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POSSIBILITY OF PROFITABLE AIR TRAFFIC BETWEEN LISBON AND RIO DE JANEIRO.

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POSSIBILITY OF PROFITABLE AIR TRAFFIC BETWEEN LISBON AND RIO DE JANEIRO.*

By Walter Sherz.

With the consent of the management of the German Airship Company in Friedrichshafen, the author presents this paper, which forms a part of a work he has undertaken regarding air traffic of the world.

Airship Type.- As the basis of the present article, I have taken the same type which the Zeppelin Airship Construction Company designed in the winter of 1921-22, for the "Compania Transaerea Espanola" (Spanish Air Traffic Company) in Madrid, for the projected airship line between Seville and Buenos Aires.

This is a Zeppelin airship of about 135000 m (1453113 cu.ft) gas capacity, with a total length of 250 m (820.21 ft) and a maximum diameter of 33.8 m (110.89 ft). The power plant consists of nine 400 HP Maybach engines, only seven of which would ordinarily be kept running and would give the airship a cruising speed of 110 km/hr (68.35 mi/hr), or 31 m/sec (100.25 ft/sec). With all nine engines running, the airship could attain a maximum speed of 132 km (82 miles) per hour. When filled with hydrogen at a temperature of 25°C (77°F) and under a barometric pressure of 750 mm (29.53 in), it would have a total lift of about 142 metric tons (313056 lb), of which about 66.5 tons (146607 lb) would be dead load and 75.5 tons (166449 lb) useful

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load. The latter would be divided, for the Lisbon-Rio de Janeiro trip, as follows:

40 passengers at 150 kg (330.7 lb) each, including provisions and baggage	6 t	13228 lb
Excess baggage	1	2205
Mail and other freight	12	26455
Crew	4	8818
Fuel for 7 engines for 90 hours	45	99208
Ballast	6	13228
Reserve lift	1.5	3307
Total	75.5 t	166449 lb

A fuel consumption of 70 kg (154.33 lb) of fuel per hour per engine is assumed, which corresponds to an hourly consumption of 230 g (.514 lb) per HP for an actual output of 300 HP by each engine, this figure being a very conservative estimate, as compared with past performances of airship engines. The relatively high fuel consumption is, however, adopted as the basis of the calculations, in order to allay any fear that the completion of a trip might be prevented by fuel shortage, even in unfavorable weather.

Also the cost of operation, as given in detail further on, would be considerably reduced in practice by the smaller fuel consumption. The 7500 kg (16535 lb) for ballast and reserve lift exceed the hitherto customary amount. This amount was adopted, in order to avoid any disappointment from either the technical standpoint (injury to the gas cells) or meteorological (weighting by

rain; high temperature) and in order to assure the completion of the trip over the long reaches of sea and thus assure the safety of the passengers and the regular delivery of the mail.

If the airship were filled with helium, instead of hydrogen, it would lose about 7.5% of its lift and 10.5 tons (23149 lb) carrying capacity (for 135000 m^3 (1453113 cu.ft) gas capacity), from which fact it is apparent that such an airship could still be used for transatlantic traffic, with the same number of passengers, by reducing the allowance for mail and ballast one-half. The employment of helium in the South American service does not appear probable in the near future, since neither in Europe nor in South America have there been discovered any helium-holding natural gas wells, which constitute an essential condition for the obtention of large quantities of helium.

For the accommodation of the 40 passengers, there are, immediately back of the pilot room, ten capacious cabins for four persons each, which are designed, along with the common dining room, to be occupied during the day. The kitchen, wash-rooms and water-closets resemble those on small passenger steamers. In this connection, it must be remembered that the airship takes only about three days to cover a distance for which sea-ships require over two weeks. Radio telegraphy and telephony are at the service of the passengers, the same as on ocean steamers. Mail, freight and baggage are stowed inside the hull of the airship.

The cost of building such an airship, of 135000 m^3 (1453113 cu.ft) gas capacity, would be about $1400000, without including the

interest on the capital required for the erection of a new airship factory, in case the airship could not be built in an already existing factory. A regular weekly airship service between Lisbon and Rio de Janeiro could be carried on with three airships, two being actively engaged and the other held in reserve. The life of such an airship is assumed to be two years, which corresponds, in this particular instance, to 100 trips between Europe and Brazil or about 800000 km (497100 mi). The airship could be insured at an annual cost of about 12%, which will doubtless be reduced when the general confidence in airship traffic has increased.

Itinerary, Airports and Time Schedules.- The following itinerary is assumed for the trip from Lisbon to Rio de Janeiro. though the pilot may deviate from it according to the meteorological conditions on any trip, in order to make the quickest and most economical passage.

	km	mi
Lisbon-Cape Verde	3000	1864.11
Cape Verde-St. Paul	1700	1056.33
St. Paul-Pernambuco	1200	745.64
Pernambuco-Rio de Janeiro	2000	1242.74
Total	7900	4908.82

In consideration of the fact that a stop at Pernambuco represents considerable loss of time and money (as well as danger under certain weather conditions), it would be desirable to deliver the European mail for this port by means of special parachutes. Perhaps it would also be possible in most cases to take on the bags of mail

from this place for Europe without stopping. Whether this would answer the purpose, can be decided only after a careful determination of the amount of mail to and from Brazil.

Likewise, the locations of the terminal stations in Lisbon and Brazil must be regarded as provisional, since the final decision as to the best locations can only be reached after thorough investigation of meteorological and traffic conditions on the spot. It may be safely assumed, however, from the data already at hand, that it will be possible to find, both in the vicinity of Lisbon and of Rio de Janeiro, places where a double hangar 300 x 90 x 50 m (984.25 x 295.27 x 164.04 ft) and a mooring mast will satisfy the demands of regular traffic, the same as appears to be the case for Seville, after the investigations made by the Zeppelin Company in southern Spain. For the sake of completeness, however, it is proposed to investigate the economical influence of revolving or circular hangars on transatlantic airship traffic, although such expensive installations, which might be necessitated by the weather conditions in North America or in certain traffic centers of Europe, do not appear to be required, even for regular traffic, in the case under consideration.

On the contrary, it would be going beyond the permissible limits, even in this very general calculation, to proceed on the basis of substituting mooring masts in place of hangars at both terminals or either one of them, as is being contemplated in the latest British plans for air traffic with India. Notwithstanding all the progress made in the construction of storm-proof airships, it would still be

rather presumptious to regard airship hangars simply as "docks" for the airships while being overhauled after many weeks' flight. We are not denying the possibility of development in this direction, especially since the experiments (begun in England and now being continued in America) with mooring masts for large rigid airships seem to confirm the hopes of the British airship pilots.

The completely equipped transatlantic airship ports in Portugal and Brazil, including double hangars, mooring masts, workshops, gas-works, radio stations, and dwellings, would probably cost $10000000. The sinking fund, and insurance for the stationary structures may be set respectively at 5% and 1/3% annually.

If, on the other hand, both terminals of such an airship line should be equipped with revolving hangars in conjunction with stationary hangars or possibly with circular hangars (of 300 m (984.25 ft) diameter), the cost would be increased to 18 or 25 million dollars, thus unfavorably affecting the profitableness of the whole undertaking.

The flight-times between Lisbon and Rio de Janeiro were calculated on the basis of the prevailing winds as given in the following table. Thus, with an airship speed of 110 km (68.35 mi) (60 nautical miles) per hour, it would take 2 days 17 hours to fly from Lisbon to Rio (in a southwesterly direction) and 3 days 9 hours for the return. An average flight-time of 75 hours (3 days 3 hours) would mean an average fuel consumption of about 36 metric tons (79366 lb).

Stretch	Distance		Wind		Time in hours	
	km	mi	Going	Coming	Going	Coming
Lisbon-St. Paul	4700	2920.43	N.E. trades +6 m/sec +19.68 ft/sec	N.E. trades -6 m/sec -19.68 ft/sec	35	52
St. Paul - Rio de Janeiro	3200	1988.38	S.E. trades -1 m/sec -3.28 ft/sec	S.E. trades ± 0 m/sec ± 0 ft/sec	30	29
			8 m/sec 26.25 ft/sec	lateral		
Totals	7900	4908.81			65	81
Fuel consumption in metric tons					32	40
Fuel consumption in thousand pounds					70.5	88.2

Under the above conditions, the probable costs per trip may be estimated as follows:

Starting and landing	$ 500
Fuel and oil (at $100 and $333 per ton, respectively), (at $98.4 and $328 per English ton respectively),	5000
Hydrogen (at 10¢ per cubic meter (1.076 ¢/cu.ft),	5000
Operation (90 persons for 3 days),	1500
Total	$12000

The annual costs for 100 trips would amount to 7.5 million dollars, as follows:

Operating costs for 100 trips at $12000 =		$1,200,000
Upkeep		1,500,000
Salaries		1,000,000
Miscellaneous		500,000
Sinking Fund (Amortization):		
Airports 5%	$ 500,000	
Airships 50%	2,100,000	2,600,000
Insurance:		
Airports 1/3%	35,000	
Airships 12%	500,000	
Personnel	165,000	700,000
	Total	$7,500,000

The required capital would be distributed as follows:

2 complete airports	10,000,000
3 airships - 135000 m^3 (1453113 cu.ft), 9 engines, 40 passengers) at $1,400,000	4,200,000
Operation	2,800,000
Total	$17,000,000

A South American line, requiring terminals with revolving or circular hangars for the maintenance of regular service, would need a capital of 25 to 32 million dollars and, since the greater expense for amortization and insurance would increase the operating expenses from 7.5 to 8 or 8.3 million dollars, it would hardly be possible

under such conditions, to make a profit with reasonable fares and freight rates.

In the special case under consideration (Lisbon-Rio de Janeiro), it is of prime importance as to whether the estimated investment of 17 million dollars would yield dividends and how large. In the following table, annual estimates for 100 trips are given for the two cases: A, with complement of passengers and freight; B, with 3/4 complement. The lucrative load consists of passengers, letters, newspapers, freight and baggage.

Complement	Passengers No.	Passengers wt.	Letters	Newspapers & freight	Baggage	Total tons
A 1/1	4000	600 t	30 million 600 t	600 t	100 t	1900 t
B 3/4	3000	450 t	22.5 million 450 t	450 t	75 t	1425 t

The transportation charges for passengers, letters and cargo (newspapers, freight and baggage) are graded in the ratio 13 : 10 : 5. On this basis, the following table combines three schedules, starting respectively with 1000, 1500 and 2000 dollars single passenger fare.

Schedule	Single trip	Letters per 20 g	Letters per oz	Freight per kg	Freight per lb	Baggage per kg	Baggage per lb
I	$1000	10¢	14.18¢	$2.50	$1.13	$2.50	$1.13
II	1500	15	21.27	3.75	1.70	3.75	1.70
III	2000	20	28.35	3.75	1.70	5.00	2.27

The above schedules would yield the following gross receipts,

from which the net profit and the dividends earned on the capital are computed.

A. Yearly income (100 trips), in millions of dollars, with full cargo.

From	Schedule I	Schedule II	Schedule III
Passengers	4.00	6.000	8.0
Letters	3.00	4.500	6.0
Freight	1.50	2.250	3.0
Baggage	0.25	0.375	0.5
Totals	8.75	13.135	17.5
Net profit, with 7.5 million dollars annual operating expenses, ...	1.25	5.6	10
Dividends (%)	7.5	33	59

B. Yearly income (100 trips), in millions of dollars, with 3/4 cargo:

From	Schedule I	Schedule II	Schedule III
Passengers	3.000	4.5000	6.000
Letters	2.250	3.3750	4.500
Freight	1.125	1.6875	2.250
Baggage	0.180	0.2800	0.375
Totals	6.555	9.842	13.125
Net profit	--	2.34	5.63
Dividends (%)	--	13.50	33.00

The ton-kilometer cost on this line (7900 km - 4909 mi) may be used for making rough estimates of the cost of transportation on other lines. Such estimates would naturally apply only under similar conditions and for long distances (5000 to 10000 km - 3107 to 6214 mi).

Charges for transportation, in dollars:

Per ton-kilometer			
Schedule	I	II	III
Passengers	0.84	1.12	1.68
Letters	0.63	0.95	1.26
Freight & Baggage	0.315	0.475	0.63

(2240 lb-ton) Per ton-mile			
Schedule	I	II	III
Passengers	1.374	1.831	2.747
Letters	1.030	1.553	2.060
Freight & Baggage	0.515	0.777	1.030

The airship passenger fares and freight charges of schedule II which afford a comparison with sea ships, when the great saving in time (3 days instead of 2 weeks) is considered, would therefore guarantee annual dividends of 13.5 to 33% on an investment of 17 million dollars. With schedule III, the profits would be still larger, so that even the above-mentioned larger investments of 25

or 32 millions would yield good dividends: 20-38% with revolving hangars ($25,000,000 capital); or 15-28% with circular hangars ($32,000,000 capital). It is hard to tell how high the charges could be raised without repelling patronage at the start. This article is only intended to demonstrate that airship traffic between Europe and South America is economically feasible, even with the very large capital investment necessitated in any event. Its technical possibility would hardly be questioned today, since in the fall of 1919, a regular daily airship traffic was maintained between Berlin and Friedrichshafen (on Lake Constance) with only one small airship and under considerably less favorable weather conditions.

The establishment of rapid transatlantic airship service presents not only a bold technical problem, but also an exceedingly important economical problem, in which the capitalists and governments of all countries should take an interest, especially since notwithstanding all the improvements in the construction of swift sea-going vessels, there appears to be no possibility of even approaching the short flight-times, over such broad ocean expanses, now attainable by airships. Moreover, it is still doubtful as to whether giant airplanes can afford the requisite safety for the transportation of passengers in non-stop flights of 5000 to 10000 km (3107 to 6214 mi).

Accurate data regarding the amount of mail between Europe and South America would be of the greatest importance in determining whether the 600 tons (1322772 lb) annual mail (30 million letters of 20 grams (.7055 oz) each), estimated for the Lisbon-Rio de Jan-

eiro line, exceeds or falls below the actual amount, which does not appear unlikely, when we consider that during the past year the American aerial mail carried over 50 million letters on the Continent alone.

Perhaps at first the profitableness of airship traffic over long distances will depend less on transportation of passengers and more on carrying the mail, especially if aided by thoroughly justifiable government subsidies for the stationary structures of the airports, such as have been already guaranteed by Spain and Argentina for the contemplated airship line between those two countries.

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