and leaves are removed by a process called *rippling.* This is done to-day by machinery, the heads of the unbound bundles being passed between rapidly-revolving corrugated rollers, which crush the seed pods. The seeds and leaves are then removed by means of a fanning mill. After this the straw is stacked until required for the retting.

The flax fibers, which appear to consist of pure cellulose and show no signs at all of being lignified, are held together by an intercellular substance consisting mainly of calcium pectate. The object of the retting is to decompose or make soluble these woody tissues inclosing the cellulose or bast fibers, so that they can be removed from the latter by the subsequent processes.

The water-retting of flax is a biological process induced by the action of definite organisms, the chief of which is an anaerobic *Plectridium*, which in the absence of air ferments the pectin substances of the cellular material, uniting the parenchymatous tissues, and thus causes a loosening of the bast fibers. The absolute exclusion of oxygen, which is necessary in order that the fermentation may be set up, is brought about by numerous oxygen-consuming bacteria and fungi. The products formed by the fermentation of the pectin substances are hydrogen and carbon dioxide and organic acids, especially acetic and butyric acid and small quantities of valeric and lactic acids. The injurious action of the acids produced, especially butyric, may be considerably diminished by adding alkali or lime to the retting liquid. It has been found to be advantageous to inoculate the liquid at the beginning of the retting with pure cultures of the anaerobic *Plectridium*.

On the retting process depends the quality of the linen, and it is that stage of the industry which presents the greatest difficulty. There are three methods which can be employed, and of these the simplest and least careful is dew-retting. The straw is simply spread evenly over the fields like hay to be retted by the action of the dew and the elements. The fiber resulting from this method is the most uneven and the least valuable product of the three processes. With the exception of that in use at Northfield, Minn., it is the process usually employed in this country. The second method, called pool-retting, consists in immersing the bundles of straw in stagnant pools, the softest waters, such as rain water, giving the best results. Holes are dug in the ground for this purpose, though a great part of the Irish flax is retted in "bog holes." The resulting flax fiber is better than the dew-retted product and is lighter in color, being a fairly light bluish brown. The third method consists of immersing the straw in running water. This is the form practised in Belgium, where the finest product of this kind in the world, the famous Courtrai flax, is retted in the murky waters of the sluggish river Lys. The flax straw, in bundles, is placed in crates which are weighted with stones and submerged in the water of the stream for two periods, each of from four to fifteen days according to the temperature and other conditions. After the first immersion the straw is taken out and carefully dried before the second retting. The Courtrai flax is of a light creamy color and of superior tensile strength. Its excellent qualities appear to be due not so much to the retting in sluggishly running water as to the actual qualities of that water and the peculiar ferment contained therein.

After the flax has been retted it undergoes a decorticating process, which removes the bark and the loosened, underlying, woody tissues and isolates the linen fibers in a purified condition. The first operation consists of passing the straw through a breaker, which loosens the woody portions of the stems and reduces them to fragments to facilitate the following operation, the scutching, which whips out the "chive" and all other waste matters, leaving the pure flax fiber. Within recent years machinery has been designed which successfully performs all the operations subsequent to retting, but in former times the work was done by hand or with very crude mechanical aids. One of the accompanying engravings shows an old-time scutching mill, consisting of a large wheel with flat radial wooden blades projecting from its periphery. These rapidly-revolving blades slashed the waste matter from the bundles of flax straw, which were held against a flat surface parallel to the plane of the wheel. The scutched flax is subsequenty hackled or dressed by repeated combings, which remove the short and broken or tangled fibers and thereby produce tow. Each hackling improves the quality of the fiber and, of course, adds to its cost.

Numerous chemical methods have been proposed for retting flax, to improve and shorten the natural processes, and numberless patents have been granted here and abroad, covering these artificial methods. Among them are processes consisting in heating with water under pressure, boiling with solutions of oxalic acid, soda ash, caustic soda, or the addition of various chemicals to the retting water, such as hydrochloric and sulphuric acids. Numerous patents also exist on retting pools or tanks. Few of all these processes have proven of any industrial value. However, one of the exceptions to this appears to be a process covered by patents issued to two Belgians, Dr. Georges Loppens and Honoré Deswarte. Briefly, the process consists in covering a mass of vertically-arranged flax straw in special tanks with water, constantly delivering fresh water, preferably rain water, beneath the mass and at the same time constantly withdrawing the same quantity of impure water from below the level of the fresh water. This method is now used at Northfield, Minn. During the first season it was not employed with entire success, but it appears that this deficiency may be ascribed to inexperience in the handling of the apparatus rather than to any fault of the process. There is little doubt that in the future the Loppens method, as it is called, will prove entirely successful, for it is extremely simple in operation and absolutely under the control of the operative.

Airship Competition at Milan.

During the Milan exhibition, 1906, the following aeronautic competitions will be organized: Dirigible airship competition; competition of free balloons carrying operator; competition of flying devices heavier than air; competition of kites; competition of sounding balloons; photographic competition. All competitions are international.

With the exception of the dirigible airship competition, the other competitions will not take place unless there are at least two competitors. Should the competitors only be two, the second prize will not be awarded. The competitors will be allowed, after arrangement with the committee, to trials *hors de concours*. Only the trials announced and controlled by the committee will be available as competitive trials. Among the latter the "classification trials" will be chosen for the awarding of the prizes.

Should the number of competitors make it necessary, each competition will consist of eliminating trials and final trials. The competitors for the final trials will be chosen among the better-placed in the eliminating trials, and their number will be fixed by the committee.

An international committee for the aeronautic competitions will be formed, and will be chosen by the executive committee of the exposition. To this committee all questions regarding organization, execution, and surveillance of the competitions will be deferred. In these matters it will represent and substitute the executive committee.

The request for entries must be addressed to the Comitato Internazionale per i Concorsi Aeronautici, Piazza Paolo Ferrari, Milano. A special application must be forwarded for each of the competitions the applicants are desirous of entering. All applications must reach the above-named committee in the time limits fixed by the special regulations governing the single competitions.

Illiterate Children of Immigrants Compared with Children of Native Americans.

It seems somewhat surprising at first to find a lower degree of illiteracy among the children of foreign-born parents than among the children of native parents. For the former the proportion of illiteracy is 8.8 per 1,000, for the latter 44.1 per 1,000. This difference, however, does not prove that immigrants are more anxious than natives to secure for their children the advantages of an elementary education. It is explainable by the fact that the foreign-born are concentrated in the larger cities to a much greater extent than the native population. Comparison for individual cities indicates that there is little difference in illiteracy between the two classes of children living in the same community. But such differences as can be detected are usually in favor of the children of native parents.

What Water Can Do.

Imagine a perpendicular column of water more than one-third of a mile high, twenty-six inches in diameter at the top and twenty-four inches in diameter at the bottom. Those remarkable conditions are complied with, as far as power goes, in the Mill Creek plant, which operates under a head of 1,960 feet. This little column of water, which, if liberated, would be just about enough to make a small trout stream, gives a capacity of 5,200 horse-power, or enough power to run a good-sized ocean-going vessel. As the water strikes the buckets of the water-wheel, it has a pressure of 850 pounds to the square inch. What this pressure implies is evidenced by the fact that the average locomotive carries steam at a pressure of 190 or 200 pounds to the square inch. Were this stream, as it issues from the nozzle, turned upon a hillside, the earth would fade away before it like snow before a jet of steam. Huge bowlders, big as city offices, would tumble into ravines with as little effort as a clover burr is carried before the hydrant stream on a front lawn. Brick walls would crackle like paper, and the hugest skyscrapers crumble before a stream like that of the Mill Creek plant. It takes a powerful waterwheel to withstand the tremendous pressure. At Butte Creek, Cal., a single jet of water, six inches in diameter, issues from the nozzle at the tremendous velocity of 20,000 feet a minute. It impinges on the buckets of what is said to be the most powerful single waterwheel ever built, causing the latter to travel at the rate of ninety-four miles an hour, making 400 revolutions a minute. This six-inch stream has a capacity of 12,000 horse-power. The water for operating the plant is conveyed from Butte Creek through a ditch and discharged into a regulating reservoir which is 1,500 feet above the power house. Two steel pressure pipe lines, thirty inches in diameter, conduct the water to the power-house.—The World To-day.

PROGRESS OF THE NEW JERSEY TUNNELS AND SUBWAYS.

The New York public is so greatly interested in the schemes for the further development of the original rapid transit Subways, and in the progress of the Pennsylvania tunnels and terminal station, that it probably fails to appreciate the magnitude of the scheme of tunnels connecting Jersey City traction systems with New York, and the equally important subways beneath Manhattan which form an integral part of that system. Since the amalgamation of the separate companies which originally were constructing, each of them, a pair of tunnels, one at Morton Street, and the other at Fulton and Cortlandt Streets, the work has been pushed along with all the energy and speed which abundance of capital and an energetic administration can command.

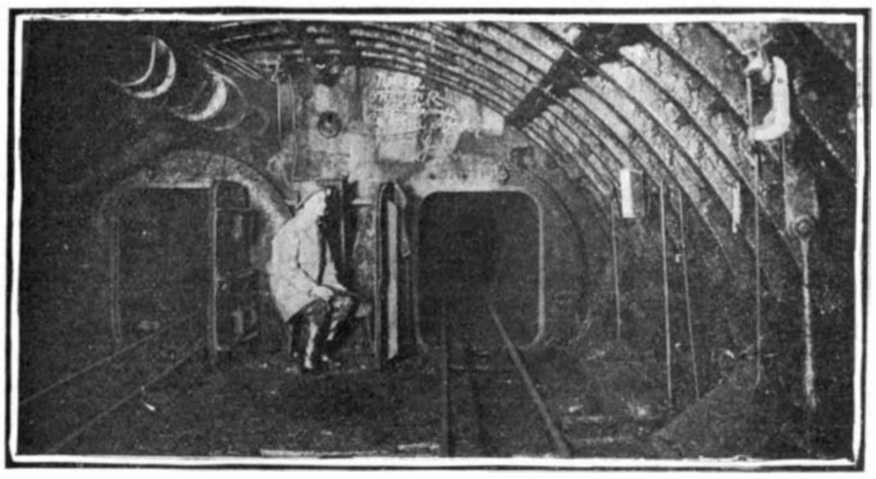
The system, as at present being built, consists of a two-track road, placed in two separate 15-foot tubes, which will extend from the Delaware, Lackawanna & Western Railroad terminal in New Jersey, along the shore line to the terminal station of the Central Railroad of New Jersey. At the intersection of the Subway with Fifteenth Street, it will be intersected by twin tunnels, which will extend from Thirteenth, Fourteenth, and Provost Streets, and connect with the two tunnels that have now been opened beneath the Hudson River to the Manhattan side. These two tunnel tracks have been carried beneath Morton and Greenwich to Christopher Street, and they will branch at the junction of Ninth Street and Sixth Avenue, into two separate pairs of tunnels, one of which will extend beneath Ninth Street to Fourth Avenue to a connection with the present Fourth Avenue Rapid Transit Subway. The other branch will extend north below Sixth Avenue to Thirty-third Street, where there will be built a large station of ample size to accommodate the great traffic which is certain to seek this route. At Thirty-third Street, also, the system will be in touch with the Pennsylvania Railroad tunnel across Manhattan Island, and consequently, New Jersey traffic, both on the trunk steam railroads and on the surface trolley lines, will be placed in direct touch with the Pennsylvania tunnels and their extensive Long Island connections, and with the rapid transit system with its many ramifications in Manhattan and Brooklyn.

The Jersey shore line Subway, south of the intersection with the Morton Street tunnels, will tap the Erie Railroad terminal, the Pennsylvania Railroad terminal, and the terminal of the Central Railroad of New Jersey. The downtown tunnels, beneath the Hudson, which will consist, like the rest of the system, of two single tubes with a single track in each, will extend from the Pennsylvania Railroad terminal in New Jersey to a large terminal station, which will be located on the two blocks on the west side of Church Street between Cortlandt and Fulton Streets. These two tracks will diverge from the New Jersey shore, one of them passing below Fulton Street, Manhattan, and the other below Cortlandt Street. The down-town terminal, in addition to the underground tracks, platforms, etc., incidental to a station of this character, will include two twenty-story buildings, one between Cortlandt and Dey Streets, and the other between Dey and Fulton Streets, and the full cost will be approximately ten million dollars. From the station an underground foot passage will be constructed through Dey Street to the Interborough Subway at Broadway, where passengers will be able to make connection with trains for Manhattan and the Bronx and for Brooklyn.

At the present writing the condition of the work is, that on the up-town tunnels the north tunnel is completed from the shaft on the Jersey side to a point where it turns out of Greenwich into Christopher Street, while the south-bound tunnel has been built from Jersey City to a point where the tunnel turns out of Morton into Greenwich Street. The first through connection on the south tunnel was made September 22 of this year, and one of the accompanying illustrations shows the first party to be taken through this tunnel from New Jersey to New York, an event which was celebrated September 29. On the down-town section of the road the work of demolishing the buildings on the site of the Fulton-Cortlandt terminal is being pushed vigorously by the wrecking companies, who are under contract to have at least half of the building removed and the ground ready for excavation within ninety days. The shafts are being sunk, and the two tunnels will be driven simultaneously beneath the river. An important feature, showing the excellent character of the work, is the fact that the whole of the Hudson Company's subways, even where they pass through solid rock, will be excavated by the shield method, and finished throughout with iron segmental lining.

The most striking photograph of those which we show is that of the interior of one of the finished tunnels at Morton and Greenwich Streets. This section was built through a sand and gravel formation, and the curve was driven by the same hydraulic shield that was used on the tangents and by the same compressed-air method. It had been freely predicted that it would be impossible to preserve correct alinement when using the shield method on a curve of such sharp radius, and the Chief Engineer, Mr. Charles M. Jacobs, and his staff of assistants in charge of this work, are to be congratulated upon the fact that the two tunnels driven on two concentric arcs of circles, although there was no direct communication between the two, were maintained in such exact alinement, that there was practically no variation in the distance between their centers throughout the whole sweep of the curve. The construction of these curves involves some nice instrumental work, and the diagram and description will explain how this is done.

A precise traverse line is first surveyed in each tunnel and joined at a common point, which is located in the east-bound tunnel near the brick bulkhead. This precise line has been connected with the surface survey by means of one plumb line down the shaft and a second line down a pipe located on Morton Street near Greenwich Street. The co-ordinates of all transit points were then computed. All measured distances are corrected for the horizontal position of tape and for temperature effects. All angles are repeated at least forty times by two different men. The angle at the point common to the two traverse lines was observed a large number of times, for upon the correct-



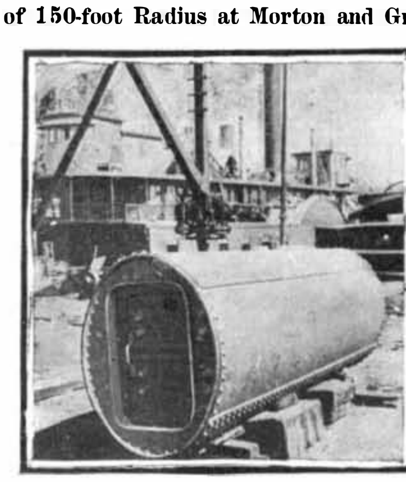
One of the Tunnel Air-Locks.

Break Through the Brick Wall in South Tunnel, Dividing Old from New Work.

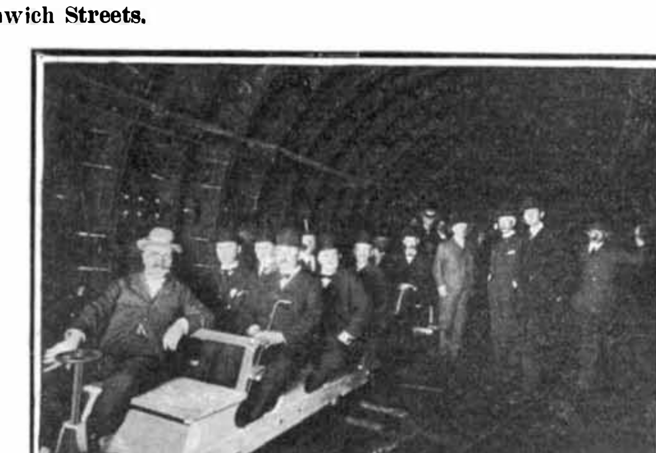
Sharpest tunnel curve driven to date by hydraulic shields under compressed air.

Tunnel Curve of 150-foot Radius at Morton and Greenwich Streets.

View Beneath the Apron Used in Front of Shield in Removing Rock Obstructions.



An Emergency Lock for Tunnel at Pier C.



Trip of First Party to Pass Through South Tunnel, September 29, 1905.

PROGRESS OF THE NEW JERSEY TUNNELS AND SUBWAYS.

ness of this angle depend the relative positions of the two tunnels.

The method by which the position of any ring is obtained with reference to its correct position can best be described by reference to the accompanying sketch. In the sketch *C* is the center of the curve, *A* and *B* are transit points in the tunnel on the traverse line. When the position of a ring with reference to the true center line is to be obtained, a transit set at *A* is sighted to *B*, and the intersection of this line with the leading edge of ring marked, and the distance measured from *A* to *D*. Knowing the distance and bearing of line *C A*, and bearing of *A B* and the measured distance *A D*, the side *C D* is computed; by taking the radius from this length and offset, *O* is determined.

The centering bar is then placed in the leading flange of the ring, and the distance from center of ring to point *D* read with the transit at *A*. This measured offset should equal the offset *O*, and any variation from this is the error of position of the ring as erected. The angle at *D* is computed, and a transit set at this point back-sighted to *A* and angle turned. With the telescope in this position, pointing to the center of curve, the offsets *N* and *S* to the face of the ring are then measured, and their sum gives the "lead" of the iron. If this "lead" is fair, these offsets will be zero. All important points in the precise line are continually being checked, and every care possible taken to have accurate work.

THE LIFTING POWER OF A SCREW PROPELLER FOR AERONAUTICAL WORK.

Among the various schemes proposed for a practical flying machine is that in which one or more horizontal propellers are used to lift the machine while other vertical propellers afterward drive it forward. Some time ago two well-known French aeronauts—Messrs. Louis Goddard and Felix Faure—conducted experiments with horizontal propellers having two or more

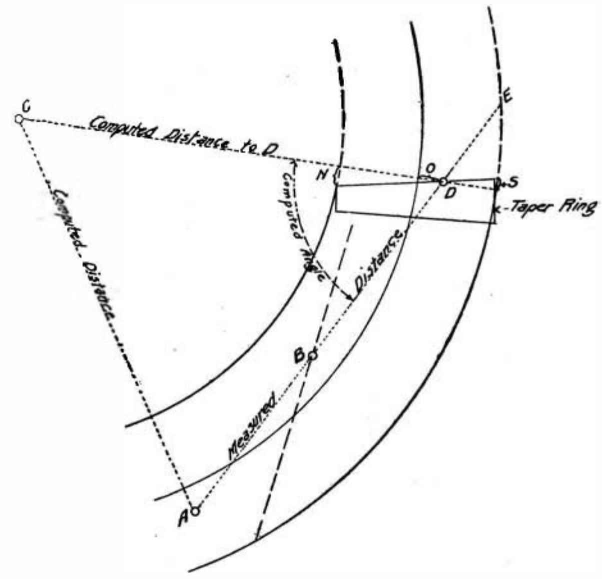
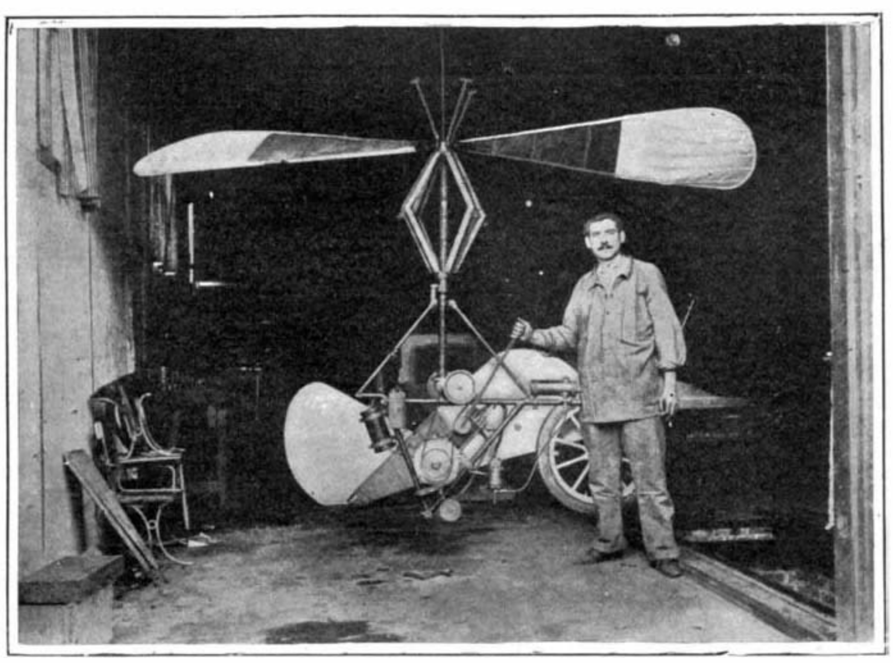


DIAGRAM SHOWING METHOD OF INSTRUMENTAL WORK IN BUILDING TUNNEL ON CURVE.

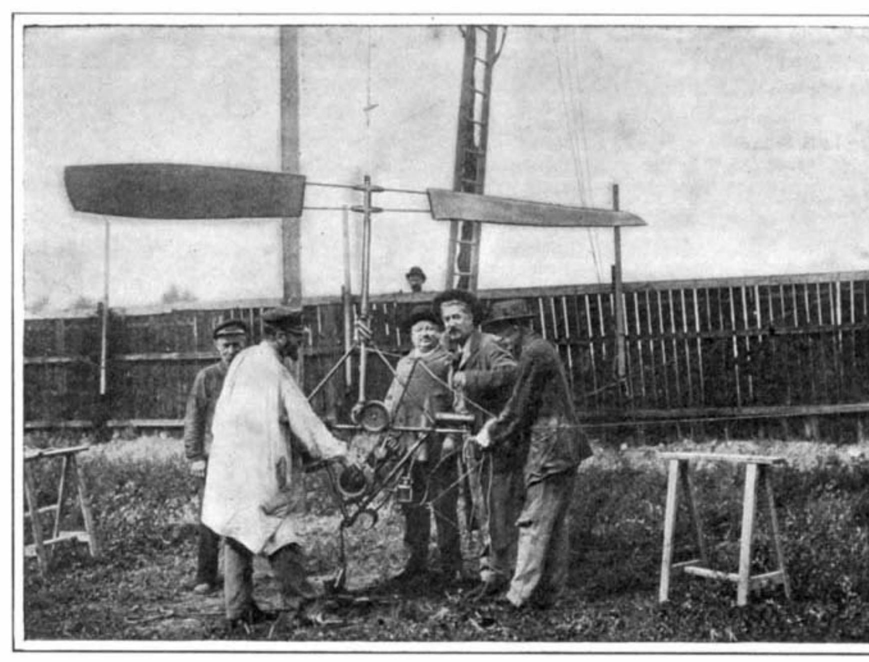
blades, the object in view being to determine how much could be lifted and what was the most efficient propeller. Starting with a six-bladed propeller driven by foot power from a specially-rigged bicycle frame (with which an upward pull of 3 kilogrammes, or 6.6 pounds, was obtained) the experimenters kept diminishing the number of blades with constantly-improving results. A four-bladed propeller gave 7 kilogrammes (15.4 pounds) lift, and, finally, with an ordinary two-bladed propeller, this lift was doubled. As this was about the limit with an apparatus propelled by pedaling, a 1¾-horse-power gasoline motor was next used as the propulsive force. With this the lift was quickly raised to 23 kilogrammes (50.69 pounds). Next, a more efficient screw designed by the well-known constructor of aeronautical apparatus, M. Hockengjos, was employed, and with this 30 kilogrammes (66.13 pounds) was lifted, or almost one-half the weight of the entire apparatus.

The third attempt was made with a Postel-Vinay electric motor as the motive power. The weight of the whole machine was reduced to 70 kilogrammes (154 1-3 pounds) and the lifting power was increased to 75 kilogrammes (165 1-3 pounds); so that the inventors at last had the pleasure of seeing their creation raise itself. By modifying their device somewhat, so that the blades were given a reciprocating motion and made to beat the air by means of eccentrics, and also by adding another smaller propeller, revolving in the opposite direction, the machine was at length made to lift as high as 100 kilogrammes (220 pounds) with an expenditure of 8 to 10 horse-power. This corresponds to a lift of over 20 pounds per horse-power; and, as gasoline motors are now constructed weighing not over 5 pounds to the horse-power, it is apparently quite practical to construct on this principle a machine that will actually fly. It is interesting to note that this apparatus was constructed on somewhat the same plan as that outlined by Mr. S. D. Mott in an article in Supplement, No. 1399. Other experiments along this line by the Dufaux brothers, in which these results were scarcely equaled, however, were described recently in our issue of October 21, 1905.



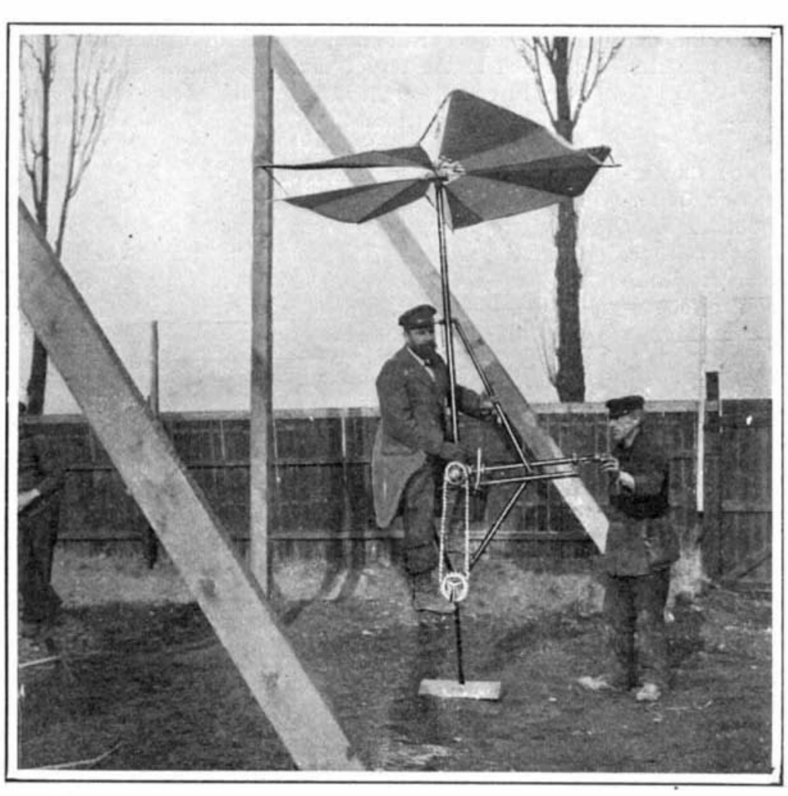
The Second Experimental Apparatus, Which Was Propelled by a 1¾ Horse-Power Gasoline Motor.

The first propeller tried with this apparatus lifted 50.69 pounds and a more efficient one designed by Hockengjos raised 66.13 pounds.

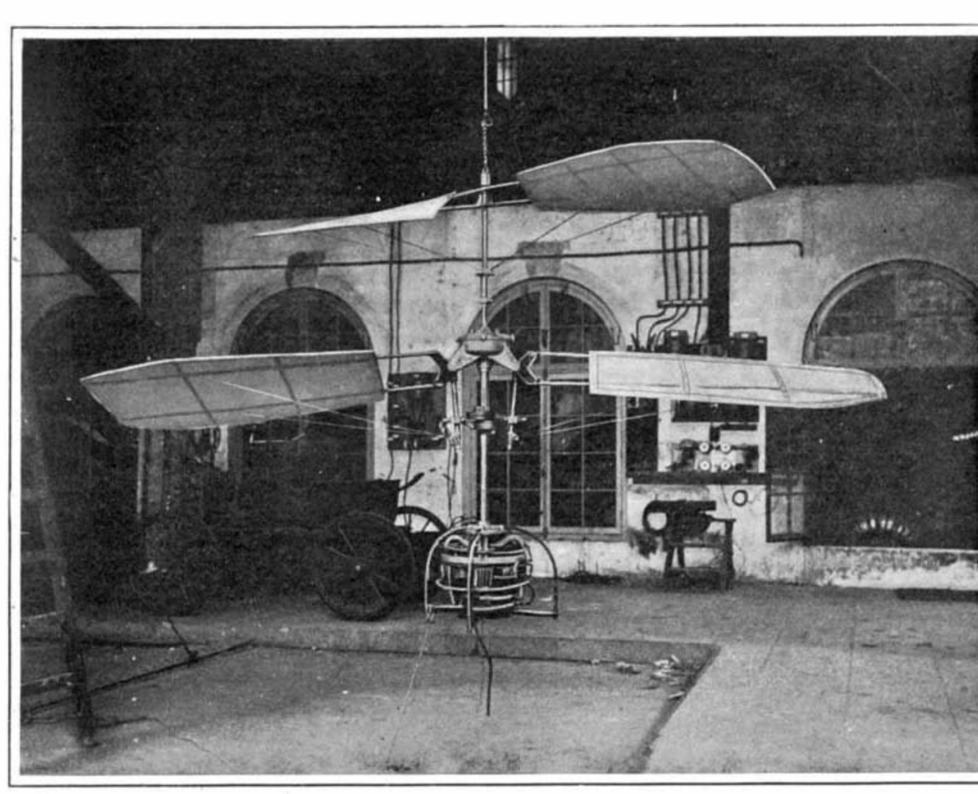


The Aeronautical Experimenters Grouped Around Their Second Apparatus.

The man in the blouse is Louis Goddard, and the other two men to the right are M. Hockengjos, airship constructor, and M. Felix Faure, the inventor of the apparatus, which is called the "Autovolant."



Aeronaut Louis Goddard Pedaling the First Experimental Six-Bladed Propeller with Which a Lift of 6.6 Pounds Was Obtained.



The Final Apparatus, Which, Driven by a 10-Horse-Power Electric Motor, Raised 220 Pounds.

The propellers are 6¼ and 8½ feet in diameter and they revolve in opposite directions at 500 and 250 revolutions per minute respectively, the lower one having besides an arrangement for giving a flapping movement to the blades. Steel ribbons were used to brace the propellers, as piano wire was not strong enough.

THE LIFTING POWER OF A SCREW PROPELLER FOR AERONAUTICAL WORK.