 feet, her beam 72 feet, and her molded depth 52½ feet. Her engines are of something over 40,000 horse-power when working up to their full power, as they did on the occasion when they drove this fine vessel day and night, for the whole eastward passage, at an average speed of 23.58 knots per hour.

The builders of the new Cunarders have guaranteed that they shall maintain an average speed of 24½ knots an hour for the whole transatlantic passage, and in view of the great size of the ships, their exceedingly fine underwater form, their great momentum when under way, and the enormous horse-power which their quadruple turbines will develop, 24½ knots should not only be easy of accomplishment, but should be greatly exceeded, at least on the trial trip. Judging from the fact that recent turbine steamers have invariably exceeded their contract speeds, the new liners should make 25½ knots on trial. It would not be surprising to see them touch the 26-knot mark.

It is difficult to gather from a mere statement of dimensions an adequate idea of such great structures as these new ships will be, and to assist in appreciating their size, we give a comparative table of eight of the largest Atlantic liners of the present day; while on the front page will be found a graphic comparison, in which one of these ships is shown standing on end amid a group of five of the most notable tall buildings in existence.

Referring to the tabular comparison we note that the new ships will be larger on every point of comparison even than the famous old "Great Eastern," whose great depth and beam, even at the present day, exceed that of any ship afloat. Comparing the Cunarders with the largest ships that have yet been built, we

THE BIG STEAMSHIPS OF THE WORLD.

	Length Over All in Feet.	Beam, Feet.	Depth, Feet.	Displacement.	Horse-Power.	Speed.
Great Eastern	692	83	57½	27,000	8,000	14.25
Lucania	625	65	42	19,000	30,000	22.01
Oceanic	704	68	49	28,500	28,000	19.50
Deutschland	686	67	42	23,000	37,500	23.51
Baltic	725	75	49	40,000	18,000	16.25
Kaiser Wilhelm II	706	72	52½	30,000	40,000	23.58
Amerika	680	74½	53	36,000	15,000	16.00
New Cunarders.	786	88	60	43,000	75,000	25.00

find that they are 61 feet longer than the "Baltic," 13 feet broader, and will have 11 feet more of molded depth; that is to say, their plating will be carried up one deck higher. Yet, in point of dead weight or displacement they will be only 3,000 tons larger than the "Baltic," a fact which shows at once how greatly the under water body of these ships must have been cut away and fined down in order to obtain the easy lines necessary to their great speed. The "Baltic" has maintained 16.25 knots an hour across the Atlantic, when her engines were indicating 18,000 horse-power; but to drive the Cunarders 9 knots faster will require over four times as much power.

Our artist has brought together on the front page of this issue a group of some of the most famous among the loftiest buildings of the world. Of these, the Park Row office building, on lower Broadway, this city, is the smallest; and yet it only lacks 10 feet of being 400 feet in height, the measurement being taken to the top of the cupola above the dome. Fifty-eight feet above this, towers the gilded cross which surmounts the cupola above the gigantic dome of St. Peter's cathedral at Rome; and we cannot refrain from slightly digressing here from our subject to draw particular attention to the vast size of this splendid architectural work of mediæval times. Its great dome has a diameter of 139 feet, and is so vast that it has a clear height from the floor of the church to the highest point of the interior of the dome of 333 feet. This means that if the American Surety Building, which is 82 feet square, and a trifle over 300 feet in height, were stood on the floor of the cathedral and immediately below the center of the dome its cornice, although it would reach 308 feet into the dome, would nowhere touch the ceiling. It is 448 feet from the ground to the top of the cross of St. Peter's. Sixty-four feet higher than that are the finials which surmount the two great western spires of the famous Cologne cathedral. Both of these spires extend 512 feet into the air, and they form one of the most impressive features of this world-renowned Gothic cathedral, which in point of lofty dimensions holds the same pre-eminent position among Gothic cathedrals as St. Peter's does among the great Renaissance cathedrals. The two tallest masonry buildings in the world are to be found in this country, one of these being the tower of the city hall at Philadelphia, and the other the Washington Monument, at Washington, D. C. The top of the hat of the statue of William Penn which crowns the tower of the Philadelphia building is 548 feet above the street level, and 7 feet higher than this is the apex of the pyramidal top of the Washington Monument, whose height above the ground is 555 feet. If one of the new Cunarders were to be stood on end, its bow pointing heavenward and the buildings we have mentioned grouped around it, it would tower 231 feet above the highest of them. Incidentally, our drawing serves to show how big the mass of the ship would bulk even among the colossal structures that are illustrated.

Of these two vessels, the one which is being built at the John Brown Company's works, Clydesdale, is expected to be launched about July next; but it is not likely that she will be ready for her trial trips until the following spring. The other vessel, which is building at Swan & Hunter's yard, on the Tyne, will probably be launched about September next and will be given her trial trip in about a year from that time. As we mentioned in our last issue, it has been proposed by the company to call the first of these ships the "Lusitania" and the other the "Mauritania." The announcement of these names has been received very unfavorably in this country, on the ground that they are cumbersome and have no appropriate importance or significance. The Scientific American has suggested that the company revive those two grand old names "Britannia" and "Hibernia," which were held by the first ships that carried the Cunard flag across the Atlantic.

The Death of Prof. R. Ogden Doremus.

Prof. R. Ogden Doremus died on March 22, at the age of eighty-two. He was one of the best-known American physicists and chemists. After preliminary training at New York and Columbia universities, he became assistant to Dr. John W. Draper in the laboratory of the Medical School. In 1848 he equipped, with Charles Townsend Harris, a laboratory where he lectured to students of the College of Pharmacy, of which he had been elected professor of chemistry. This was probably the first laboratory of its kind founded in America. From 1853 to 1903 he was professor of chemistry and physics of the College of the City of New York. The laboratory which he designed for that institution has been a model for many a college laboratory since established.

In his teaching he was greatly aided by his power of speech. He was popular as a lecturer, illustrating his addresses with experiments. On one occasion at the Academy of Music, in 1855, he took daguerreotypes of all the persons in the boxes by an arc light and exhibited an induction coil with a 6-inch spark, a marvelous achievement in those days.

Dr. Doremus was the first toxicological expert called in New York in a murder trial. For many years he was a well-known expert in litigation involving expert testimony. He was a member of the Medical Advisory Commission of the city, helped to found the municipal Department of Health and Bureau of Chemistry. He introduced the disinfection of ships by the use of chlorine, and thus did away with the necessity for prolonged detentions at quarantine.

Scientific Circus Attractions.

At the annual opening of the Barnum & Bailey circus for this season on March 22, in this city, in addition to the feat of Mlle. de Thiers traveling through the air gap in her inverted automobile (a novel feature last year), was the introduction of a new attraction styled "The Limit" or in Paris called "The Whirlwind of Death," both of which were illustrated and described in the Scientific American of October 14, 1905. For carrying out this new feat an inclined plane about 40 feet long and 4 feet wide is used. This has a starting platform at the top, and at the bottom a reverse incline for guiding the vehicle upward. Under this is a combination of springs and levers so arranged that when the miniature automobile travels down the incline at high speed a rear shaft on it impinges against two projecting release levers above the short upward incline, thereby releasing a large spring-operated lever lying nearly level with this incline. The lever gives a sufficient impulse upward to the rear of the vehicle to cause the latter to rotate one revolution in the direction of its length while passing through an air space of approximately 25 feet. The machine is timed to land in its normal position upon a thickly-padded, guarded platform, where it gradually stops. Of course the young woman who risked her life was strapped firmly to the vehicle. The act was very successfully carried out and showed skill in securing the right degree of momentum and the correct operation of the mechanism. Were it not for the special apparatus at the bottom, the vehicle would fly off into air space in its normal position and land on the platform beyond. The act occupied about four seconds.

Another new feature was the operation of a gasoline automobile runabout by acrobatic experts much on the plan of bicycle trick riders.

A Dash for the Pole in an Airship.

Mr. Walter Wellman, that notable explorer and journalist who has twice gone to the Arctic regions in attempts to reach the North Pole, expects to start from Spitzbergen the first of August on a third expedition, which will travel through the air in the largest dirigible balloon ever built. The envelope of the balloon is being constructed by Louis Goddard, of Paris. It is to consist of two layers of rubber-covered cotton and one layer—the inside one—of rubber-covered silk. In its central zone, which is the strongest, the envelope is to have a tensile strength of 2,800 kilogrammes per square meter (about 575 pounds per square foot) thus giving a factor of safety of 6 to 1. The average factor of safety is 5 to 1, as against 3½ to 1 of the Lebaudy airship. The form of the balloon is to be maintained by an interior ballonette filled with compressed air by means of a 5-horse-power motor and compressor. On account of the triple rubber layers (which are lapped one inch at the seams and sewed together, and the stitching then covered with cemented strips) the leakage of gas is guaranteed not to exceed 1½ per cent per day. The amount of fuel and supplies consumed daily will more than counterbalance this. The length of the gas bag will be 50 meters (164.04 feet); its greatest diameter, 16 meters (52.49 feet); its surface, 1,960 square meters (21,098 square feet); its capacity, 6,350 cubic meters (224,244 cubic feet); and its lifting power (with gas having a lifting power of 1,130 grammes per cubic meter) 7,240 kilogrammes, or 16,000 pounds. The weight of the balloon is 2,860 pounds, while the framework, steel car, motors, and all other paraphernalia bring this up to a total of 7,500 pounds. This leaves an available lifting power of 8,500 pounds for the crew of 5 men, three or four motor sledges, a metallic boat, and all supplies.

The airship is to have two 4-cylinder water-cooled gasoline motors of 55 and 25 horse-power. The larger motor drives a forward propeller through reduction gearing, and the smaller one a propeller at the rear in the same manner. A speed of 15 miles an hour will be obtainable with the 50-horse-power motor, and 19 miles an hour with both. The total distance to be covered is about 1,200 miles, while the 5,500 pounds of gasoline to be carried should drive the airship nearly twice this distance. This fuel is sufficient for a 140-hour run of the main motor.

Should one motor break down beyond repair, the travelers can use the other one; and if the airship gives out from any cause, the travelers can take to the sledges. A wireless telegraph outfit is to be taken along, so that communication can be maintained with the base as long as possible.

At a meeting of the New York Motor Club on March 23, Mr. Wellman explained fully his plans for the trip, and showed how he has tried to provide for every contingency. The airship is to be transported to Spitzbergen, inflated there, and experimented with during the month of July. If everything works satisfactorily the dash will be made in August and provisions will be carried sufficient for 75 days. Everything has been so carefully planned by Mr. Wellman, who has an intimate knowledge of what is required, that the expedition through the air, if not altogether successful, bids fair to be by no means a dismal failure.

A New Comet.

A cable message dated March 19 has been received at Harvard Observatory from Prof. Kreutz at Kiel, stating that a comet was discovered by Ross at Melbourne, 1906, March 17 d., 914, G. M. T., in R. A. 2h. 3m. 52s., and dec. —7 deg. 41 min. Daily motion in R. A., +3m. 36s.; daily motion in dec. +1 deg. 10 min. The physical appearance of the comet is as follows, viz.: Circular, 3 min. in diameter, magn. 8, some central condensation.