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 CA, and bearing of AB and the measured distance AD, the side CD 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

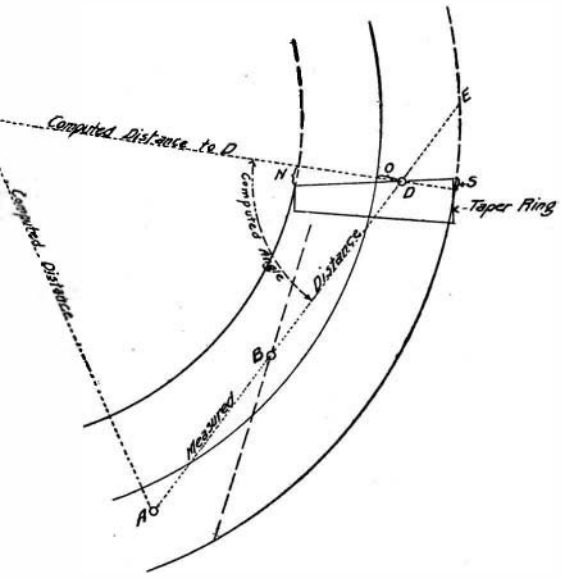
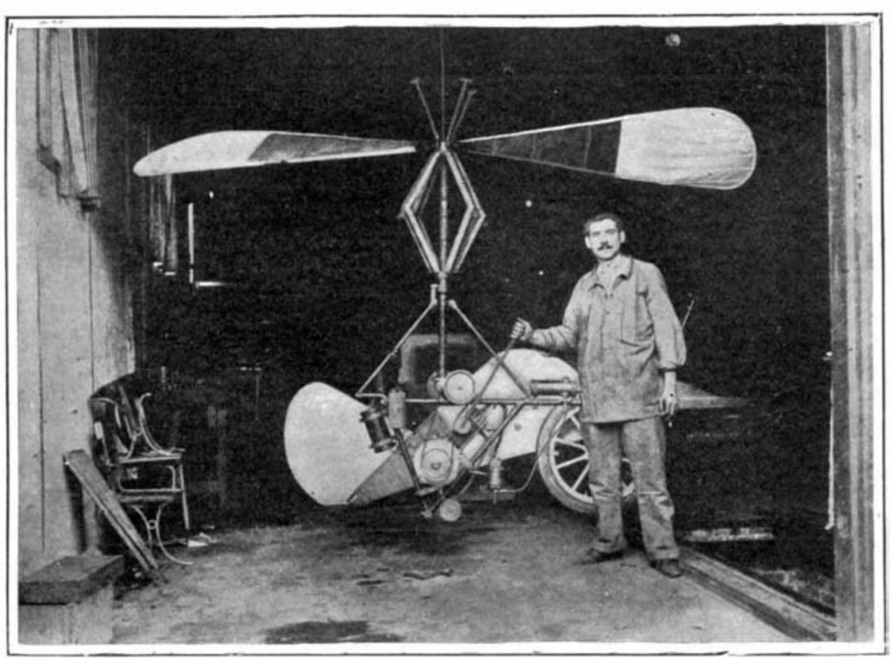


DIAGRAM SHOWING METHOD OF INSTRUMENTAL WORK IN BUILDING TUNNEL ON CURVE.

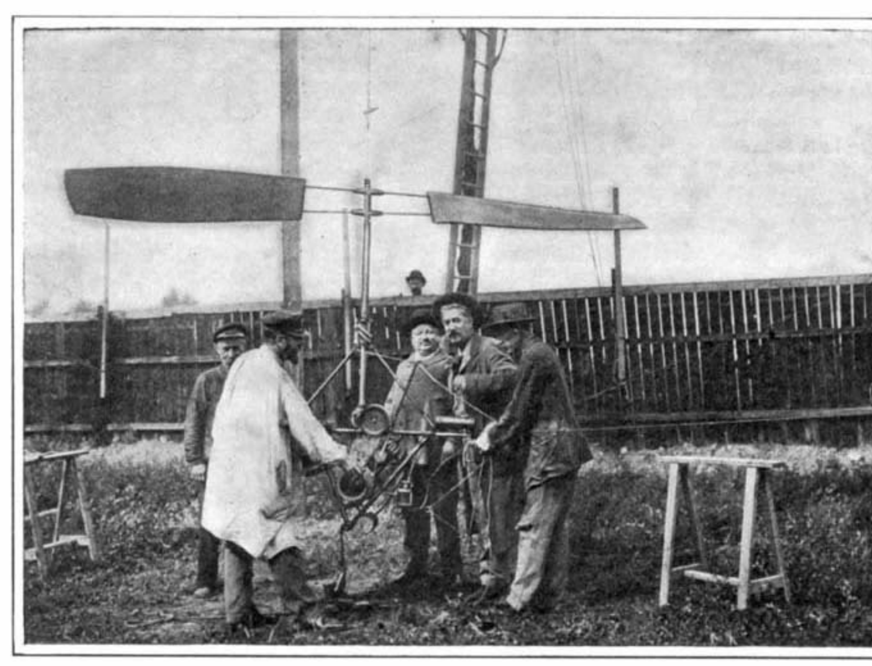
blades, the object in view being to determine how much could be lifted and what was the most efficient propeller. Starting with a six-bladed propeller driven by foot power from a specially-rigged bicycle frame (with which an upward pull of 3 kilogrammes, or 6.6 pounds, was obtained) the experimenters 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.



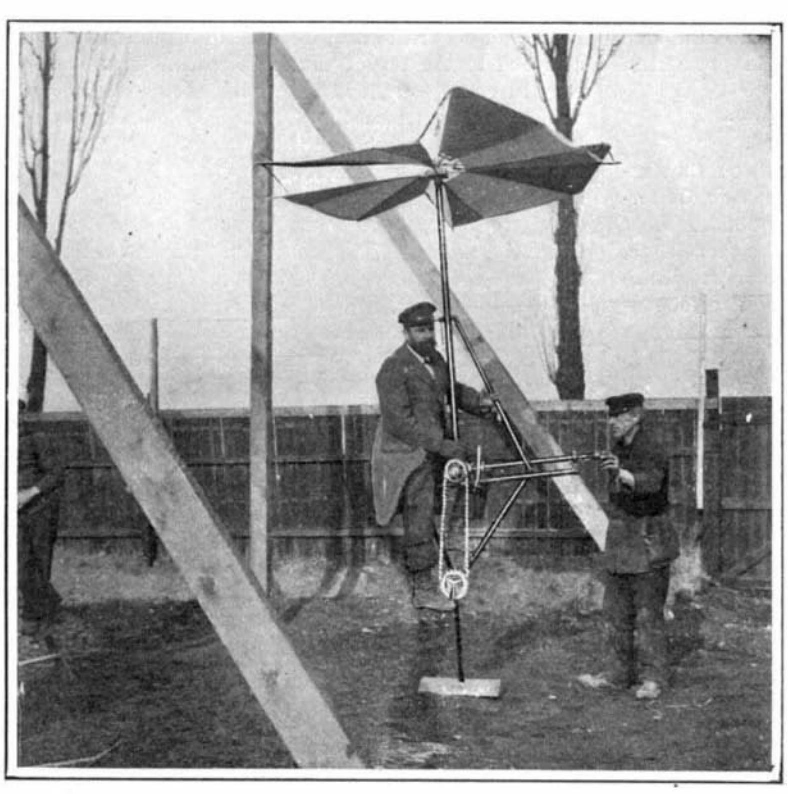
The Second Experimental Apparatus, Which Was Propelled by a 1¾ Horse-Power Gasoline Motor.

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

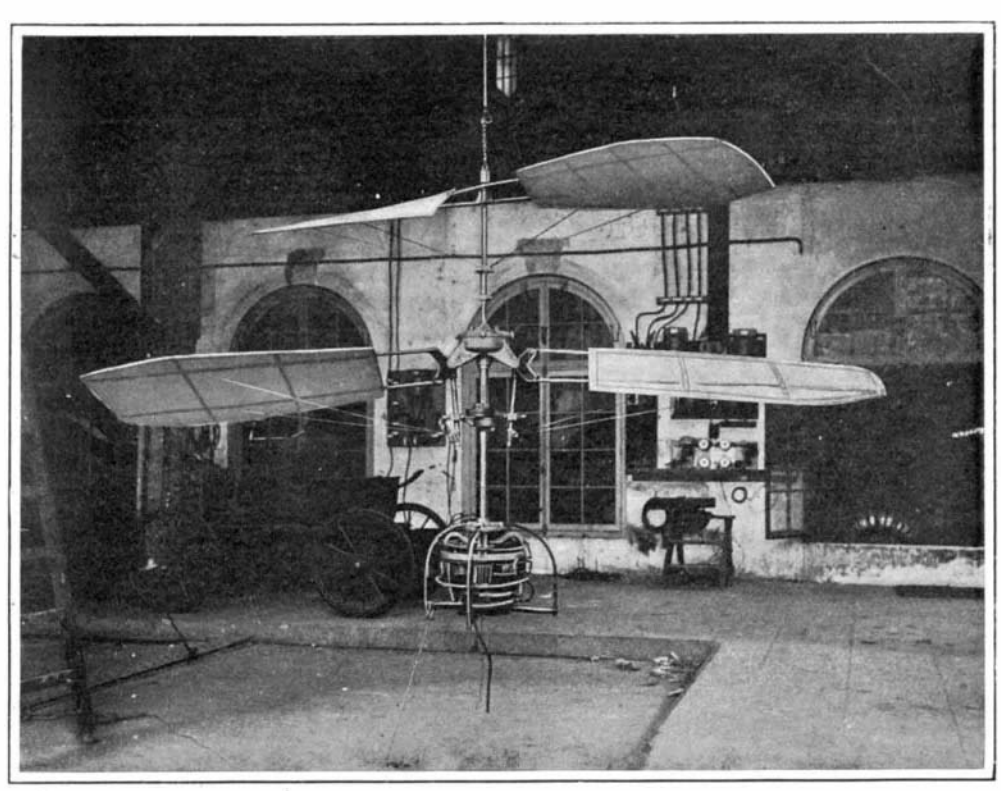


The Aeronautical Experimenters Grouped Around Their Second Apparatus.

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.