kept from buckling outward by a few bolts fastening column to girder.

It is to be hoped that the day is coming when cast iron will be entirely replaced by steel in buildings of a composite character. Its great compressive strength is more than offset by its low shearing and tensile strength and its uncertain behavior renders it altogether unfitted for use where the strains are more or less complicated and where, as in the present case, the lives of many scores of operatives are at stake.

If cast iron is to be used at all in the skeleton of a composite building, it should be used with great care and careful judgment. The abutting ends of posts and columns should be in all cases carefully machined, and the flanges and flange bolts should be larger than are now frequently employed. Loads should be concentrically applied to wall columns, even if it involves the use of twin girders, one on each side of the column. Above all, transverse bracing of some kind should always be employed for the exterior or wall columns, and it should be attached to the columns as close as possible to the abutting joints. Where heavy superimposed loads are to be carried the wall should not be entirely depended upon to furnish lateral stiffness. There is liable to be poor contact between wall and columns, and a small clearance would be sufficient to allow a fatal lateral movement of the column line.

It is sincerely to be hoped that the lessons of this disaster, which might well have been one of the most calamitous on record, will be noted by the building departments of this and other cities, and that, if cast iron columns continue to enter into building construction, they will be subject to a most searching scrutiny by expert professional men.

CHARGES AGAINST A PATENT FIRM.

Owing to the large number of complaints from inventors received at the Patent Office relative to the alleged unprofessional methods used by Wedderburn & Company to obtain clients and their neglect to serve them properly before the department, Commissioner Butterworth has summoned the firm to appear before him and answer numerous charges of unprofessional conduct. A hearing is to be had before the Commissioner in a few days, and if the charges are sustained they will be debarred from practicing before the Patent Office.

ANOTHER TRANSATLANTIC STEAMSHIP SERVICE.

After some years of unsuccessful agitation of the question of a subsidized express steamship line between England and Canada, it now seems that the Canadian fast Atlantic service is to be established on a permanent basis. The contract has been signed by Messrs. Peterson, Tate & Company, of Newcastle, who are the parties interested. Four vessels are to be provided, each of which must be able to maintain an average speed of 500 nautical miles per day, or about 21 knots. The contract calls for ships 520 feet long and of 10,000 tons register, and they are to be equal in every respect to the best steamers in service on the Atlantic to-day. Each vessel is to accommodate 300 first-class, 200 second-class and 800 steerage passengers, and must possess a cargo accommodation of 1,500 to 2,000 tons, 500 tons of which must be cold storage.

Two of the ships are to be ready by May 31, 1899, the other two by May of the following year. The ships will be run fortnightly during the season of 1899 and weekly during the season of 1900. The starting point will be from Liverpool, and during the summer months the ships will run to Quebec and Montreal as long as the navigation permits; during the winter season they will run to Halifax, N. S., or St. John, N. B., according to the option of the contractors. Vessels are to call at an Irish port, if required to do so by the government.

Messrs. Peterson, Tate & Company will receive a subsidy of $773,000, one-third of which will be paid by the British government and two-thirds by the Canadian government, and the contract is to cover a term of ten years.

This addition of four first-class express steamers to those already afloat, together with the giant Oceanic building for the White Star Line, and the truly splendid twin ships of the North German Lloyd Company, which commence active service this year, will give transatlantic passengers the choice of over a dozen boats that are of 20 to 22 knots speed and furnished with the latest luxuries of ocean travel.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

The twentieth convention of the National Electric Light Association met at the International Hotel, Niagara Falls, N. Y., on June 8, 9, and 10. There was a very large attendance, three hundred members being present, and nearly one thousand visitors who were interested in the proceedings were also at Niagara Falls. The meeting was called to order by President Frederic Nicholls at 10:45 A. M., on June 8. Letters of invitation were read from the various companies located in Niagara Falls and the vicinity which invited the members to visit the various plants. Letters of regret from Lord Kelvin and others were read. President Nicholls made an interesting address and the reports of the committees and reading of papers followed. Each day of the convention was filled up with the transaction of business, the reading of papers, and excursions to the interesting places and plants in the vicinity. The following were the principal officers elected: President Samuel Insull, of Chicago; first vice president, A. M. Young, Waterbury, Conn.; second vice president, George R. Stetson, New Bedford, Mass.

THE AEROPLANE FLYING MACHINE.

BY A. M. HERRING.

Owing to the wide interest excited by the many articles on the mysterious but elusive airships with which the daily papers have been filled in the past few months, it may be of interest to the SCIENTIFIC AMERICAN'S readers to learn that though these "news items" were all the creations from the brains of imaginative persons, yet scientific experiment has been carried on by many able inventors in working on what may be called the true flying machine; that is, one which is hundreds of times heavier than the air upon which it rests, by reason of its dynamic impact, and not by the aid of any balloon or gas bag whatsoever. This line of experiment has resulted in such great progress in the last few years (and especially so in the last six months) that the attainment of long, free flight for man, which not long ago seemed an invention for the far distant future, is a thing now near, if not quite at hand.

Of all the experimenters who have attacked this problem previous to the last decade, but very few indeed have seemed to have known and comprehended the nature of the real difficulties which were to be met with in the securing of the flying machine; i. e., the difficulties involved in obtaining automatically a safe equilibrium, and in securing horizontal flight. Perhaps the greatest genius who ever worked on the flying machine problem was M. A. Pénaud, a Frenchman, who in 1871 produced a screw-driven flying model provided with a small rear surface which acted as a regulator. This regulator controlled his model to such an extent that its average flight, as a whole, was horizontal, but its course, however, was composed of a number of undulations. It has been pointed out, and insisted upon by several writers, that in the elasticity of its surfaces it contained the fundamental principle which made this regulation possible—but this is not the case; for actual experiment distinctly proves that a Pénaud model will fly farther and is more stable with perfectly rigid surfaces than with those which are flexible. This regulator does not maintain a horizontal equilibrium except in very mild winds. Yet this model should stand out above all others, because it was the first dynamic aeroplane provided with an automatic regulator that actually made free flights. These were up to 131 feet in length and lasted on some occasions as much as eleven seconds. Pénaud calculated that it sustained 81 pounds per horse power.* (His model weighed a little over half an ounce and had half a square foot of sustaining surface.)

As his model exposed 15 square feet per pound weight, it is evident that a practical machine on this basis could never be built. Besides that of Pénaud many dynamic aeroplane models have been produced in the past by Tatin, Moy, Stringfellow (whose model is now preserved as a historical relic in the National Museum in Washington), Lawrence Hargraves, of Australia, an indefatigable worker, who produced no less than twenty models which would actually fly, the most of them being actuated by rubber springs, but some by steam and a few by compressed air. One of the latter type, which was presented three years ago to the Field Museum, of Chicago, is on exhibition in this country. It is remarkable for the fact that it sustained a horizontal flight for 19 seconds, during which time it covered a distance of over 300 feet and carried in flight a little over 75 pounds per horse power.† Its surfaces, however, are unduly large, 6½ square feet per pound weight. (A practical machine will probably be required to sustain from six to fifteen times this loading.) Mr. Hargraves is the inventor of the cellular kite used by the weather bureau. He is purely a scientific experimenter who has given his valuable work to the world without reserving to himself any patents. Besides the above mentioned the writer, in 1890, produced a rubber spring driven model which attained horizontal flight through the action of an automatic regulating device, working on a new principle, but in outward appearance somewhat similar to that of Pénaud. This model sustained 157 pounds per horse power with 6 square feet per pound weight.‡ Its flights lasted from six to seven seconds, during which time it covered distances from 100 up to 135 feet. This model, which is still in existence, was exhibited in the spring of 1892 to an acquaintance who, some time later, described its flight in a small account in one of the Rochester, N. Y., papers, and in the fall of 1895 it was exhibited also to Dr. Langley, the distinguished secretary of the Smithsonian Institution, who took dimension sketches of it and who was so much pleased with the flights and the action of its regulator that he requested the writer to fly it repeatedly, first with the regulator in action and then without it.

In the year 1891 the writer constructed an improved and larger model (weighing 5 lb. and exposing 15 square feet of surface), fitted with compound steam engines and a condenser. This model furnished the power for its own start—but its best flight was only about 240 feet—although it carried fuel and supplies for several miles. Petroleum was used instead of water in the boiler. The reason that only a short flight was obtained was due to the boiler blowing up before enough trials were had to properly adjust the regulator. The damage from the heat of the burning of the boiler's contents ruined the small engines, which were built of tempered tool steel. Owing to the pressure of other affairs, this model was not rebuilt.

Pre-eminent in the field of aerodynamics stands the secretary of the Smithsonian Institution, Dr. S. P. Langley, who has done more than any one else (except possibly it be the late Otto Lilienthal, of Berlin, Germany) to place the subject on a sound basis; for his "Experiments in Aerodynamics" will hereafter be looked upon as one of the pioneer lights which directed modern scientific effort to the subject of aerial navigation. This work, contrary to the prevalent belief of engineers, showed that in so far as the question of power was concerned, flight was possible. Dr. Langley has since then directed his efforts to the production of a model which should demonstrate that the further difficulties might be overcome. This model flies from one-half to seven-eighths of a mile, uses steam, weighs about 30 lb. complete, and employs a pair of engines furnishing between one and one and one-half horse power. It may be questioned, however, whether Dr. Langley's expressed views as to what he has accomplished, and his predictions of the future prospects and uses of the flying machine, are not too sanguine; for it is doubtful whether with the most economical heat engines that have ever been constructed the flying machine, carrying even one passenger alone, will ever be able to fly for a day--not days at a time or at a speed which exceeds 80 to 90 miles an hour. That it will never carry freight is almost certain. It is even probable that the machine of sufficient size to carry more than two persons is an invention for the relatively distant future. With all deference to the opinions expressed by so eminent a scientist, it might be pointed out that with the low economy in supporting effect obtained with this model (30 lb. per horse power) * it is not possible to add a condenser, and a machine built on anything like a similar scale for carrying a man would not be able to lift its own weight! For, if we double the lineal dimensions, we would have but four times the surface (lifting effect), while we would be hampered by eight times the original weight. It may be argued that, by reducing the angles at which the surfaces are presented to the air, a larger lifting effect per horse power would be obtained. The maintenance of a small angle in flight is, however, one of the most formidable difficulties of the whole flying machine problem. From the simple laws which govern the thrust of helical screw propellers, it might be shown that the expenditure of 1 horse power on a pair of screw propellers 39 inches in diameter (the size given by Langley) would produce a flying or a standing thrust of 16·3 lb., or 54·3 per cent of the weight of his aerodrome. It can further be shown that with a boiler pressure of 150 lb. to the square inch, the pair of engines of the size given (1¼ inch bore, 2 inch stroke) would each produce 40 to 45 foot lb. (net) on the shaft per revolution. This much spent on a 39 inch properly made screw would produce a thrust (flying or standing) of at least $10\frac{29}{100}$ lb., and the pair of engines acting on a pair of propellers would give a thrust $20\frac{58}{100}$ lb., that is, $68\frac{6}{10}$ per cent of the weight of the aerodrome, and possibly more. The lower boiler pressure given, 110 lb., would give a thrust in flight for standing of 16·4 lb. These thrusts are so extraordinarily large in proportion to the weight carried on the aeroplanes that it might well be questioned if the possibilities of aerial navigation, which Prof. Langley claims to have demonstrated, are not more imaginative than real.

It has not been possible in an article of this length to touch upon the value of the work done by the late Otto Lilienthal nor the exceedingly valuable results published of the experiments of Mr. Hiram Maxim, which, although fragmentary, are of the utmost value to the engineer.

* Even if we accept Pénaud's figures and reduce the weights sustained to what it would have been on a model loaded to 1 pound per square foot, we should find that he could have carried but 81 ÷ $\sqrt{15}$, or say 22 pounds per horse power.

† Seventy-five pounds per horse power on 6½ square feet of surface to the pound weight is equivalent to 29·8 pounds per horse power, if the model were loaded to 1 pound per square foot.

‡ One hundred and fifty-seven pounds per horse power on 6 square feet to the pound is equivalent to 60 pounds per horse power with a loading of 1 pound per square foot.

* The dimension sketch given by Prof. Langley in the Aeronautical Annual for 1897 shows about 75 square feet of supporting surface. The whole weight is given about 30 lb., equivalent to 2½ square feet per lb. wt. Assuming the power at 1 horse power, it shows 30 lb. were carried at that weight with a loading of 1 lb. on 2½ square feet. This, reduced to a loading of 1 lb. per square foot, is equivalent to barely 19 lb. per horse power, with which lift neither a condenser nor man flight is possible.