AIR TRANSPORTATION SYSTEM FOR SHIPPING OUTSIZED CARGOES

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Abstract

Among the equipment manufactured by various branches of industry there is a class of bulky heavy products Reactor cases, turbine rotors, colomns for refineries etc. are examples of these products. At present similar cargoes are carried by ground-water means of transportation, which requires much delivery time, the necessity for dividing cargoes into parts and provision of trans-shipment bases. Advantages of utilizing for these purposes an air transportation system consisting of airplanes with 500t cargo capacity and helicopters capable to lift 250t of payload are analysed. The utilization of such a system shortens the delivery time up to some days, eliminates the necessity for dividing cargo into parts with subsequent assembling it and the need to provide trans-shipment bases, speeds up installation work using crane helicopters.

At present a characteristic feature of the technology evolution and one of the determining factors of the progress in the fields of energetics, oil-gas refining, chemical industry, mineral fertilizer production, metallurgy and some other industrial branches of many countries are increase in unit power of the equipment and the desire to achieve a maximum degree of subassemblies readiness, converting the process of construction into the process of mounting enlarged blocks to reduce the production cost and cut the cost price.

A systematized analysis of the demand of our country national economy for transportation of heavy, large size freight made it possible to forecast the amount of transportation, their routes and overall dimensions and weights of the equipment which cannot be delivered by the ground means of transportation. Fig.1 gives some examples of oversized cargoes such as reactor case of 11m in length and 300t by weight, a turbine rotor of 14m in length and weighing 200t and other equipment. At present heavy cargoes are carried almost exclusively by ground means of transportation: railway, motocar and ship.

Stringent limitations on cargo sizes imposed by the railway transport, availability of numerous (some thousand) bridges not allowing high loads on axis, presence of tunnels in some mountain regions considerably reduce the nomenclature of the cargoes to be delivered by railway.

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AMONG CIVIL EQUIPMENT UNITS MANUFACTURED BY VARIOUS INDUSTRIES THERE IS A CLASS OF OVERSIZE HEAVY PRODUCTS

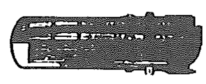
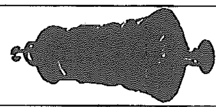
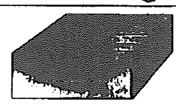
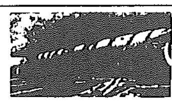
ITEM		BASIC DATA		
REACTOR CASE		DIAMETER LENGTH WEIGHT	m m t	5,28 10,88 306
TURBINE ROTOR OF ATOMIC POWER PLANTS		DIAMETER LENGTH WEIGHT	m m t	4,5 14,0 200
CONDENSER		WIDTH HEIGTH LENGTH WEIGHT	m m m t	12,0 8,0 10,0 500
COLUMN FOR OIL REFINERY PLANTS		DIAMETER LENGTH WEIGHT	m m t	45 60,0 300

Fig.1

The primary drawback of Russian inner water transport is a relatively short period of navigation and the meridian direction of its rivers.The only way of communication between rivers of Siberia and Far East is the North Sea way with all difficulties of navigation and long duration of cargo delivery.

Use of motor transport for delivering heavy cargoes is associated even in the most favourable cases with the necessity of a radical route reconstruction: widening some road legs,strengthening bridges,providing crosses etc.In many cases there are simply no motor roads.

Because of large extension of sea and river routes the actual range of delivering heavy outsize cargoes by a combined water-motor transport exceeds the distance between the manufacturer and the customer along a straight line by 3-5 times.There arises the necessity for division of especially large units into smaller parts with subsequent assembling,arrangement of trans-shipment bases,erection of temporary structures and roads.All these factors significantly increase the delivery time and cost.The stated shortcomings of traditional transport means together with the growth of demand for shipping large size cargoes give rise to the problem of widening the use of air transport for similar deliveries and increasing its effectiveness.

Considered is an air transport system involving airplanes and helicopters(Fig2). The cargo is supposed to be delivered from the plant-manufacturer to the nearest airport by any suitable transport means - - motorcar,water or air capable of performing vertical takeoff and landing. The delivery of cargoes from the departure airport to the airport of destination would be carried out by airplanes.Cargo transportation from the destination airport to the customer would be performed mainly by helicopters,since end points of cargo delivery routes are primarily in low developed and almost inaccessible regions of the country.

Transport system using aircraft and helicopters

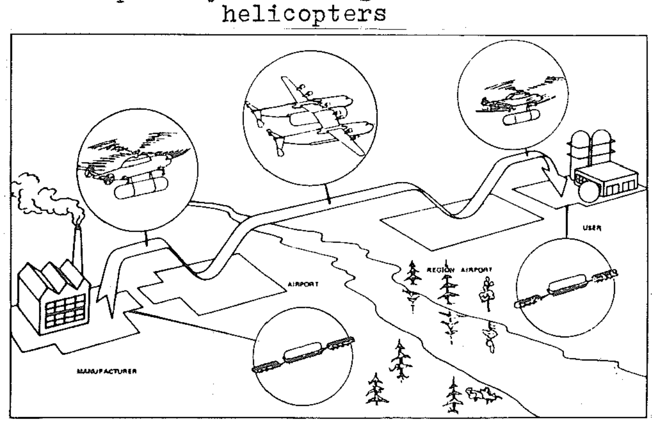


Fig.2

Available transport high-payload airplanes such as IL-76,An-124 and An-225 (Fig.3)could be used for transportation of heavy large size cargoes.The An-225 with the largest cargo capacity can carry freight weighing up to 250t.The configuration of an airplane with cargo capacity up to 500t and takeoff weight of 1200 - 1300t is being developed.One of the concepts for this airplane is presented in Fig.4.This is an airplane with the wing of large aspect ratio(λ =7,5 - 9,0) and external suspension of a monocargo below the wing,which enables loading/unloading operations at the airfield and, if

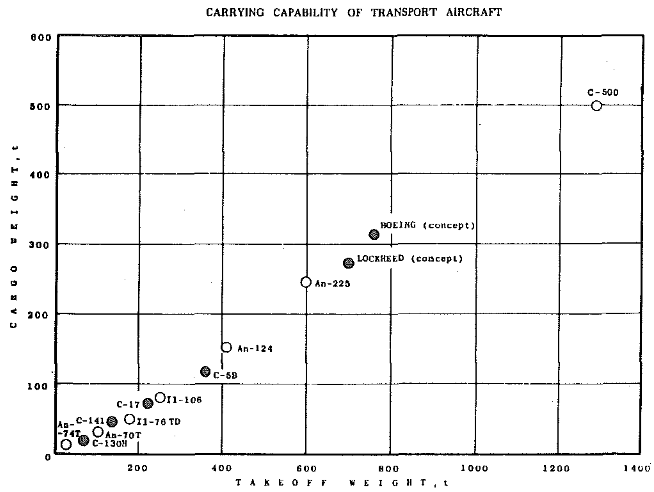


Fig.3

necessary, dropping it in flight without violating the center-of-gravity position. A multiwheel undercarriage is supposed to be used, simultaneously the possibility of using a cushion undercarriage is being investigated. Installation of eight engines with thrust up to 45t each is foreseen. Main characteristics of the airplane are tabulated in Fig.5.

BASIC AIRCRAFT PERFORMANCE

TAKEOFF WEIGHT	1300 tons
POWER PLANT: - THRUST	8 TURBOFANS 8 x 441kN
CARGO WEIGHT	500 tons
RANGE	3000 km
GROUND SRENGTH: - with multileg gear - air-cushion gear	 6 kg/cm^2 2 kg/cm^2

Fig.5

Within the flight range of 300km the cargo capacity of the airplane being developed is higher by a factor of 2 as compared to the An-225, more than three times superior to the An-124 and the USA

AIRCRAFT WITH UNDERWING MONOCARGO OF 500 TONS ARRANGED ON STORES

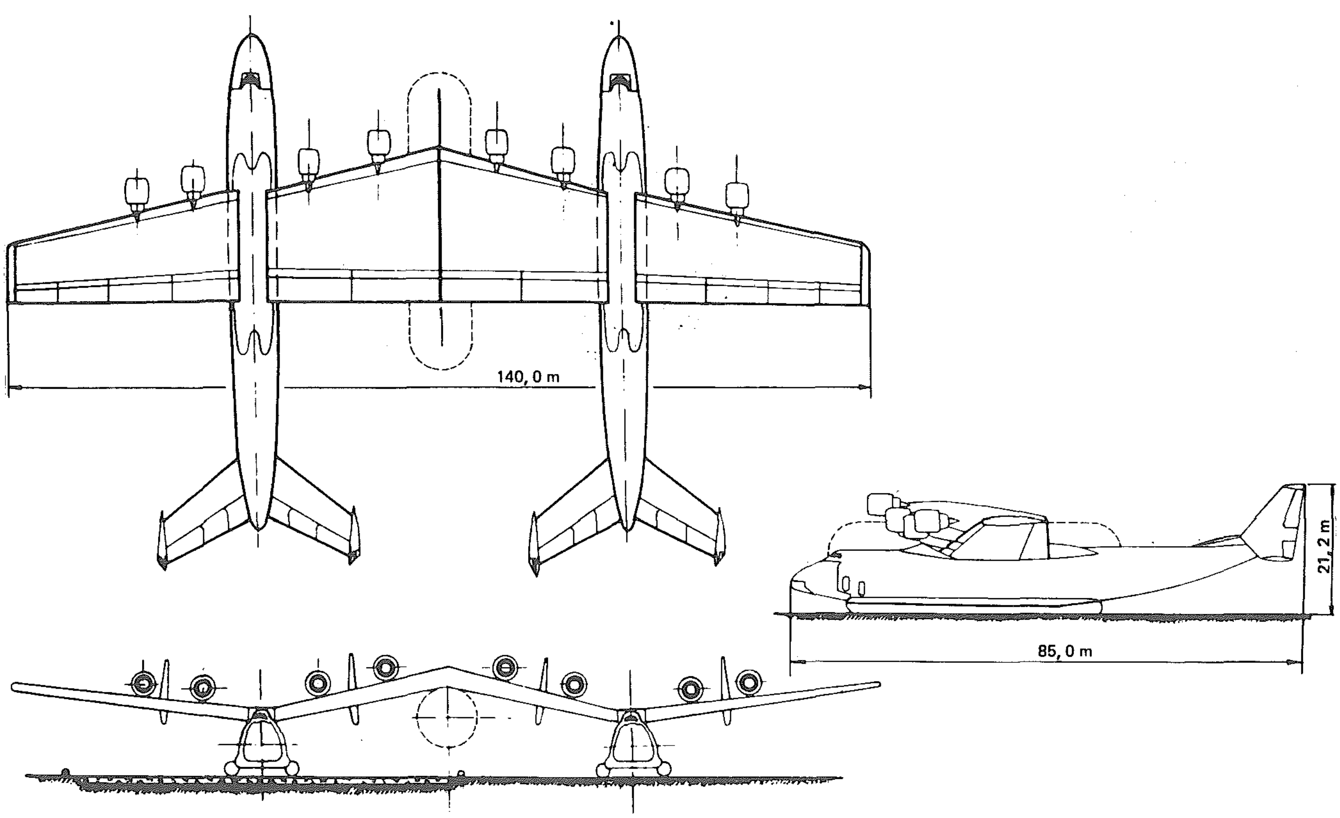


Fig. 4

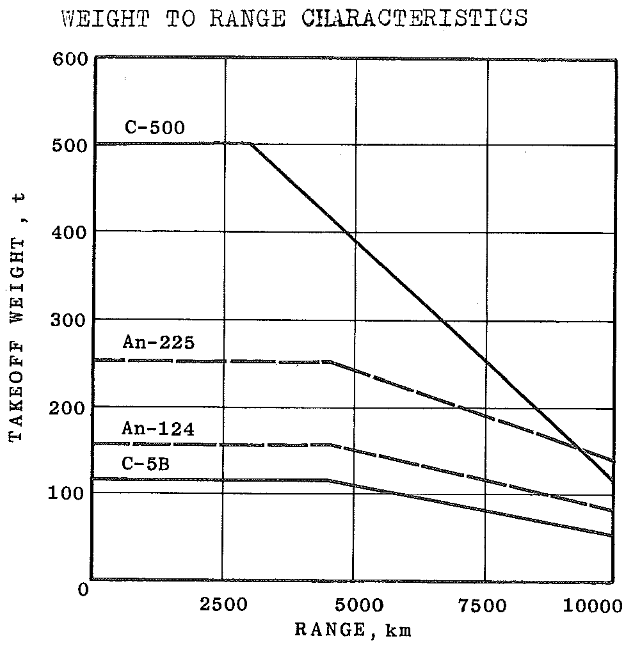


Fig.6

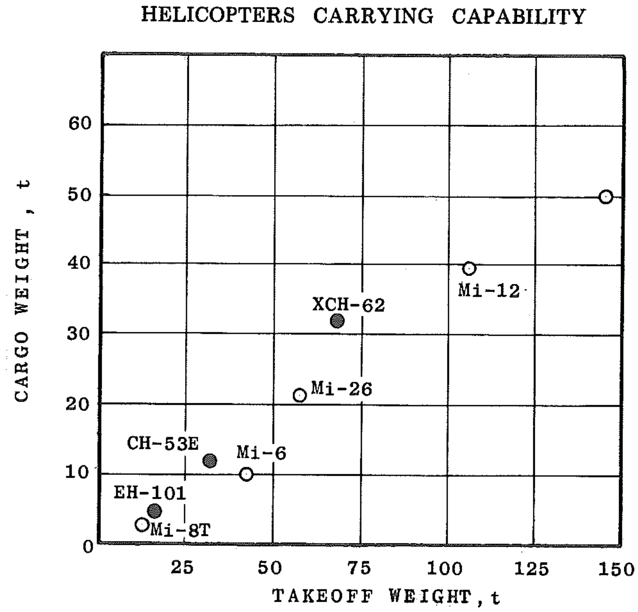


Fig.7

C5B(Fig.6).Among production helicopters the Mi-26,which has the highest cargo capacity could be used for transportation of large size cargoes (Fig.7).Being intended for delivering cargoes and facilities weighing up to 20t it could be used during construction of bridges, boreholes and electric power lines in regions difficult of access. The development of an advanced helicopter with lift capacity of 50t is being carried out. It can be created both by advances in the cargo capacity of a conventional single-rotor configuration and through using several (3 or 4) lifting modules with dimensions already realized by industry.

Creating within the present state-of-the-art a helicopter with cargo capacity of 200-250t is a problem of principle. In this case it is necessary to search for unconventional approaches and new technology solutions. As one of the versions the layout of a helicopter with a large number of main rotors-modules, forming in total a lifting surface has been studied. Another opportunity is the development of a super-heavy crane-helicopter with the main rotor driven by turbojet engines popositioned on the blade tips (Fig.8).

The following features differ the design under consideration from a conventional one:

- there is no primary gearbox;
- there are jet engines on blade tips;
- the fuselage has no cargo bay and its volumes are used for fuel tanks;
- there is a hingeless main rotor of large diameter;
- the main rotor is controlled by servo-flaps;

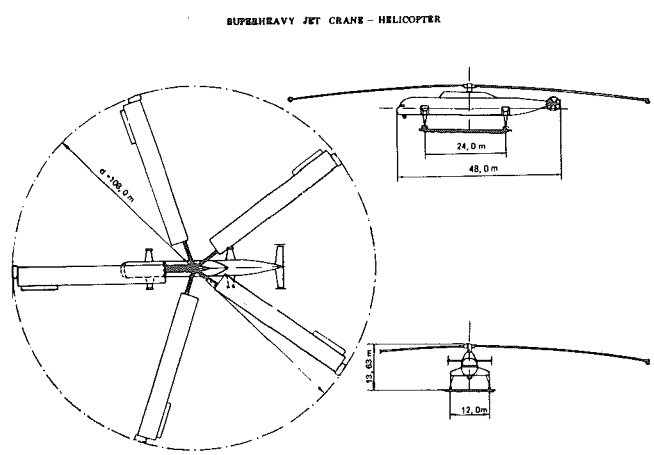


Fig.8

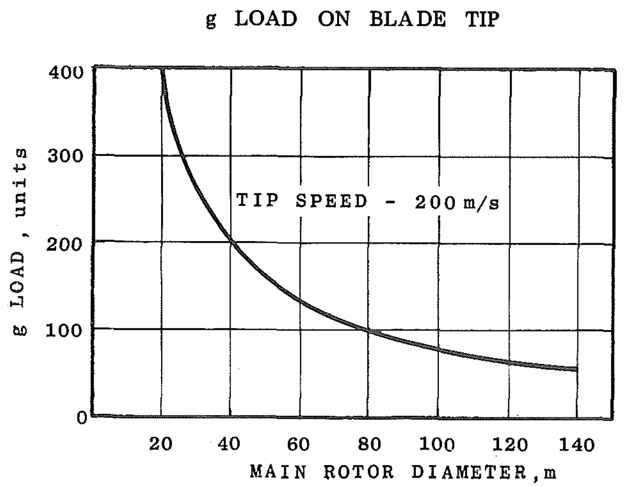


Fig.9

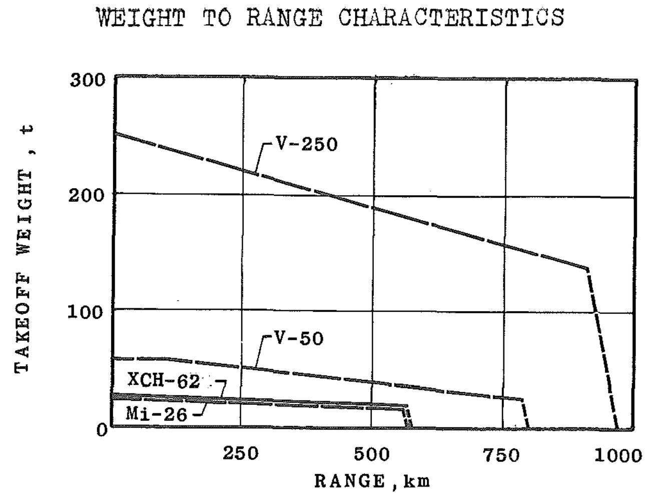


Fig.11

It is known that one of the obstacles in the way of creating a helicopter with rotor jet-drive is high centrifugal acceleration of blade tips, which complicates the operation of engines. The blade tips acceleration factors of a large diameter rotor reach acceptable values n =70(Fig.9), at which normal operation of engines is possible. Main characteristics of the heavy jet helicopter are presented in Fig.10.

Fig.11 shows diagrams of cargo capacity versus flight range for the production Mi-26 helicopter and advanced XCH-62 (USA), V-50 and V-250 helicopters under development.

BASIC HELICOPTER PERFORMANCE

TAKEOFF WEIGHT	500 tons
ENGINE NUMBER AND THRUST	5x112,75 kN
CARGO WEIGHT: - maximum - with 400 km range	 250 tons 200 tons
CRUISING SPEED	210 km/h
SPECIFIC FUEL CONSUMPTION	0,63 kg/t·km

Fig. 10

An analysis of a route network for transportation of bulky heavy production equipment by an advanced air transport system allows one to choose some main regions, where traffic is the most intensive (Fig.12).

Regions of Siberia, the North and Far East are characterised by widely spaced airfields, which could be utilized as airports of cargo delivery. Therefore populated points with airports could be considered as the centers of regions (six in Fig.12), while subsequent deliveries would be accomplished, as was stated above, by helicopters or ground/water transport provided appropriate conditions exist. Meeting the demand for transportation of heavy bulky cargoes foreseen by the year 2000 would require 40-45 aircraft of all types including 9 C-500 airplanes with cargo capacity of 500t and 30-35 helicopters including 12 V-250 helicopters of 250t cargo capacity. Undoubtely there exist similar needs for transportation of heavy bulky cargoes in other countries and it would be expedient to carry out an analysis in order to investigate the possibilities of creating a worldwide air transport system. Joint efforts would make it possible not only to reduce the time of creating the system, but also to increase its economical efficiency owing

MAJOR ROUTES FOR HEAVY-BULKY EQUIPMENT TRANSPORTATION TO SIBERIA AND MIDDLE ASIA REGIONS

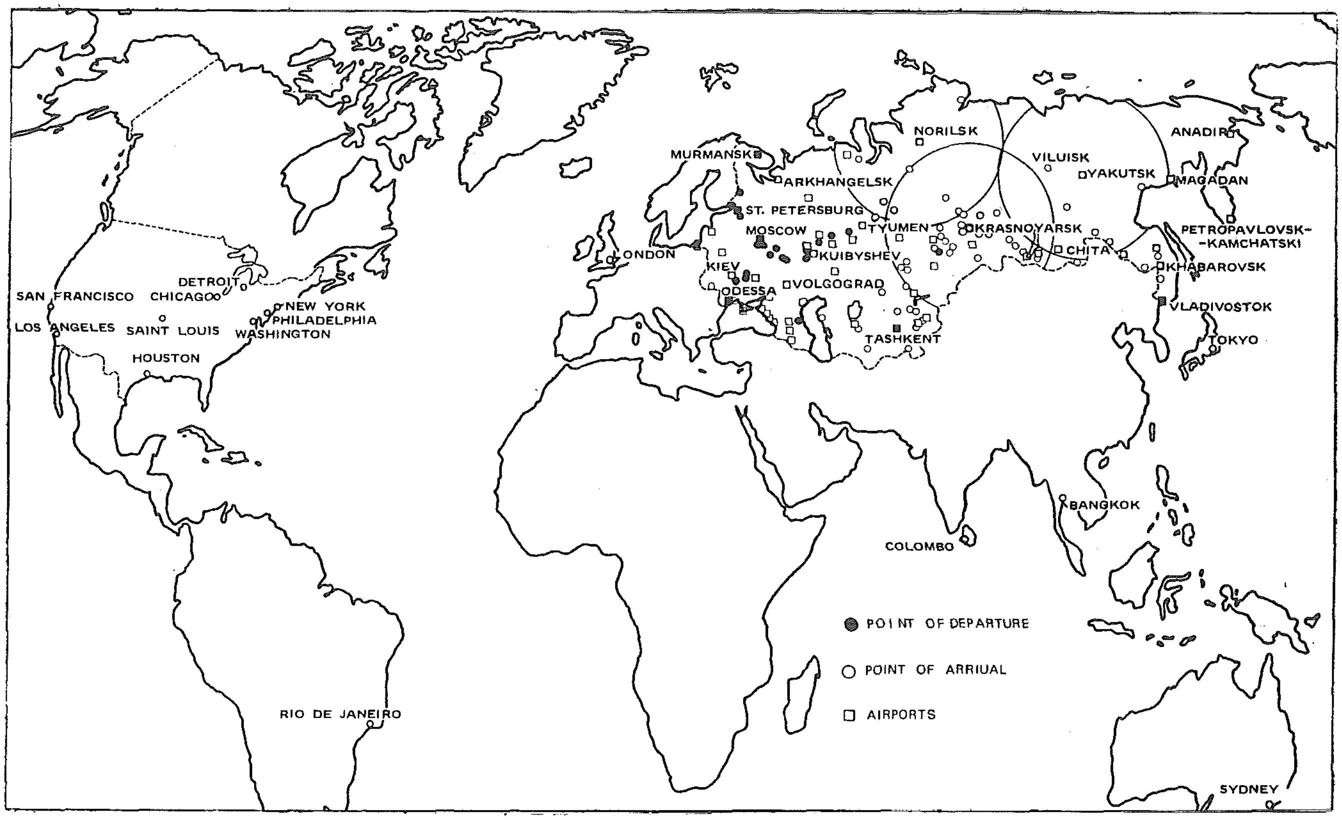


Fig.12

to increasing the quantity of aircraft and helicopters to be produced.

The efficiency of the advanced transport system could be estimated by comparison of expenditures for its creation and operation with those for freight delivery by ground-water transport (Fig.13). The annual expenditures shown for air transport incorporate investments and operational cost.The expenditures for the ground system include not only these two cost components but also the expenditures associated with the equipment reassembly due to its division into smaller parts and losses connected with the idle time cargo cost because of a long period of transportation cost in Russia appears to be lower by a factor of two as compared to ground-water transport and this difference in cost could be considered beneficial for national economy.

National economy benefit of using air transportation system

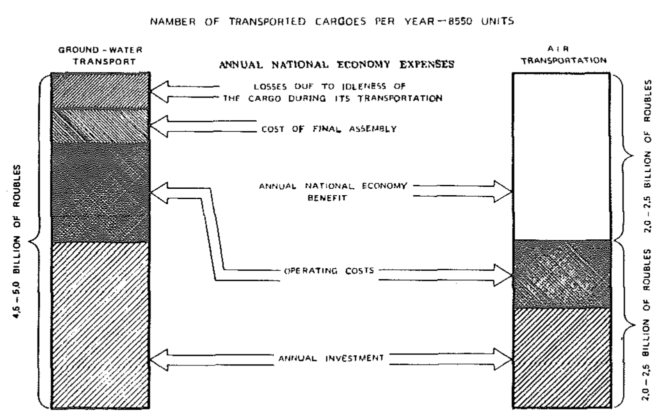


Fig.13