



U. S. ARMY MARTIN AERIAL TRANSPORT EQUIPPED TO CARRY PASSENGERS

The Airplane as a Commercial Possibility*

Changes Necessary in Present Equipment, and Future Developments

By D. W. Douglas

THE cessation of the great war has left the airplane machines and engines of the highest quality in the world. It has, however, left it in poor shape for existence, for few of the airplanes developed for military purposes hold much promise of successful adaptation to peace-time commercial uses. Future military business of any magnitude is problematical. That the war has advanced the science of aeronautics and in a way that will help to solve even the commercial problems is true; and it has given the industry opportunities for the betterment of its products that would not have come to it in double the period of time in peace. That commercial use must be made of airplanes to support even a part of the capital and interests involved in the business at present, seems necessary.

Many people argue that the Government cannot afford to allow this great and new industry to languish because of lack of business, but must foster and further it by subsidy or continued military orders. That such a course would be welcome at this critical period is undeniable, but total dependence of existence on this problematic possibility would be fatal. Governments are sometimes slow in acting in a sufficiently decisive manner on such problems, as is witnessed by the disappearance of our merchant marine in the latter part of the nineteenth century. Furthermore, government subsidy does not always appear healthy for the sound development of commercial projects. Of the early transcontinental railroads,

those that received the least or none of the support accorded by the Government remained the most financially sound.

The problem before us today is: What practical use can be made of airplanes, what volume of business can we expect to secure with them, what changes of or developments from present military machines will be necessary to give us an efficient commercial machine, and what does the future hold for this new means of transportation? Let us inquire into the probable fields that the commercial airplane can hope to enter, and, either competing successfully with other means of transportation or supplying the lack of such transportation, become a recognized factor in the development of commerce and the furtherance of social and economic intercourse throughout the world.

PASSENGER TRANSPORTATION.

Since speed is the most outstanding present-day advantage of the airplane, I rank passenger carrying first in importance. Many of our daily business and personal affairs can be successfully conducted only by a personal meeting or inspection. Correspondence, telephony and telegraphy cannot supply the complete satisfaction of actual personal contact. Where any great distance separates the subject and his objective, present-day express train service often proves too slow.

Time wasted in travel means money lost, suffering endured or pleasure sacrificed. Granted safety comparable with that of our present means of travel, in point of fatalities per miles traveled, and that I trust will be demonstrated soon, are there not many instances in the life of any person when he

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would gladly pay twice the railroad fare to reduce his travel time to one-half or one-third? Is it not conceivable, then, that having once found that this saving is worth something to him at a critical time, he will avail of it again for some less important reason? Soon he will find, if he be a man of large and pressing affairs, that he is remodeling his schedules on the basis of this new time-annihilating service. The first problem, then, seems to be to win the confidence of the public, to institute a successful passenger transportation line between two great cities such as New York and Cleveland.

Aeronautical people all feel confident that with the lessons learned from military experience and with new safeguards thrown around the airplane in its operation and maintenance, such a service can be safely embarked on with our present-day knowledge and material. This must be proved by actual performance rather than by statement, and so the airplane builders or those with the necessary knowledge, enthusiasm, and capital who will come forth as commercial operators must take the risk. In one way or another they must actually carry passengers. They must carry them on schedule, comfortably and without mishap, and for a reasonable period of time. Experimental human material is needed, then, in addition to the experimental carriers of it. To my way of thinking, and from observation of and conversation with many people, there is plenty of such material in the adventurous, the curious and those whose extremity may be so great as to warrant the chance they are sure to believe they are taking at the time.

Granted, then, that sufficient patronage of a not too serious order can be counted on for starting a passenger-carrying airplane line of small size, what form will this first venture assume? Three methods of attack can be followed and are being followed at this time. They are:

- (1) Scheduled regular service
- (2) Special taxi service
- (3) Tourist service

Of the three the first seems to hold the most promise of giving us our first real data on costs, maintenance and traffic. While it appears offhand to involve the risking of more capital than the last two, it need not preponderate greatly in this respect and certainly will offer a more accurate count of the public pulse than the other methods. By scheduled service I mean, of course, the operation of one or more machines flying between two or more points on a time schedule properly based on the safe speed of the plane, the altitude flown and the head winds likely to be encountered. No such service has as yet been actually started either here or abroad.

In England various airplane firms have ready machines carrying from 10 to 40 passengers; the French Farman carrying 12 persons and the big Caudron Company are only waiting for military questions to be settled before opening up regular service between London and Paris and other European cities. England has big projects along these lines throughout her colonial possessions and seems imbued with the determination to realize them. In Italy Caproni is building larger passenger planes than anyone, which it is said will be operated from the northern to the southern part of that country and even across the Mediterranean to the African possessions.

Other enthusiasts believe that the safest course to pursue in breaking into the transportation of passengers is through the use of the taxi system. To illustrate this I may state that the Curtiss Aeroplane Company intends to maintain a fleet of fast machines at a flying field near New York City, always in readiness with expert pilots in attendance to take anyone with the necessary confidence and money to any part of the United States. Our Air Service has for some time been using planes for a similar service. In Washington several machines and some of the best pilots in the service are ready at any time to carry high officers or officials on a joy ride or a quick official trip to other cities within 400 miles.

At Atlantic City companies are planning to handle the tourist trade. That they will meet with success in joyriding

pleasure seekers next summer seems dependent only on their intelligent use of the best materials and personnel.

AIRPLANES AS MAIL CARRIERS.

Passing to the second commercial use of airplanes, mail carrying, we enter a field where the element of danger is not of so much importance. It is not to be neglected any more than in passenger carrying, but the possibility of crashes do not limit the initial business.

Under the heading of mail carrying I will group several functions:

- (1) Regular mail transportation
 - (a) By the government
 - (b) For the government
- (2) Fast dispatch service
- (3) Financial service

In regard to the carrying of mail by plane, everyone is acquainted with the fact that the Postoffice Department has had a service in operation for the past year between New York City and Washington. It has operated this with its own personnel and material, and made a remarkable record on this run for efficient and continuous service. The amount of mail carried has, of course, been small as the service is only a beginning. About 160 pounds of mail is carried every day from each city, the pilots flying in all sorts of hazardous weather. Rain and storms fail to frighten them, and the instances of failures have been very few. The Chicago-New York City route was, as you know, unsuccessful in the first trials, but this was due mainly to faulty machines for this long haul, ignorance on the part of the pilots of the country traversed and a rather hasty start without proper organization and equipment. Next spring this run will again be instituted, and judging from the preparations being made and the machines that will then be available it should be as successful as the aerial postal service operating between New York City and Washington.

Whether the Postoffice Department will contract with airplane transportation companies for carrying mail in other localities will depend to a great extent, I judge, on the record of performance actually accomplished in operating their lines for some other uses. It is not inconceivable that a company which had been regularly and successfully carrying passengers on a certain route would be able to secure contracts to carry some government mail along with the regular load.

Under the second function of mail-carrying types of planes comes independent carriage of special commercial dispatches. A service could be maintained with fast planes, flying both night and day, that would bid fair to outrival the night telegram service between cities over 300 miles apart. It would be as quick at probably lower charges and have the great advantage of accurate transmittal and the possibility of conveying information other than that written.

Machines engaged in this work could also handle the third class of mail-machine operation. Where the saving of a few hours in the time of transmittal of a draft on a bank in one town, to be deposited in the other, may mean the saving of a day's interest, fast airplane service would certainly be an advantage.

GENERAL EXPRESS TRANSPORTATION.

If we now take up the third peace-time use of the heavier-than-air machine, general express transportation, we enter a field which at first glance does not appear to offer much encouragement to the airplane as a carrier. Express and fast freight service throughout developed parts of the world is generally good and, of course, much cheaper than similar service by wing. On the other hand, as in carrying passengers, the future promises a class of people to whom the greater speed is a worthy consideration; so in the transportation of merchandise we will find classes of goods which can bear the extra cost of moving in exchange for the time saved. This may prove particularly true in conveying goods from small

towns with indifferent rail service to the larger centers. Among the articles which can bear the extra tariff are:

- (1) Perishable goods
- (2) Replacement parts for damaged machinery
- (3) Medical and surgical materials
- (4) Motion picture films
- (5) Newspapers
- (6) Luxury articles

Taking up the question of perishable goods that can bear the expense of airplane travel, we may list such things as high-grade certified infants' milk, rare and out of season fruits, vegetables and flowers. The milk for New York City is supplied largely from upstate dairies not having the fastest of rail service. With a preliminary cooling at the dairy this milk could be carried quickly and deposited still cold in the city. Where the breakage of intricate machine parts threatens the tying up of a plant, the aerial express line should find an opportunity to be of value. Shortages in factories working on a production basis that could ill afford an interruption could be made up from stock in a distant town in the minimum time possible through the air. Occasions arise in epidemics or catastrophes where the shortage of medical and surgical materials, personnel and food becomes serious. With airplanes such supplies could be rushed in the fastest way. Motion picture films could not only be distributed in the shortest time by airplanes, and thus cut down exchange and idle time, but the service would add to the advertising campaign of film companies. News grows stale quickly and small-town papers do not always satisfy the residents of such communities. The faster distribution would increase the out-of-town sales of the daily papers of our large cities and widen the range of their circulation. Articles of luxury which bring high prices in proportion to their weight could in many cases have quicker distribution profitably. Advertisement would enter here to a greater extent than in any other class of service possible. Confectioners and florists in the large cities, enjoying a wide reputation and a high-class trade, could broaden the field of their patronage considerably.

AERIAL TRANSPORTATION OF MINERAL ORES.

Mineral ore, while appearing to be a difficult cargo for seemingly flimsy aircraft to carry, is, in certain localities and in certain grades of ore, a practical load for airplanes. Where mines producing rich ore are located in inaccessible country not tapped by railroads or highways, barring exceptions where the character of the terrain precludes the possibility of landing fields or where altitudes are excessive, an aerial transportation system could be installed without the necessity for heavy investments in roadbeds and grading and could be operated at costs that would not be excessive. If the mine be a small one, removed from the possibility of surface service, the airplane can take out the ore and when the workings are barren leave no great amount of useless investment on the location. In addition to carrying the ore out, labor, equipment and supplies can be brought back on the return trip. Where speed in the operation of a newly found mine and in the marketing of its ore is an advantage, because of high market prices, an aerial system could be put into operation much faster than any surface system and would be delivering the ore months before the road or grading work could be finished.

The transportation of the ore from the mines to the nearest railroad might not be found to be the limit of this service, for at times and in certain undeveloped localities it might pay to carry the load farther to a district of better rail service. The distance of handling might today be limited to 300 or 400 miles because of the poor economy of carrying too much fuel, but there is reason to believe that with great load capacity and machines developed for this class of service, this range could be increased without too much loss in economy to 500 miles. To obviate the necessity of landing with a great load of

ore, the machines could fly low over the receiving yard and drop their burden from the air. Where the haul was short, several round trips from the mine to the depot might be made with no landings at the latter, and time and the wear-and-tear incident to landing could thus be saved.

AERIAL PHOTOGRAPHY AND MAP MAKING.

One of the uses of aircraft that the war has done the most to develop to its present high state of accuracy is aerial photography and its application to the making of mosaic maps. Developed from the necessity of gaining accurate information as to the location and nature of enemy gun emplacements, fortifications and supply lines, the science of aerial photography has become such an exact one that not only can it be used to get true topographic maps, but it can be applied in the making or checking of maps and mapping observations. The bulk of this work, and all interested in the furthering of flying throughout the country are hoping that much of it will be done, will probably be directed by the Government through its military or civilian personnel. It is not inconceivable, however, that companies engaged in the publishing of maps of the various parts of the country, such as Rand, McNally & Co., could find a market for better maps based on aerial photographs.

Owners of great ranches and plantations might find it of value to have the added insight of their possessions and the correlation of their various sections that would be afforded by a complete mosaic map. Advertising literature and descriptive maps of cities, resorts and real estate developments made by the aid of actual aerial photographs would undoubtedly possess enough value to warrant the expenditure necessary to compile them. In surveying undeveloped country for laying new railroad lines through it, the airplane would not only be a valuable adjunct in transporting the surveying parties and supplying them with necessities, but would aid in the making of their contour maps.

OTHER MISCELLANEOUS USES.

Among the miscellaneous uses that we may hope to put airplanes to, come those of supervision and exploration. While in many of its aspects this work would dovetail with the photography previously outlined, in other ways it presents new fields. Consideration is being given today by the Government to the patrolling of the great National Forest reserves by airplanes driven by or carrying an expert forest ranger. A greater check on forest fires could be exerted by this means and in that way much natural wealth conserved. More ground could be covered with smaller personnel, and reports of fires by wireless from the air to a central receiving station would expedite the rushing of fighting crews to the scene of the impending catastrophe.

The inspection and supervision of large properties is made more efficient and rapid by the employment of an airplane by the manager. It is reported that J. P. Morgan has bought a plane and engaged a pilot to aid the manager of some of his large wheat lands in keeping in touch with his work. Policing operations, both state and municipal could be aided by airplane squads. State constabulary could throw a force of men into an isolated town where a strike or riot impended, by the use of large fast machines kept at central flying grounds. In the exploration of undeveloped country for following waterways or determining suitable waterpower developments, airplanes would provide vision and perspective to the pioneers.

USE OF AIRPLANES FOR SPORT.

Among the last and what has appealed to so many as the first and best use to make of our present aircraft is the sporting development. Undeniably there is a field here, and had the war not intervened it would be further advanced. For customers the producers of sporting types of airplane will surely have many of the returned and discharged military aviators. Most of them would probably enjoy the possession and use of a fast, able little craft, but unfortunately an airplane will always be more expensive than a motor car and

hence few but the wealthy will be able to indulge their fancy.

One of the first obstacles to pleasure flying is the fact that suitable flying fields are not numerous or located in respect to each other in such a way as to make possible an ordinary jaunt of an afternoon. Flying in the vicinity of a field soon becomes tiresome. One way out of this difficulty is through the use of machines of the flying-boat type. Coastal waters, inland lakes and rivers provide ample landing room for sportsmen. Sport flying will not doubt increase in popularity in spite of its cost and probably be fostered by the Government. The enlargement of the landing facilities provided by the mail routes and commercial lines will assist. That it will ever approach the magnitude and popularity of motoring seems improbable; skill in flying is not possible of attainment by everyone; the hazards of flying can be combatted only by the employment of elaborate precautions beyond the means of individual fliers.

CHANGES IN PRESENT EQUIPMENT.

Having covered in general the uses of aircraft, we approach now the subject of the initial developments that are necessary before entering the field of commercial endeavor. These in the order of their importance are:

- (1) Engines
- (2) Airplanes
- (3) Means of navigation
- (4) Landing grounds
- (5) Legal questions

As I expect to cover the future developments later, I will confine myself here to a summary of what changes, if any, we must make in our present equipment and methods.

Our best engines at present, as exemplified by the Liberty Twelve, seem to give promise, if properly handled and not overtaxed in power or length of service without overhauling, of giving satisfaction in regular service.

Our airplanes, of course, need considerable reworking to fit them for carrying passengers or inert cargoes, except possibly in the case of smaller machines used for special service. Some of our planes, built to give the ultimate in performance from a military standpoint, possess unpleasant features when applied to peace-time uses. These planes will be worthless as far as everyday use is concerned. Others will require only a changing of interior arrangements. Bomb compartments will be replaced by comfortably appointed cabins or conveniently arranged cargo holds. Accessibility and ease of replacement of wearing parts will be given prime consideration in redesigning these machines.

Our navigation means probably call for the most immediate developments. Air compasses now in use are not thoroughly satisfactory at all times and in all weather. Radio direction-finders have been developed and seem to promise a more accurate and dependable method of keeping a true course in flying across country above the clouds or in a rain or fog. Better maps are necessary at once. Present-day maps are usually lacking in true accentuation of natural landmarks such as rivers and mountains. Confusion is caused by the omission of some marks and the inclusion of others when perhaps both look to be of the same magnitude when observed from an altitude of 10,000 feet or more. Cities flown over should be marked in some way to be readily recognizable by night or day.

Means of signaling the location of a field are necessary in a fog. Since most fogs are close to the earth, captive balloons riding above the fog in daytime, or star lights shot above the fog at night, will make it possible for the aviator to find his field. Proper and adequate means of lighting fields for night flying are advisable, since in some kinds of service this will present advantages over day flying.

Radio lighthouses along established routes sending out distinctive signals at regular intervals will aid the pilot in checking his position, which may be rendered uncertain by unknown wind conditions and loss of visibility of the ground. Landing fields should be provided at reasonable intervals

along the course of aerial routes. An endeavor should be made to locate suitable fields as near to town as possible in all cities contemplating airplane service, as a field distant from the center of a town tends to offset the time-saving of aerial travel. The shorter the run the more will be the magnitude of the disadvantage.

Serious contemplation should be given by the proper representative bodies of the State and the Federal Governments to the legal aspect of aerial transportation. Uniform laws governing the behavior of machines in the air and when alighting are needed, as well as inspection regulations to safeguard the public and eliminate ignorant and foolhardy operators. Proper instruction and examination of pilots are necessary; while the examination should not be so exacting at this time as to be unjust, it should be and can be thorough enough to safeguard against unsuitable and incapable operators.

FUTURE DEVELOPMENTS IN AIRPLANES.

It seems safe to assume that the uses of aircraft will expand rather than contract. This would indicate that we shall always have as many different sizes of machine and engine as now. Small single-engine planes will continue to attract sportsmen, will be used in special service and even in mail or passenger lines between small towns. Multiple-engine machines, however, possessing, as they do today, the added safety of being able to continue flight when one engine stops, seem certain to come more into use for all regular systems requiring the maximum of safety and dependence. Even though engines develop considerably in reliability, as they must and will, this type of airplane seems bound to predominate from other considerations. The size of the multi-engine machine will therefore probably vary more than at present. Starting with small two-passenger twin-engine airplanes, we shall probably have two, three, four and five-engine planes with horse-powers up to 5,000 and useful loads up to 20 tons, operating in different services in the near future.

As to the speeds that we may expect the machines of the future to attain, it appears that while more efficient machines and engines will undoubtedly increase the maximum possible, many types will be slow. Where a service is operated over country not possessing fast surface transportation, or over broken country and large bodies of water, the slower plane, say that having a maximum speed of about 80 m.p.h., will be the most economical. The attainment of higher speeds will always mean the lowering of the useful load carried. Where there is good rail service, or other conditions call for the maximum speed, we may expect to find planes in operation making with their full load anywhere from 150 to 200 m.p.h. Speed does not mean less dependence or safety but more often surer and safer service. It does, however, except in certain instances, spell higher costs per pound of load carried.

The tendency in engines, as far as their size is concerned, seems still to be toward greater power. What the limit will be is hard to predict, since it is restrained somewhat by developments in other directions. Unless radical changes in the methods now used in the making of air propellers occur, it does not seem that units larger than 1,000 h.p. will be practical. Two or more propellers driven from one powerplant by shafting or other means may, however, make it possible to double or treble this figure, lacking any developments in air screw construction.

As to new developments in airplane design, aside from larger or faster machines, it is difficult to see that this will follow any new or startling lines. The problem of descending and arising vertically with heavier-than-air craft, while probably not impossible of solution, seems to present insuperable difficulties. Very likely compromises will be effected which will permit airplanes to land in more restricted fields and in terrain of a rougher character than is now advisable. Lifting screws, air brakes, variable camber, variable area and better landing gears may be used in the solution of this problem.

Refinements of structures by more careful design or employment of better materials will undoubtedly continue and

will, by decrease of weight and head resistance, give greater speed ranges or greater load capacities.

Developments in engines seem to point toward the maintenance of power with increase in altitude and the consequent increase of speed and miles per gallon of fuel. Some success along this line has been attained already, and practical solutions appear to be forthcoming soon. More reliability in engines and the possibility of longer running without overhauling are of such advantage in commercial work that efforts will surely be bent in this direction. Better fuel economy will be sought not only from the fact that costs will be cut in this way but because weight will be saved by the reduction in the amount of fuel carried and the space gained will be available for more cargo or more comfort for the passengers. The three main developments in the engines then would seem to point to a higher weight per brake horse-power at sea level, but, of course, the maintenance of power at great altitudes and the lowering of the fuel consumption should offset this and perhaps eventually put us ahead of the present low-weight engine unit.

In the development of accessories and safeguards the field is broad and offers many opportunities. Automatic controls for the relief of the pilot seem certain of early attainment. Safeguards against fire and leakage from fuel tanks are well developed now, although not always applied. Improvement in both as to effectiveness and weight can be expected.

Muffling of engines, heating and ventilating of the cabins and housing-in of operators without restricting their vision will all come shortly and add to the efficiency of the pilot by reason of the increased comfort and freedom.

More durable materials for the covering of wings and bodies, protective coatings and the like will lower the present high rate of deterioration.

SERVICE COST DATA.

No doubt you have all at one time or another thought that you might like to take a trip in a passenger-carrying machine. You have no doubt wondered what the initial costs would be and what the rate per passenger-mile can be expected to be in the near future. With this thought in mind I have prepared the following brief cost calculations on a problematic service between Cleveland and Detroit. The costs include all operating and overhead expenses of a complete operating company. For this service I have assumed the use of one of the Glenn Martin Co.'s twin-Liberty, 10-passenger planes equipped with pontoons for water landing. I have done this rather than use the land machine as in both Cleveland and Detroit suitable landing fields are too far from the center of town. Also, with a water machine no hesitation would be felt in taking a straight course from the one town to the other. If a land machine were used, prudence would dictate the following of the shoreline, with the increased distance thus made necessary, combating the time saving of the service. It should be understood, however, that this particular service is not the best example as to economy or locational advantage. Moreover, costs over the water will be higher than over land because of the poorer efficiency of water machines. That the estimates shown can be bettered for more advantageous service is possible of proof.

CONDITION OF FLIGHT.

The distance is assumed to be 100 miles.

The high speed of the plane full out will be 105 m.p.h.

Regular flying will always be conducted at a reduced speed of the machine and the engines. This speed will average about 95 m.p.h. when each engine is delivering about 310 h.p.

Schedule flying time will be based on this throttled speed, less 15 m.p.h. Scheduled speed will then be 80 m.p.h. and schedule time for the trip $1\frac{1}{4}$ hours. Schedules can be maintained against head winds up to 25 m.p.h., by running full out. As winds above this speed are occasional and usually accompanied by bad weather for flying, schedule time should be maintained on over 90 per cent of the flying days.

In figuring the costs of operation and the depreciation of the machines and engines, this schedule time of $1\frac{1}{4}$ hours per trip will be used, although the majority of runs will be made in less time than this. This will provide a factor of safety and cover idling of machines on the water.

We will assume that flights will be made 170 days out of the year, or about 75 per cent of the time. Further, we will consider that our average load will be eight people, or 80 per cent of the maximum.

The gasoline consumption will run 26 gallons per hour per engine or a total consumption per machine of 52 gallons per hour. The total oil consumption should not exceed 2 gallons per hour.

SERVICE.

Assuming that the amount of traffic will permit the operation of two machines, each making six trips a day, three machines a year will enable this service to be maintained, as this would allow each machine a yearly flying life of 100 days, with 90 days for repair out of the 270 flying days in the year. We will assume that the total life of the machine is 1350 flying hours, and that to keep it in the air this time 15 per cent of the original cost is expended in replacement parts. Labor and material for fabricating other parts will be figured also.

We will assume that to keep each machine in the air 1350 hours two sets of engines will be used and junked. The total running life of each engine would then be 675 hours. We will assume that in the life of each engine it is completely overhauled six times and that at each overhauling replacement parts equal in value to 10 per cent of its cost are used in addition to other labor and material for repairs.

TIME SCHEDULE

	LEAVE CLEVE- LAND	ARRIVE DETROIT	LEAVE DETROIT	ARRIVE CLEVE- LAND
Machine No. 1 Pilot.....A	7.00a.m.	1 8.15a.m. A	2 7.00a.m. B	2 8.15a.m. B
Machine No. 2 Pilot.....B	9.00a.m.	2 10.15a.m. B	1 9.00a.m. A	1 10.15a.m. A
Machine No. 1 Pilot.....A	11.00a.m.	1 12.15p.m. A	2 11.00a.m. B	2 12.15p.m. B
Machine No. 2 Pilot.....C	1.00p.m.	2 2.15p.m. C	1 1.00p.m. D	1 2.15p.m. D
Machine No. 1 Pilot.....D	3.00p.m.	1 4.15p.m. D	2 3.00p.m. C	2 4.15p.m. C
Machine No. 2 Pilot.....C	5.00p.m.	2 6.15p.m. C	1 5.00p.m. D	1 6.15p.m. D

It is seen then that four pilots are operating every day, each making three flights totaling $3\frac{3}{4}$ hours in the air. Six pilots will be required to give the proper relief and reserve.

Here follows a detailed statement of capital invested and expenses, which is omitted. The estimated cost per passenger mile is \$0.18, total investment, \$349,800 and percentage of profit on investment 30.—EDITOR.

Assuming larger and faster land machines working up to the limit of their capacity, it can be shown that passengers can be carried at a good profit as low as 10 cents per passenger-mile. The fuel consumption mentioned is a little high because the engines are throttled and the Liberty burns 33 gallons per hour full out, developing 400 h.p. Throttling down to 310 h.p., the engine speed is approximately 1600 r.p.m. We have no accurate results on gasoline consumption at that speed, but I know that going to Washington we burned a little more than 26 gallons per hour per engine at about 1600 r.p.m. I think that consumption could be reduced.