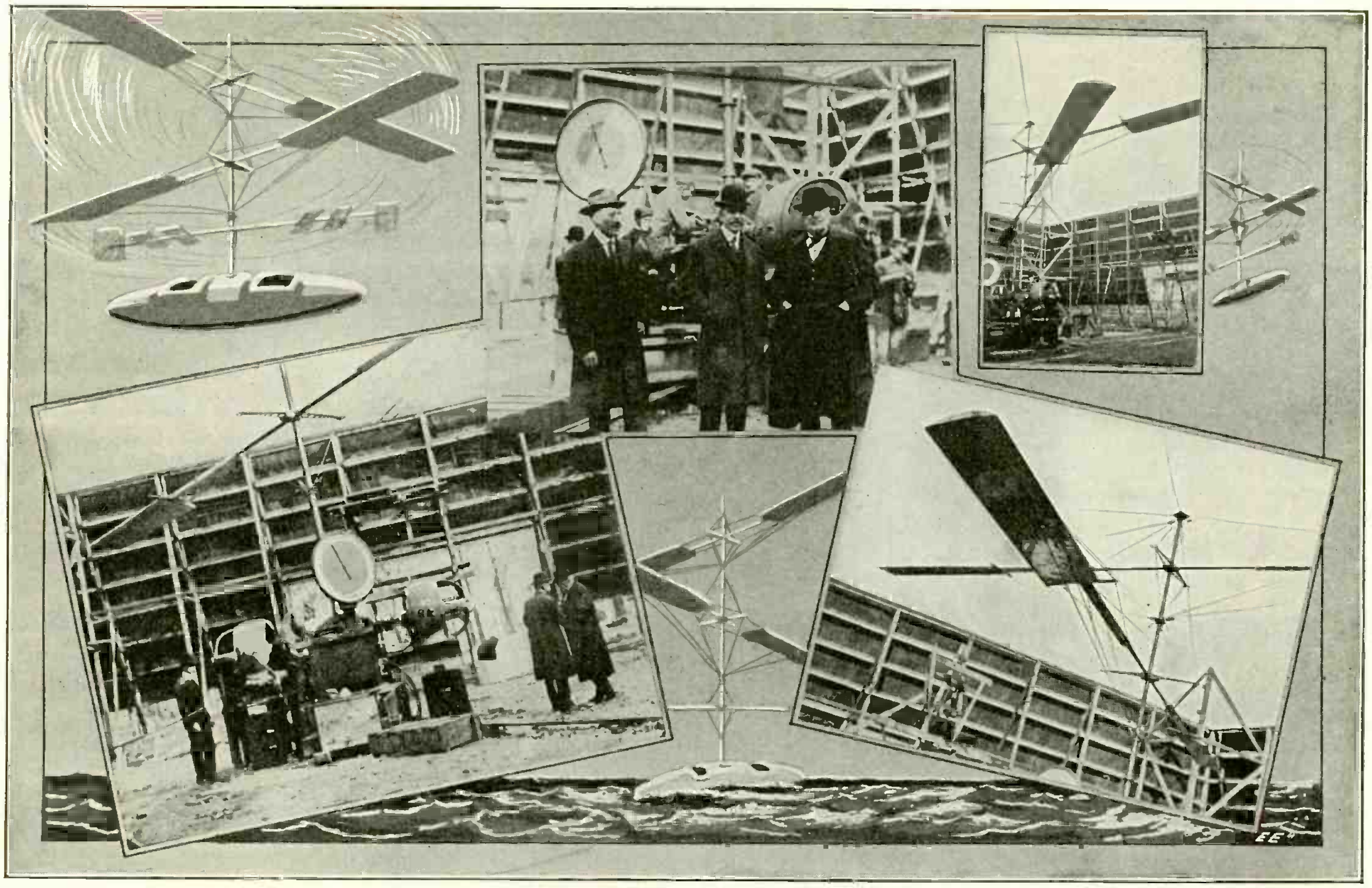


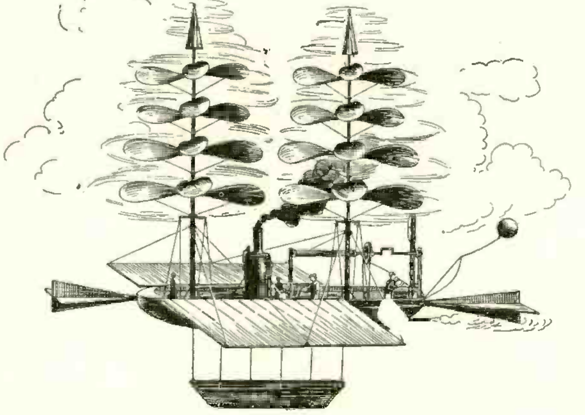
Top Right: Full Length View of Helicopter No. 1, Showing the Testing Installation of the Vital Features of the Machine. Lower Left: Showing the Temporary Installation of Two Electric Motors Each Capable of Developing a Maximum of 100 Horse-power. The Upper Gear Wheel of the Reducing Gear Is Seen Just Above the Box-Like Structure, Which Carries the Large Dial of the Platform Scales Used in Measuring the Lift or Thrust of the Propellers at Different Speeds and Power. The Motor Foundation Was Pivoted So That It Would Show Any Tendency of the Propellers to Turn the Whole Machine About Its Center. This Impulse Was Found to Be Practically Negligible, and the Entire Apparatus When Running at Maximum Trial Speed Could Be Rotated Freely to Right or Left by the Pressure of One's Hand. While Guys Were Attached to the Top of the Shafting to Steady the Machine, This Precaution Was Found Unnecessary, Because the Apparatus Stabilized Itself in a Pronounced Manner, the Faster the Screws Revolved. Lower Right: Details of the Propeller Blades, Guying and Shafting of Helicopter No. 1. Top Center Photo: Dr. Peter Cooper Hewitt in the Center. Thomas A. Edison, Who Is Interested in the "Helicopter," at Dr. Hewitt's Left and One of Dr. Hewitt's Technical Assistants to His Right.

The "Helicopter", A Vertical Airplane

By ROBERT G. SKERRETT

THE HELICOPTER has been an aeronautical puzzle ever since inventive genius tackled the problem of producing a heavier-than-air flying machine. Mechanical success of a sort has been realized from time to time by those variously engaged in this undertaking; but so far as the records show no full-sized craft of this type, with one exception, has been produced capable of lifting its designed full load. In short, they have been unable to rise as they stood. The one exception is the reason for being of the present article.

In an effort to strengthen our coast defense during the recent conflict, Doctor Peter Cooper Hewitt, who has given the world the most economical form of artificial light in his mercury vapor lamp, and Professor Francis Bacon Crocker, long the head of the Department of Electrical Engineering of Columbia University, combined their talents to bring to a practical head certain experiments with the helicopter initiated by Dr. Hewitt in 1906. They began their work in 1917, and a year ago brought their labors to a brilliant climax after they had put *Helicopter No. 1* thru a series of exhaustive tests. The armistice was declared just as the ground trials were finished and *flight* was the next feature of the program. The cessation of hostilities caused a tremendous slump in aviation, and interest for the nonce in the helicopter lagged. Now, however work is about to be resumed, and both Dr. Hewitt and Prof. Crocker are positive in their assertions that the craft will do as well aloft, as it has done within its hangar at Ampere, New Jersey.



An Early Forerunner of the Helicopter—a Steam Driven Vertical Flier Proposed by Mr. de La Landelle in 1863.

The fundamental stumbling block heretofore has been a propeller capable of translating into effective thrust, or *lift*, a sufficient measure of the prime mover's developed power. None of them has in the past given, at useful working speeds, more than 10 pounds of thrust per unit of horse-power—most of the aviation propellers fall considerably below this in performance. The propellers evolved by Dr. Hewitt and Prof. Crocker have yielded more than 20 pounds of thrust per horse-power! These engineers have achieved this by breaking away from the generally accepted types of aeronautical screws both in the matters of size, design, and the materials employed. To be brief, they are adaptations of the aerofoil—the blades are relatively miniature airplane wings.

Without elaborating upon the physical circumstances under which the usual airplane propeller of relatively small diameter functions, it will suffice to mention that it revolves at a speed varying from 1,000 to 2,000 times a minute; it has a very large percentage of slip; and its effectiveness is greatly reduced by the way in which it disturbs the air well ahead of it. This latter motion cuts down proportionally the screw's hold upon the atmosphere and its capacity to exert a propulsive effort. As the outer portions of a propeller's blade do most of the helpful work, it is evident that the hub and the massive inner sections of the blades are something of a handicap. Finally, owing to its moderate diameter, the ordinary airplane screw has only a modest volume of air to work upon.

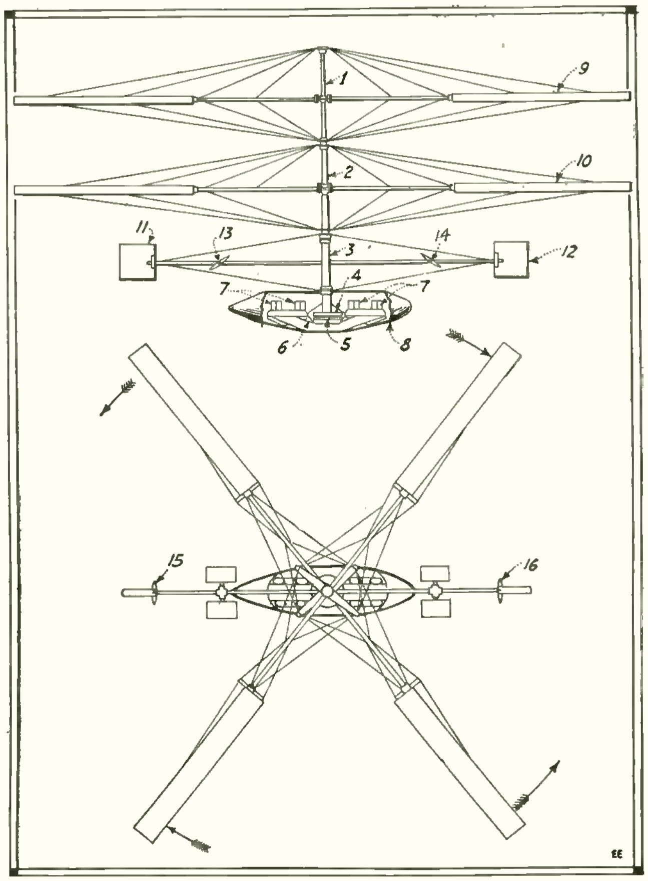
In planning Helicopter No. 1, the first aim was to obtain propeller blades having high sustaining and propulsive factors, as the entire burden of lift and horizontal movement was to depend upon the screws. These were mounted upon concentric, tubular shafts, revolving oppositely. It was not enough to use aerofoil blades; it was quite as necessary *to have recourse to propellers of large diameter, driven at comparatively low angular velocities,* which would act upon a large mass of air without previously setting up discounting perturbations. To this end, each of the propellers of Helicopter No. 1 has a diameter of 51 feet, and the speed of revolution is about 100 turns a minute.

The blades are attached to tubular steel arms, and placed where the periferal speed will make most effective their length of 15 feet and their breadth of 2½ feet. The blades consist of a succession of transverse partitions or frames of aluminum over which is laid, top and bottom, a single sheathing of the same metal. To prevent "chattering" the blades are attached to the supporting arms forward of the center of pressure. Therefore, the blades are, in effect, drawn instead of being pushed thru the air. This arrangement gives the blades a certain measure of automatic adjustment of pitch when meeting with varying stresses and changing angles of travel on the part of the machine.

The vital features of Helicopter No. 1, as assembled for testing, weighed something less than 2,300 pounds. When the screws were turned at the rate of 70 revolutions a minute—their two electric motors then developing 126.5 horsepower—the total effective *lift* amounted to 2,550 pounds, i. e., 20.2 *pounds of lift per horse-power!* Electric motors were used in place of aviation engines because they made it possible to carry on the tests progressively, from the lowest speeds upward, and to read off at the electric meters the actual power consumed at any moment. The driving apparatus between the motors and the shafts consists of an ingenious reducing gear by which it is feasible to step down the prime movers' speed from 1,400 to 100 revolutions a minute. This makes it practicable to employ the high-speed aviation engine and yet to obtain the desired low rotary movement of the propellers.

The reducing gear was developed by Dr. Hewitt, and, while possessing a measure of flexibility to meet the variable stresses of mechanical flight, is, nevertheless, positive in the contacts between the pinions of the engine shafts and the two geared wheels to which the upper and the lower tubular propeller shafts are, respectively, secured. Revolving oppositely, the propellers exert a very notable stabilizing moment; *and so marked is this effect that it was unnecessary to steady the machine by guys during the ground trials!* Furthermore, due to the fact that the screws neutralize one another, so far as they might tend to turn the engine platform about its center, it is at once evident that the helicopter will not spin about its own axis when aloft. Also, it will, for this reason, be easily steered by the rudders to be provided for that purpose. Dr. Hewitt has designed a double reducing gear which will operate at a ratio of 23 to 1. By means of the wide use of opposing forces, and the employment of antifrictional bearings, this engineer-scientist obtains a series of dynamic couples which neutralize one another and thus insure balanced action.

In all of its essentials, Helicopter No. 1 is a practical man-carrying machine, and can be made ready for flight by substituting two airplane engines in place of the testing electric motors. *It is only necessary to tip the machine a matter of about five degrees toward the bow or toward the stern, to propel it at high speed in either of these directions.* This tipping action is effected by suitable rudders; and when the helicopter has assumed the desired angle, a double set of vertical rudders, opposed to the line of advance, act against one another and hold the machine in that plane of motion. The helicopter will be able to hover aloft, and can be made to ascend or descend vertically with the utmost deliberateness. With half of the engine power "dead" the helicopter will return to earth at a safe speed. However, because of its high ratio of thrust per unit of power, it is feasible to equip an aircraft of this kind with a reserve motor which can be put in gear at the will of the pilot or automatically upon the failure of any of the working engines.



1. Inner Concentric Shaft Which Rotates Upper Propeller, 9.
2. Outer Concentric Shaft Which Rotates the Lower Propeller, 10.
3. Permanent Tubular Sleeve Which Takes the Weight of the Machine and Alternately Bears the Lift and Compression Loads When the Craft Is Flying or at Rest.
4. Upper Wheel of Reducing Gear.
5. Lower Wheel of Reducing Gear. The Geared Pinions on the Engine Shafts Are Introduced Between These Wheels and Drive Them Equally. The Shaft of the Lower Propeller Is Secured to the Upper Wheel and the Shaft of the Upper Propeller Is Attached to the Lower Gear.
6. Engine Foundation Structure.
7, 7. Aviation Motors.
8. Fuselage.
11 and 12. Rudders That Can Be Swung Both Horizontally and Tipped to the Right or Left from the Vertical. By Tipping Them Oppositely, the Down Draft from the Propellers Tends to Rotate the Fuselage So That the Craft Will Swing to Port or Starboard. By Tipping No. 11 So That the Rudder Face Is Vertical Instead of Horizontal the Machine Is Inclined by the Head and Will Then Advance Horizontally in that Direction. Similarly So Inclining No. 12 will Cause the Helicopter to Travel Rearward.
After the Craft Is Started Horizontally at Any Angle of Advance, the Rudders 13 and 14 Are Set Oppositely, Thus Forming a Dynamic Couple Which Tends to Hold the Machine Inclined and Upon the Desired Line of Travel.
15 and 16. Rudder Yokes.

Professor Crocker has thus summarized the advantages of the present type of flying machine: "The helicopter will start from any moderate space such as a roof or ordinary street, and come back to land on the same spot. It is inherently stable and cannot dive, the support being all above and the weight below; so that special skill is not required to operate it at high or low speeds to prevent it from getting out of control. The helicopter is substantially *fireproof,* being constructed thruout of metal. To build it, no labor or materials that are difficult to obtain are needed. The craft can be constructed in an ordinary machine shop, and can be assembled, disassembled, or repaired with the skill and facilities commercially available. The helicopter is far less noisy than the airplane and, because of its general design and arrangement, less conspicuous when up in the sky."

As the editors see it this remarkable development in flying machines certainly looks like a long step in advance, if all of the many predicted qualities inherent in its design are fulfilled in actual flight. Especially in war-time will the marked advantages of this type of aircraft be apparent, for its visibility will be far less than that of the present airplane, which has wings of considerable area. Besides, the small wings or revolving screws of the Helicopter will prove a difficult target for the enemy gunners, whether aloft or on land. The cab of the Helicopter can be armored so as to readily withstand ordinary bullets and shell fragments. And just imagine the great superiority of an aerial observing station that can "hover" about, in one spot if need be, in order to gain an accurate sight on enemy artillery and other activities.

We have now considered some of the advantages of the Helicopter, but it would seem to the editors that there are also some disadvantages. For instance, owing to the small sustaining surface of the screws, which act virtually as wings also, what will happen if accidentally or in battle, the engines happen to fail? It would seem that the airship would obey the law of gravity and dart earthward at a rapid rate. Airplanes can volplane down safely if the engine stops, as their superior wing surface allows of their doing so; but perhaps the inventors of the Helicopter here shown have circumnavigated this problem in a manner which they have kept to themselves so far.

Those interested in trying out the merits of the Helicopter flying machine will find a most interesting article on a successful flying model of this type, by Mr. William J. Beach, in another part of this journal.