Experiments With Tandem Planes

The Langley and Eiffel Models, and a New Design

By Robert Gilbert Ecob

A GREAT amount of time, energy and money has been spent on various types of tandem plane machines, and while some success has been attained, the final solution has by no means been reached.

Dr. Langley and M. Eiffel showed very clearly that:

1. In some cases a tandem arrangement of two planes may be more efficient than a biplane arrangement.

2. In a tandem arrangement of two planes it is more efficient to have both planes at equal angles than it is to have the rear plane at a negative angle.

3. It is more efficient to have a wide than a narrow spacing.

4. Changing the angle of incidence of the rear plane has a very great vertical steering tendency.

5. A tandem machine will fly.

6. In tandem plane constructions the full size machines follow the same general laws as the models.

It is certain that the 400 h.p. motors in use today would fly the Langley machine at such a speed that it would be whipped to ribbons by the wind, but it is doubtful if the 50 h.p. motor of Dr. Langley's would be powerful enough to lift a modern biplane as much as a single inch off the ground. If we consider the efficiency of an airplane as so many pounds carried per horse power miles per hour, we conclude that there must have been great merit in Dr. Langley's interpretation of aerodynamics.

It is easily seen and has been proven that an aerofoil moving through air produces various eddies and currents in its wake. At flying angles the eddies are much reduced, but a decided downward trend is produced. Air, being an elastic medium, tends to return to a state of calm after the passage of the aerofoil. As a general theory the downwash is greatest very close to the trailing edge and diminishes as the distance behind the trailing edge increases. We do not know how soon or at what distance, either relative or absolute, the air will become calm after the passage of the aerofoil, but we do know that there must be some point at which the air will show no appreciable effect from the passage of the aerofoil. Some people claim that the downwash is changed to an upwash, but this is by no means certain, and was clearly shown not to be the case in any of the various dispositions tried in the experiments.

Fig. 2 illustrates the flow of air around an aerofoil at a flying angle. No data is available on the condition of the air at a greater distance behind the aerofoil, but it is safe to assume that the downwash will diminish rather than be augmented. The following plane is shown in the same relative position as the following planes of a majority of the flying models described later.

In all experiments with varying horizontal separations of planes, varying from 2 to 5 chord lengths, the

downwash was seen to diminish as the gap was increased. At 5 chord lengths the downwash was still noticeable, but it was considered that in full sized machines it would be more economical to take a slight loss of efficiency in the planes rather than to increase the length of body and thereby increase the weight, and friction.

M. Eiffel assumed that a tandem plane machine must have a positive longitudinal dihedral angle in order to be stable, but Dr. Langley's "Aerodrome" had a nega-

A model of the plane shown in Fig. 3

tive longitudinal dihedral angle, and was said to be very stable.

Fig. 1 shows Dr. Langley's tandem monoplane at A, the Jeansen-Calliex tandem biplane at B, and the six-plane tandem models at C. It should be noted that the planes in arrangement A are very wide from front to back, they are heavily cambered, spaced very close together, and set at greater angles than are ever used in modern practice. The tail must have caused considerable loss of efficiency.

In arrangement B the planes are spaced farther apart, and the rear planes are larger than the front planes. The longitudinal dihedral is produced by setting the tail at a negative angle, but as it is spaced very far aft the steering effect on the whole machine would be very great, but the loss from having a negative surface would have to be made up by having a greater area of positive surface.

Arrangement C was very satisfactory and was achieved after numerous trials with models having four, five, six, eight, and ten planes. The arrangement

with six planes was studied more carefully, not because it promised the best results, but because it seemed best adapted to full size machines.

The model shown in the photograph on this page is one of a series, the weights of which varied from 11½ oz. to 14 oz. The wing area is 350 sq. inches. It is evident that the planes are lightly loaded.

The models were built to make a rough estimate of the function of the following planes. The plane units or cells were fitted loosely on the bodies and could be shifted fore and aft very easily, as they were held down only by rubber bands.

The location of the centre of gravity relative to the centre of pressure formed a good index to the amount of work performed by the following planes. The centre of gravity could not well be shifted without changing the weight of the model, but by shifting the planes the location of the centre of pressure could be changed at will, without altering the model in other respects, and consequently various changes could be studied closely, and the results compared by the actual performance of the models in free flight.

Referring to Fig. 3, if there were no interference of planes the centre of gravity should be located at $C_1 G_1$ to secure horizontal flight. As a matter of fact the models did fly with this arrangement, but they were too tail heavy, and were greatly improved by locating the centre of gravity at CG.

A very small change in the spacing of the planes relative to the centre of gravity produced a great difference in the performance of the models. A shift of one-eighth of an inch in the two forward units made no perceptible change in the location of the centre of gravity, but in flight it made the difference of driving the model to a height of 20 feet or causing it to barely rise higher than six inches from the floor.

In order to determine whether the intermediate planes of the rear planes were doing the lifting, the top intermediate plane was removed. Greater speed was produced, as might be expected owing to decreased head resistance. The model flew very low, probably due to the fact that the surface had been decreased. The balance seemed to be the same or so nearly the same that the results could not be noticed. The other intermediate plane was next removed, but the surface had been so much reduced that the model could not fly.

In straightaway flight the models performed very uniformly and steadily. It was noted that toward the end of a flight, as the power died out, every model had a tendency to rise, which might have been due to the fact that the centre of thrust was above the centre of gravity, or it might have been that as the propellers slowed down, the wash from them did not continue to support the rear planes. The models were very nose-heavy however, so that the rising tendency was soon overcome by the force of gravity pulling the noses downward.

Fig. 1

The models were excellent floaters, and could go into a dead stall and recover themselves. They could be dropped without power from a dead stall, launched with the wings making an angle of 90 degrees with the horizon, dropped sideways, dropped nose first, or launched backward and upside down, and invariably would right themselves, start to glide and make good landings.

An arrangement was tried with the two front units at an angle of three degrees and the rear unit at four degrees. This necessitated a forward shifting of the two front units. The centre of gravity remained about the same, so that the distance between the centre of gravity and the centre of pressure was very much reduced, and proved that the one degree increase in angle of the rear planes had increased their lift to a considerable extent. The increase in head resistance was so small that no difference was made in the total length of flight. It was found that the negative longitudinal dihedral angle was not necessary for the stability of the models.

The experiments, as far as the models were concerned, seemed to prove in every way that the original theories were correct.

In considering full size machines with six planes similar to the models, while there is bound to be some interference of the planes, there are many mitigating features which might be mentioned as follows:

1. The propellers will break up a large percentage of the interference between the first and second set of planes.

2. The planes may be made thinner, and consequently more efficient.

3. The aspect ratio of the individual planes can be improved, as the tandem planes may be very long and narrow without increasing the total span to an unreasonable extent.

4. A system may be worked out for vertical control which will entirely eliminate the elevating rudder, thus saving considerable loss of efficiency.

5. Weight for weight the tandem machine will be a great amount stronger, or if the factor of safety is the same the tandem will be lighter than the other.

6. No stabilizer, automatic or otherwise, would be required, as the tandem is inherently stable.

7. The tandem permits of larger constructions than have as yet been attempted.

European Apple Beverages

In view of the health-giving properties of the apple it is regrettable that non-alcoholic apple beverages fall so far behind those prepared from the lemon in popularity. It is said of the apple that it is the most commercial of fruits, and in Europe people are accustomed to value an orchard in accordance with the number of apple trees it contains. Unfortunately, however, the quality of the European apples is far behind the quantity; apple production in Europe is so far from being profitable that it does not prevent the importation of the fruit from foreign countries, particularly from America, in great quantities. The average quality is undeniably poor and in consequence of the planting of inferior varieties and the keeping quality of the fruit is quite limited.

The methods of working up the fruit in Europe are so primitive that American dried apples are not exposed to any serious competition by the home product.

The marmalade industry employs for its cheaper products the refuse from ring apple production, especially parings and cores, which are imported by the shipload. Before the war even the soft drink industry employed dried American apple peelings for the production of apple essences.

Of somewhat more importance is the use of apples for the preparation of soft drinks. Drinks prepared from the natural fruit are naturally regarded as being more valuable than the artificially aromatized imitations. Considerable speculation has been indulged in as to whether beverages prepared from the dried

fruit, especially such as are made from peelings and cores, are likely to win out in competition with drinks prepared from the fresh fruit. In favor of the drinks prepared from the dried by-products is the fact that in these the larger part of the aroma is still contained in the peelings, even after they have been subjected to a drying process. Furthermore, it is a much easier and simpler matter to prepare a beverage from the dried product than from the fresh juice, which is so easily exposed to alteration by alcoholic fermentation. Furthermore, in the dried fruit a large part of the albuminoids not only make the juice difficult to clarify, but influence its keeping quality. From a practical standpoint the most prominent advantage in favor of the dried fruit is the fact that the manufacturer is confronted only by the simple problem of redissolving the dried soluble components of the material, which he can do in such a way as to control the concentration

Fig. 2

of the liquid, and in consequence is able to turn out a uniform product. To attain such a uniformity is impossible with the fresh juice on account of its varying composition and particularly its varied acid content, on which chiefly depends the flavor of the beverage. As a matter of fact, the natural acid content of apple juice is from 0.5 to 0.9 per cent. too low for the production of the desired palate-fulness. To attain this palate-fulness about 1.5% of acid is necessary. A juice with less than this amount of acid is likely to appear to the average palate as lacking zest. The beverages prepared from the dried apples contain the natural extractive matters of the fruit, such as the fruit sugar, the fruity acids and the nutritive salts, of which the phosphoric acid compounds are the most valuable. Since in the production of a drink with the desired acid content the dilution of the re-dissolved substances is not carried as far as is the case with the natural

emptying and filling. These vessels are not provided with heating arrangements, but are in connection with an elevated basin filled with water at a temperature of 80-90° C.; water flows out of this hot water reservoir at a constant rate of about 200 liters per hour, which makes possible a daily output of 2,000 liters per day of ten hours.

The hot water passes into the first of the cylinders in operation. This cylinder, like all of the others, has received a charge of 100 kilos of dry apple peelings or other by-products. In the course of two hours, it has been filled by the water coming from the hot water tank. The extract is then drawn off from the bottom by means of a syphon, which delivers it at the top of the second cylinder. From here the process repeats itself, the extract from one cylinder being delivered to the next one until the last vessel has been filled.

When this occurs, which generally requires about eight hours from the beginning, the finished extract is drawn off. The first draught yields 400 liters. During the running out of these 400 liters, water is continually drawn into the system from the hot water tank. In this way the first vessel has been emptied four times and filled five times. The first vessel is now removed

from the system and its place is taken by the second one, while the reserve vessel which has just been filled with fresh material is connected with the vessel which has just yielded 400 liters extract. In this way a fresh vessel is brought into operation and 400 liters of juice are obtained every two hours. During the manipulation the hot water becomes considerably cooled, and reaches the last vessel after it has lost a great deal of its heat. The last extractions are, therefore, cold extractions, which is of great importance for the taste of the product. This method, therefore, is an improvement on the one previously employed, as it eliminates entirely the cooked taste. To eliminate such albuminoids as it now contains, the extract is heated to 80° C. After cooling it is filtered clear through a vacuum filter and carbonated in a mixing kettle under a pressure of 1½ atmospheres (22 lbs. per square inch) and then bottled and closed with the well-known crown corks. The process of sterilization finishes the manufacture.

The finished average contains about 1.5% of total acid, 20% of natural fruit sugar and 0.8% of mineral matters, of which the phosphoric acid compounds, amounting to 0.1%, are considered the most valuable.—*Pure Products.*

Polishing Glass

WHEN acids are used for polishing glass instead of the customary mechanical methods with abrasive materials, the irregularities in the surface are removed by solution of the glass. Hydrofluoric acid is chiefly used, but other acids (such as sulphuric acid) may be added for subsidiary purposes such as the solution of calcium fluoride formed by the action of the hydrofluoric acid. A solution suitable for polishing Bohemian lead glass consists of water 1 part, sulphuric acid 2 parts, and hydrofluoric acid 1 part; for other glasses the most suitable solution should be found by

trial. The solution should be heated to 40°-50° C. and maintained at that temperature. The glass is cleaned by immersion for 45 seconds in a mixture of sulphuric acid 12 parts, hydrochloric acid 1 part, and water 100 parts, and then in water at 35° C. It is then immersed for 30 seconds in the polishing solution and is afterwards washed thoroughly. If one treatment is insufficient it may be repeated. Fine glass ware may receive a final polish with the aid of tin ash. The glass ware may be etched by covering it with a stencil and exposing it to the gas evolved from the polishing solution. If the glass is not polished after 30 seconds' immersion, more hydrofluoric acid should be added to the solution. Good ventilation should be provided. This method of polishing is applicable to all kinds of glasses except the very finest ware; it is cheap and requires little skill.—*Note in J. Soc. Chem. Ind. on an article by O. Parkert in Sprechsaal.*

Fig. 3

juice, the dried apple beverages contain more sugar and other components in proportion to liquid, and therefore are more nutritive and satisfying than the juice in its original condition.

The process of manufacture requires but few mechanical appliances, since the process is merely a thorough extraction with hot water. For this purpose there are employed five cylindrical enameled vessels, each with a capacity of 600 liters. In each of these vessels there is a false bottom covered with a straining cloth. Each is provided with a tight enameled cover, and to facilitate removing of the exhausted material is provided with a tipping device. These extractors must communicate with one another; the necessary connections are made through easily removable enameled, or better, aluminum pipes and the extractors are provided with draining cocks of the same material. Four of these vessels are continually in operation, while the fifth is cut out of the series for the purpose of