In the dark they quickly fell down, without growth. Considering these results we are brought to conclude that without light, the synthesis operated by green plants free from carbonic acid in artificial starchy soil becomes impossible. This synthesis therefore appears as a chlorophyllian function. Thus the chlorophyllian assimilation may be a work of synthesis essentially, being accompanied, it is true, in ordinary growth with

escapes at their edges, thus adding the effect of a reaction engine to that of the turbine, and also partly preventing the formation of eddies. The power may be furnished by an explosive mixture or by steam from a Serpollet boiler. As the turbine may be subjected, without injury, to shocks and high temperatures and is the simplest, lightest, and most easily controlled of motors, it is the best one for this use, and, being made

they rest only on theory and calculation? Only practical experiments, carried on persistently in spite of repeated failures, will attain the goal. The cost of a few failures ought not to frighten the true-hearted pioneer, for no victory was ever yet won without sacrifice, and success in this case would be the most glorious triumph of the human mind. Only the most careful testing of sound theories and the proper utiliza-

FIG. 1.

carbonic acid, by the double exchange of gases, that is, absorption of carbonic acid and disengagement of oxygen, which is characteristic of that assimilation.

A PROPOSED SOLUTION OF THE PROBLEM OF FLIGHT.

By FRANZ PABISCH.

It seems almost incredible that our highly developed technical skill has not produced an aerial vehicle that is at all practical. The reasons are, probably, that ignorant and unscientific experimenters have injured the cause, and that the method indicated to us by the birds, and used and improved by them through countless ages, has been neglected. We find in nature various modes of flying, but never the action of the screw-propeller, balloon, or kite, alone. Wing action combines all methods and such a combination and result should be the object of the aeronaut. Extreme lightness, stability, great power and automatic control are the fundamental conditions of success.

We shall see how well the proposed apparatus shown in Fig. 5 satisfies these conditions. First, however, some technical explanations are necessary.

For the navigation of the air two vehicles are available: the gas balloon, which is lighter than the lower stratum of air and floats upon it, and the flying machine, which must be kept in suspension by a motor. There is still a great difference of opinion among aeronauts concerning the respective merits of the two vehicles. The recognition of the impossibility of steering a spherical balloon has led to the adoption of cigar-shaped balloons, with which partial success has been attained. But perhaps the best result possible can be reached with the flat balloon of which three views are shown in Fig. 1. The silk-covered skeleton of steel tubes and wires has a broad bearing surface while its sharp edges offer little resistance to the air. The screw propeller, driven by a turbine or electric motor, should be mounted on a ball and socket joint and dirigible from the car, making rudders unnecessary. Still, however, a satisfactory solution of the problem is scarcely to be expected from balloons. Flying machines which depend wholly on wings or screw propellers promise much better results.

In the propeller (Fig. 2, above) two or more inclined blades turn swiftly about a vertical axis and create a conical base of support by means of the reaction of the air particles which they set in motion. Fig. 2 (below) shows a construction which has not yet been employed but which should be particularly efficient. The axes, or longest dimensions of the blades, are here inclined to the axis of rotation. This arrange-

FIG. 3.

ment greatly increases the air resistance for a given diameter of the screw, providing a base of support in the form of an annular conical frustum whose cross section steadily increases as it is followed downward. The effect, therefore, is like that of the flapping of wings. Fig. 3 shows such a screw-propeller driven by a turbine aided by reaction. The steam, or the explosive mixture, enters the turbine through the hollow axis, and then passes through the hollow blades and

of sheet steel, it offers a stable base of attachment for the propeller. A single propeller, mounted on a ball and socket joint, would serve for support, propulsion, and steering, and the weight of the aeronaut would enable the center of gravity to be shifted, as occasion demanded.

From the nature of the molecular movements of the air very favorable predictions may be made for flying machines with moving wings. At the commencement of the downward stroke the base of support is far greater than the area of the wing, and at the end of the stroke the air is compressed from both sides, as shown in Fig. 4. Unfortunately there are few experi-

FIG. 2.

tion of the necessary means can secure the splendid results that are possible.—Translated from Stein der Weisen for the SCIENTIFIC AMERICAN SUPPLEMENT.

TRANSPORTATION ROUTES AND SYSTEMS OF THE WORLD.

"THE Transportation Routes and Systems of the World" is the title of a monograph just issued by the Department of Commerce and Labor through its Bureau of Statistics. It includes, in addition to statistical statements showing the development of transportation facilities on land and sea, a map by which is

FIG. 5.

mental data concerning the action of wings, owing to the delicate mechanism involved and the effects of inertia brought into play in the changes of direction of heavy and swiftly moving wings. There can be no doubt, however, of the possibility of overcoming, by skillful steering, these difficulties, which have been overcome in the much heavier steam hammer.

Fig. 5 shows a winged flying machine which seems to satisfy the necessary conditions most fully. The long tubular axis of the apparatus carries the peculiar oscillating engine shown in section below. For the sake of lightness the cylinder and the two pistons are made of pressed nickel steel. The bent piston rods terminate in the arms which work the wings. The ends of these arms are connected by steel wires to the ends of the axis of the machine and the areas thus marked off are filled with adjustable "blinds" of very thin sheet steel. In the upstroke of the wing these blinds open to a certain angle, allowing air to pass through from above and driving the machine forward because of their inclination. In the downstroke they are closed and a lifting effect is obtained. Equilibrium and motion in a vertical plane are controlled automatically by the compressed air escaping from the pointed ends of the two large cylinders. Steering in a horizontal plane is effected by moving only one wing.

For the soul of the apparatus, the source of energy, alcohol vapor, which is easily condensed and also available as fuel, is particularly well adapted, though explosive mixtures may be employed.

The powerful downstroke of the wings is effected by means of the compressed air contained in the upper part of the cylinder and the vapor is used only for the upstroke. This secures economy in working. The boiler, of spiral steel tubes, is tested to fifty atmospheres and even in the case of a breakdown of the engine a sudden fall is prevented by the parachute action of the wings which are then directed downward. In landing and in violent gusts of wind safety is assured by the elastic construction, the vapor and compressed air.

In this machine propelling, steering, and gliding are combined in a simple manner, as in the flight of a bird, and its practical success is therefore almost assured. But of what use are the most beautiful schemes if

presented a bird's-eye view of the world's principal railway and steamship routes and the auxiliary relationship which one bears to the other.

Many maps showing vessel routes on the ocean have been published, also many maps showing the railways of the principal countries; but few if any attempts have been made to show even in outline in a single map the great transportation routes and systems of the entire world. The map, in conjunction with its accompanying tables, presents in outline a combination of the information regarding land and water routes usually found only in separate form in other publications. It does not enter upon any elaborate discussion of transportation routes, methods, or systems, but simply outlines in condensed form a few of the great high-

FIG. 4.

ways of commerce by land and sea in combination. This seems especially appropriate at this time when the land and water transportation systems of the world are offering facilities by which the producer or merchant in the interior of one continent may ship his merchandise from his own door to that of the consignee in the far interior of another continent upon a through bill of lading, and therefore with a knowledge of the cost of transportation from his own establish-