

AD-A039 206

FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO
EKRANOPLANS ARE WINGED SHIPS OF THE FUTURE (U)
OCT 76 D PIPKO

F/G 13/10

UNCLASSIFIED

FTD-ID(RS)T-1432-76

NL

1 OF 1
ADA039 206



FTD-ID(RS)T-1432-76

①
NW

AD-A039206

FOREIGN TECHNOLOGY DIVISION



EKRANOPLANS ARE WINGED SHIPS OF THE FUTURE

by

D. Pipko



DDDC
RECEIVED
MAY 11 1977
D

Approved for public release;
distribution unlimited.



UNEDITED MACHINE TRANSLATION

FTD-ID(RS)T-1432-76

26 October 1976

FTD-76-C-001081

EKRANOPLANS ARE WINGED SHIPS OF THE FUTURE

By: D. Pipko

English pages: 39

Source: Nauka i Zhizn', Nr 1, 1966, PP. 33-41
and 32b.

Country of origin: USSR

This document is a machine aided translation.

Requester: FTD/PDXS

Approved for public release; distribution un-
limited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	sin ⁻¹
arc cos	cos ⁻¹
arc tg	tan ⁻¹
arc ctg	cot ⁻¹
arc sec	sec ⁻¹
arc cosec	csc ⁻¹
arc sh	sinh ⁻¹
arc ch	cosh ⁻¹
arc th	tanh ⁻¹
arc cth	coth ⁻¹
arc sch	sech ⁻¹
arc csch	csch ⁻¹
—	
rot	curl
lg	log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	<i>А а</i>	A, a	Р р	<i>Р р</i>	R, r
Б б	<i>Б б</i>	B, b	С с	<i>С с</i>	S, s
В в	<i>В в</i>	V, v	Т т	<i>Т т</i>	T, t
Г г	<i>Г г</i>	G, g	У у	<i>У у</i>	U, u
Д д	<i>Д д</i>	D, d	Ф ф	<i>Ф ф</i>	F, f
Е е	<i>Е е</i>	Ye, ye; E, e*	Х х	<i>Х х</i>	Kh, kh
Ж ж	<i>Ж ж</i>	Zh, zh	Ц ц	<i>Ц ц</i>	Ts, ts
З з	<i>З з</i>	Z, z	Ч ч	<i>Ч ч</i>	Ch, ch
И и	<i>И и</i>	I, i	Ш ш	<i>Ш ш</i>	Sh, sh
Й й	<i>Й й</i>	Y, y	Щ щ	<i>Щ щ</i>	Shch, shch
К к	<i>К к</i>	K, k	Ъ ъ	<i>Ъ ъ</i>	"
Л л	<i>Л л</i>	L, l	Ы ы	<i>Ы ы</i>	Y, y
М м	<i>М м</i>	M, m	Ь ь	<i>Ь ь</i>	'
Н н	<i>Н н</i>	N, n	Э э	<i>Э э</i>	E, e
О о	<i>О о</i>	O, o	Ю ю	<i>Ю ю</i>	Yu, yu
П п	<i>П п</i>	P, p	Я я	<i>Я я</i>	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
 When written as ë in Russian, transliterate as yë or ë.
 The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

GREEK ALPHABET

Alpha	Α α	α	Nu	Ν ν	ν
Beta	Β β	β	Xi	Ξ ξ	ξ
Gamma	Γ γ	γ	Omicron	Ο ο	ο
Delta	Δ δ	δ	Pi	Π π	π
Epsilon	Ε ε	ε	Rho	Ρ ρ	ρ
Zeta	Ζ ζ	ζ	Sigma	Σ σ	ς
Eta	Η η	η	Tau	Τ τ	τ
Theta	Θ θ	θ	Upsilon	Υ υ	υ
Iota	Ι ι	ι	Phi	Φ φ	φ
Kappa	Κ κ	κ	Chi	Χ χ	χ
Lambda	Λ λ	λ	Psi	Ψ ψ	ψ
Mu	Μ μ	μ	Omega	Ω ω	ω

10-09-76

hzhzh

1

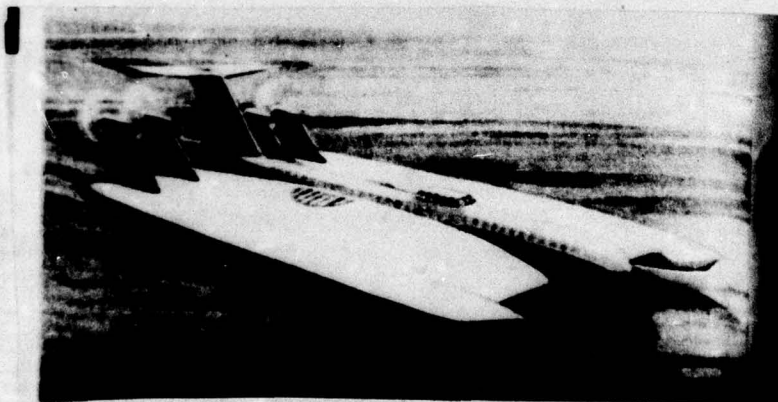
MT/ST-76-1432

~~DATA~~

SUBJECT CODE D4157

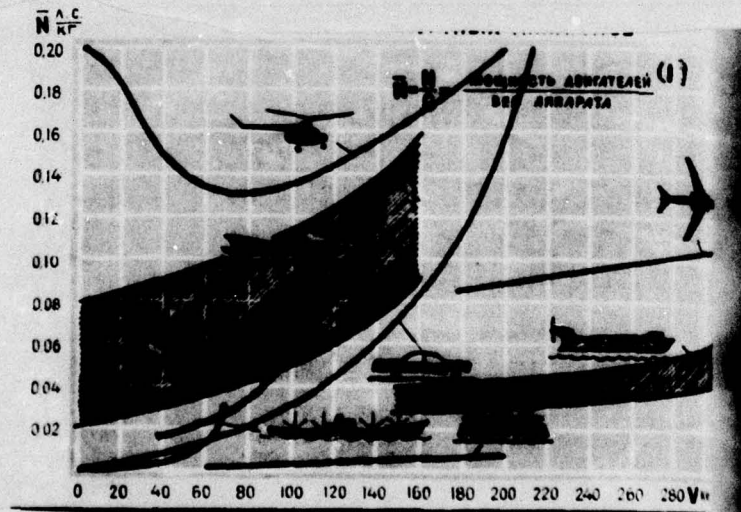
OK
3 KRANOFANS-WINGED SHIPS OF THE FUTURE.

Engineer D. Pipko.



FTD-ID(RS)T-1432-76

The required relative power of engines depending on the speed of motion for are different types transport apparatuses.



Key: (1). Power of engines the weight of apparatus.

10-09-76

hzhzh

3



FTD-ID(RS)T-1432-76

Without exaggeration it is possible to say, that the transport of the future is equal for the aviation: to avtstroiteli create the flying hovercrafts, railwaymaces - the expresses, skl'zyashchiye on aerolubrication. But especially vividly this succession of views is visible in an example of the water transport for which the problem of an increase in the velocity is a question "life and to mert'i".

Nct for whom it is no secret that under onset more the skorostnykhsopernikov of vodny the transport gradually loses bygone positions. It suffices to say that even on the transcontinental lines, where still recently he was considered monopolist, today almost 65o/o of the passengers give the preference of aviation and only remain 35o/o travel aboard of oceanic liners. This is the regular phenomenon: while jet aircraft will bear pasairov with a velocity of 800-900 kilometers an hour, mighty ships they measure the ocean at the "tortoise" velocities into 50-60 kilometers an hour. And to entire by fault the enormous resistance which experience/tests the immersed in water ships hulls.

With an increase in the velocity, this resistance increases first proportional to its square, but then rapidly gathers rate - increases proportional to the velocity in the third, fourth and even fifth degree. Here no longer is necessary to speak about fight for skorost'putem increases in the power of the engines: for this into engine plant, it was necessary to pevratit' entire ship. This is why

only with the advent of hydrofoils, which built up ships hulls above waves crest, ship-builders could overcome the cherished border of the commercial velocity on water into 100 kilometers an hour.

But hydrofoil ships not to end are released from contact with water, but main, with an increase in the size/dimensions of law courts, they noticeably lose their high quality. Therefore their nearest achievements on water routes ship-builders today link with aerokhodasi - to ships on air cushion, similar lowered recently to water to pyatidesyatimestnomu "Sormovichu". These flying expresses, capable of developing velocities to 180 and more kilometers in hour, another tol'k enter the life. And nevertheless in them already appeared terrible rival - the winged apparatuses, which obtained the name of ekranoplanov..

Majority of those which are develop/processed today in the different countries of the world of ekranoplanov at first glance differs little from the aerokhodov: will hold them above water all the same air cushion. but the principle of the creation of this cushion already entirely another. And in this the major advantage of the new means for water transport. Here it is appropriate to recall the differences between the helicopter and the aircraft: while the first it is held in air on the thrust/rod of its screw/propeller, which must be equal or more than to the weight of the apparatus itself, aircraft holds in air the lift of wings, and engines they provide only forward motion and their thrust/rod is equal

approximately the e0-evesa of machine.

Approximately so they differ the friend of otdruga and aerokhody with the ekranoplanami: of the first the air cushion is created by the continuously working fans, and of the second the power of engines is expended/consumed only on the overcoming of aerodynamic drag, and cushion (is more precise - lift) it is provided by wing. Hence the same advantages that and of the aircraft before the helicopter: less powerful and heavy dvigatel'ya is installation, the lowered/reduced fuel consumptions, more vysokayapoleznaya load and finally the possibility with other ravsloviyakh to obtain higher flight speeds (see curve/graph n4-y page of colored inset). The design/projected already segodn ekranoplav, figure of one of which is given there, will spsobny accept on board several hundreds of pasazhirov or dozen tone of the load and supply them through the ocean with speeds to ¹⁸⁰⁻²²⁰ kilometers an hour. But in the future of the speed of similar machines in printspe they can grow to 300 and even 450 kilometers an hour.

The phenomenon, placed as the basis of the principle of the dvizheiya of ekranoplanov, is known already more than forty years. Even at the glow of aviation, in the middle of the twentieth years, the specialists focused attention on the strange behavior of the wings of aircraft during the motion of the uzemli: in spite of all laws of classical aerodynamics, they created large lift, than at remaining height/altitudes pole/

Page 34. To perceive entire significance of this phenomenon it was necessary almost immediately: it served as one of the reasons for the emergency of the heavy aircraft of the "Terent of Tripleyn". But later a little time in almost so unpleasant a situation with it clashed the designers of the English aircraft to "Suollou".

Light/lung monoplane to the "Suollou" of pednaznachalsya for a sale to the pilot-amateurs and for the sake of simplicity in the piloting is bygone is equipped by sufficiently large wing. This machine possessed fair flight characteristics, but already during tests in it, was reveal/detected disadvantage - it thrust did not desire to make a landing. It is more precise, to make a landing according to rules. Accomplishing technique landing at that time in principle differed little from the contemporary: after maintain/withstanding aircraft in gliding flight in two-three meters from the Earth, pilot gradually geared down to the value by which the lift of wings staovilas' less than the weight of machine, but still it made it possible for it to smoothly sparashyutirovat' to landing strip. Aircraft "Suollou" continued to plan/glide almost to the total loss of speed. Here lift, it is natural, instantly fell almost to zero, and aircraft roughly slapped itself to the earth, causing in the pilot of perception in any way from pleasant.

The "insidious" behavior of aircraft was explained whole by that phenomenon of a unforeseen increase in the lift of the Earth. This

force held machine in air even when, according to all calculations, speed was bygone by clearly insufficient. Is removed this defect is bygone exactly as this is made on contemporary glider/airframes, aircraft they supplied with the landing flaps, allowing for the pilot at the necessary torque/moment was sharp to impair aerodynamics of wing and thereby to force machine to be lowered. But at the same time this precedent forced the scientists and koruktorov more vinimatel'no to study this phenomenon, obtain the name of the "effect of the effect of the Earth", or the "effect of the effect of screen". In the Tab the theoretical and experimental studies, carried out at the end of the twentieth - the beginning of thirtieth years, they showed that the "effect of the effect of the Earth" was caused by three pinami, by one of the ktorykh it is the appearing under wing air cushion. The driving above the earth/ground or any knoy surface (screen) wing seemingly pressed hearth itself relative wind, and under wing is formed high-pressure area (diagram 1 on 4-1 page colored inset). As a result on the force ΔY whose value depends on flight altitude N - the distance between the wing and the screen. When height/altitude N is equal to the half of wing chord V , lift increment composes a total of 2-30/o. But if wing is approached the earth/ground already to one fourth of chord length, then increase will increase to 100/o.

The given numerals can seem by those incomparable with the size/dimensions of those "trcubles", which supplied to the aviators the "effect of the effect of screen". But the fact is that along with the formation/education of air cushion screen causes even a change in

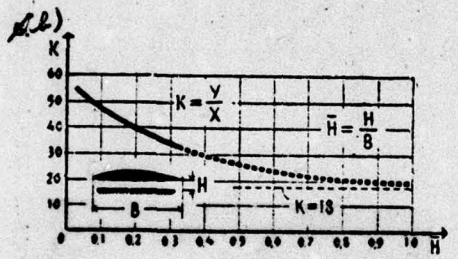
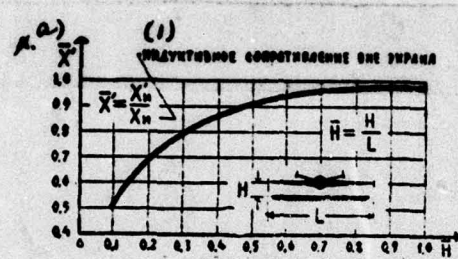
the entire flow pattern of wing of air flow. In this case, also occurs certain uveicheniye of lift and substantially descends drag, which is explained by the following two reasons.

It is known that if the rzmakh of wing is not infinite (but the latter can exist only in theory), then at its ends unavoidably appear "khvosty" from the strongly twisted air - the so-called end visri. The Istochnik of the emergence of the etikhkh of eddy/vortices is part of the air, which overflows through wing tips from under its lower surface where the pressure is higher, by upper (diagram 2 on 4-1 pages colored inset). Tip vortexes serve as one of the basic pichin of a deterioration in the aerodynamic characteristics of real wings in comparison with "ideal" infinite-span wings. Screen, as is evident in the diagram, partially "it destroys" these eddy/vortices, which with respect gives to an improvement in the aeyacdinamiki of wing.

The second reason for an improvement in the aerodynamic wing characteristics during motion of screen is connected with the process of lift formation - the latter is accompanied by drag divergence. This part of total resistance x whose emergence is connected with the formation/education of pod'yemny force, is called of the inductive reactance of X_{i} . The very "mechanism" of lift formation, figuratively speaking, lies in the fact that the wing reject/throws relative wind down, deflecting it to certain angle of α , called the downwash angle (diagram of 3 on 4-1 pages colored inset). On the value of this angle depends the inductive reactance: than it

more, that more and resistance. ~~Page~~ Altitude effect of the flight of H during the motion of wing near screen to the values of the inductive reactance of X_k and lift-drag ratio of K .

Key: (1). inductive resistance outside screen.



When the wing moves at screen, the latter seemingly reflected the downwash of air. In this case, the rake angle decreases, and together with it inductive reactance decreases to the value of X_{ind} .

The size/dimensions of an improvement in the aerodynamic characteristics in the last/latter two cases just as value of supplementary lift at obrazovani under the wing of air cushion, depend on flight altitude. Specifically, a reduction/descent in the inductive reactance with a decrease in the clearance (distance) between the wing and screen can be evaluated with the pomo'yu of the curve/graph of A to the right. On curve/graph it is evident that if the flight altitude of H composes 0.2 from the spread/scope of the wing of L , then inductive reactance becomes less almost to 30% . Even more boshchia is the given to the right curve/graph of B , constructed taking into account the formation/education of air cushion. On it the pckzano is the altitude effect of the flight of H on value, the so-called lift-drag ratio of K is one of the fundamental characteristics of all flight vehicles. ρ The lift-drag ratio of K - this is its kind the efficiency of the aerodynamic shape of flight vehicles. It pedstavlyaet in itself the ratio of the od'yenncy (useful) force of Y to the drag of X , for the overccwing ktorogo, strictly speaking, and is expended entire work of the dvigate'noy setting up of machine. If we compare, for example, two aircraft with identical weight, but the different values of quality, then better/best, it is natural, will be that of them at whose quality is above: producing the necessary (equal to weight) lift of this aircraft will be

connected with the overcoming of less drag, and therefore to this aircraft are necessary they will be the less powerful and heavy engines, which expend less than the fuel/propellant. But furthermore, pleznaya output/efficiency of aircraft with large lift-drag ratio will be above.

Of contemporary passenger the samoletc lift-drag ratio on the average is equal to 18. But if we now look to the curve/graph of ~~abz~~ **6**, then it is not difficult to note that with the very low vysotakhkh of flight, components less the 0.1 of the chord length of wing, the effect of screen becomes so considerable that the lift-drag ratio grows to **40-50**. There is no need to explain, how large advantages would give aviation the use of this effect. but for etogonuzhno to bygone "learn" aircraft, which is called, "to polzat'" at Earth itself. This "but" became that stumbling block, against ktoryy were divide/marked off all attempts to run the "effect of the effect of screen" on aviation.

Even today, when high-altitude aircraft "changed" the fourth ten kilometers, and rockets are fixed to the moon, the layer of the atmosphere, which lies in immediate proximity of the Earth, still remains not to end the subjugated zone. Of course, helicopters and aircraft successfully overcome it during takeoffs and landings. But only overcome. the prolonged low-level flight (flight on low vysoye) requires of the pilots of maximum of attention, resourcefulness, skill, the courages: is too capricious and cut the dandshaft of our

10-09-76

hzhzh 13

planet, are too insidious izmenniv the raging of its surface descending and up drafts, too few instants it remains here in the pilots to the restraint "vzbryknuvshikh" machines.

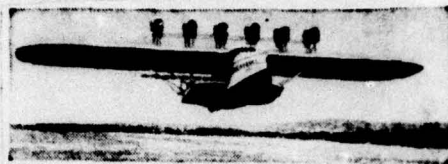
And nevertheless these difficulties could not eliminate the attempts to utilize an "effect of the effect of screen"; are very tempting tale promised to them prospects. one of such attempts, true, only with the partial use of an effect, undertook into ~~sb~~ 1932 to year the German aviation specialists.

10-09-76

hzhzh

14

Page 36.



Aircraft split to-x during the experimental flight above North Sea
(1932 are year).

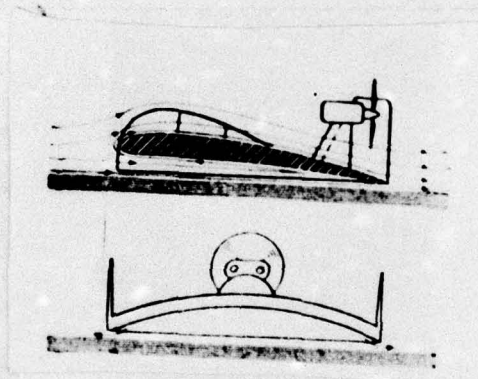


Diagram of the areosleigh-3kranoplana of construction Finnish engineer
T. Kaariyu.

On the curve/graph of Δ , the flight altitude of H not is randomly compared not with wing chord, but with its spread/scope; whole the fact is that the "destruction" of tip vortexes, but main, a decrease in the downwash angles are observed at height/altitudes considerably greater than necessary for formation/education under the wing of vozdshnoy cushion. this circumstance and blo used during the experimental flights of heavy German seaplane for Dorn'ye to-x: aircraft flew above North Sea at height/altitude of approximately ten meters, and in this case the fuel consumption proved to be less than during flights outside screen (photo above).

In spite of this success, the "effect of the effect of screen" so and not "got accustomed" in aviation. But already then, to the vseredine of thirtieth years, it accepted "upon armament" the designers of ground-based cross-country machines. By pioneers in this area became our compatriot, inventor Pavel Grokhovskiy, who proposed to utilize this effect in apparatus-amphibians, and Finnish engineer T. Kaario, that developed a series of the constructions of the flying areosleighs. These machines and tales by the prototype of those flying ships, ktorye obtained today the sonorous name of ekranoplanov.

The first areosleigh-3kranoplan, ostroyennye Kaario into 1935 to year, were engineless apparatus with wing-shaped korgusom and "chassis/landing gear" in the form of skis. First in vreya testing the apparatus moved yua buksireye after special areosleighs. Then to machine is bygone is established/installed small piston engine with pusher propeller, and it obtained possibility to move independently.

This apparatus began acceleration/dispersal on skis, and then, when the lift of housing became sufficiently large, it blew away from the Earth and slipped above snow cover on air cushion. During the subsequent years of T. Kaaric, constructed another a series of similar machines whose by basic aggregate/unit is bygone "wing-ram" - the wing, using velocity head of relative wind (diagram below).

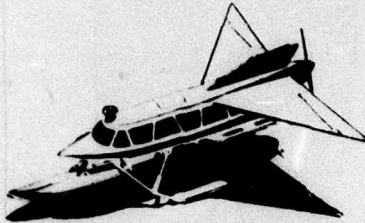
It cannot be said that following twenty five years would pass without leaving a trace by the developments of the idea of ekranoplanov - for these years the different designers in the different countries would create a whole series of the already more advanced machines. Would be undertaken the attempts at least to partially utilize an "effect of the effect of screen": for example the inventors G. Lipman and A. Morozov proposed project azrosaney with wing, the lift ktorogo must was bygone unload rear ski (Fig. on page of ~~37~~ 37). But already then it is bygone it is clear that the necessary effect wing can give only when it moves above the screen with sufficiently high speed - ~~150~~ 150 and more kilometers in hour. For a dry land these range in any way it is not possible to name safe: the inequality of relief, the stumps, hidden under snow stones and hummocks can lead to the emergency of the sliding of the Earth machine. Perhaps of all developed during many years ground-based apparatuses, which use during motion aerodynamic lifts, only areosleigh-amphibian, created into ~~KB~~ KB, headed by design project leader A. N. Tupolev, poluchli universal acclaim are constructed seriyno (photo in 4-1 pages colored inset). This is why "originated

10-09-76

hzhzh 17

in air" the idea of ekranoplanov again replaced "registration": from dry land - to water

Approximately at the end fiftieth - the beginning of the sixtieth years a series of firms and scientific organizations approached toward serious investigations in the field of producing ekranoplanov - oceanic liners.



Winged areosleighs, proposed by the Soviet inventors by G. Lipman and A. Morczovs (project).



Experimental boat-3kranoplan of the American firm "Lockheed" during tests.



Radio-controlled model of the ekranoplana of the English firm "Collins".

10-09-76

hzhzh 9 20

The last/latter tales are selected as the most promising object of study not randomly: large role here played the sad experiment of aviation in mastery by flight of the Earth. In order to simplify piloting technique winged ships and to avoid their "collisions" with sea waves, the designers attempt to ensure the sufficiently high altitudes of flight and at the same time to preserve the "effect of the effect of screen". Above has already been said that the effective flight altitudes depend on the size/dimensions of wing - its chord and spread/scope. But this means that to kill those which were indicated "two hares" possible only in one manner - by making large-size ekranoplany.

But, holding course of producing the enormous flying liners, the designers and the scientists thus far conduct investigation and experiments on models and small experimental launches. With one of the first such investigations began to carry out the American firm "Lockheed". In 1962 to year on it constructed that which fly boat-catamaran, equipped with five-meter wing with the airfoil/profile of large curvature (photo above). This wing is bygone established/installed in such a way that its leading edge was arranged/located highly above water, open/disclosing to air free "inlet" under wing, and rear, on the contrary, almost concerned the surface of water and thereby impeded the rapid discharge of air cushion. From the side the outflow of air from under wing it was restricted to two lowered down washers, ikreplennymi on the knsakh of wing. During tests, the boat was accelerate/dispersed similar to usual launch, and when airfoil lift it became sufficiently large,

10-09-76

hzhzh 20 →

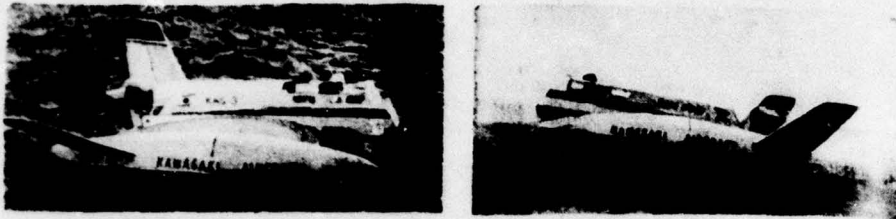
housing heaved above water, leaving in it only the screw propeller of suspension motor.

The similar diagram of apparatus with the wing, equipped with kntsevymi washers, used in the model of ekranoplana the English firm "Collins" (Fig. below). This model prednachatals' for the stability analysis of stability and controllability of winged machines and outwardly it reminded the aircraft of the diagram of "weft" - on to the nose of elongated forward from the wing of the fuselage of model was bygone was established/installed rotary stabilizer. With the aid of this stabilizer and the simplest uprvlyayushchego device in the form of pendulum, automatically was provided the so-called longitudinal stability of the machine: in direction nose - tail. When model nosed down down, pendulum it was deflected forward and in this case it turned stabilizer n larger angle of attack.

10-09-76

hzhzh 2/22

Page 38.



Experimental ekranoplan of the Japanese firm of "Kawasaki": to the left - to the time of apron, to the right - during road tests.

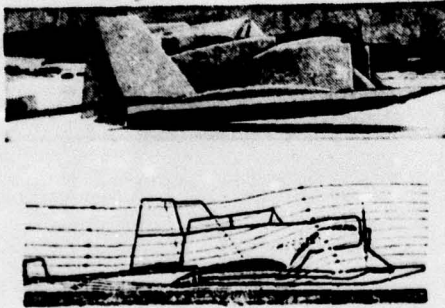


Photo and the diagram of T. Kaario's areosleigh-ekranoplana from povorotnm by the supplementary wing, which ensures the emergence of air cushion at the low speeds of motion.



Hypothetical figure of transport ekranoplana with turbojet engines for the uskreniya of acceleration/dispersal.

10-09-76

hzhzh 12 ~~24~~

Lift on stabilizer increased and returned the nose of apparatus to normal position. But if not, on the contrary, it was scored, then pendulum automatically decreased the angle of attack of stabilizer.

The "geography" of investigations in the field of producing ekranoplanov supplemented the Japanese designers of the firm of "Kawasaki" (photo above). In 1963 to year they initiated the tests of the dyadic/two-place winged apparatus, executed by the diagram of "trimarana" - during apron machine held on water three housing-floats. two of them tails are fastened on wing tips and played in flight the role of the washers, preventing the discharge of air from under wing. But in the third, central float was placed crew, and was bygone from behind was suspended the motor of apparatus. This ekranplan passed a series summer and winter tests both on calm water and during certain sea rating and showed the maximum speed into 85 kilometers an hour. *FP* The enumeration of experimental models and apparatuses it would be possible to continue it is further, if all they not tails are connected by their ultimate purpose - in their example the scientists and the designers attempted to trace ways to the resheiyu of basic to the problem of producing the ekranoplanov among which to central place occupies the problem of start. Above has already been said that the "effect of the vliniya of screen" comes into action with complete output/efficiency only at sufficiently high speeds. Slechovatel'no, thus far apparatus not dignet these speeds, its housing first completely, and then partially will be submerged in water, experience/testing in this case so high a resistance as and housings vodoizmeshchayushchikh law courts. The calculations show

10-09-76

hzhzh 23 25

that for the overcoming of this resistance to ekranoplanam will be required by power, several times that exceed those, that are necessary for a cruise.

The simplest solution to this problem lies in the fact that the engine plant of ekranoplana is divided by two is frequent - march, that ensures cruise, and starting. Since the latter will work only during comparatively short booster duration, in it can be used the engines with less reserves dolgovechnosti and, therefore, more light/long and cheaper, than the cruising "motors" of ekranoplana (Fig. below). After the apparatus will leave to the cruise setting of slip, booster engines, it is natural, they will be turned off by i. they will be converted into the source of additional drag. This circumstance forces the designers to stop its selection of the type of starting "motors" at engines turbojet or turbofan: they do not have screw/propellers which after the engine shutdown create high resistance. But furthermore, these engines more easily to make those which are being removing inside ship.

Of the method of start with the aid of special engine plant, there is one disadvantage: in order that the expenditure of the fuel/propellant of take minimum, acceleration/dispersal must be realized with high accelerations. There Are No Tekhicheskikh difficulties here, but to the passengers this start hardly will supply pleasure. Therefore the designers of ekranoplancv search for the today more comfortable and, it is natural, more economical methods of acceleration/dispersal, attempting in this case to utilize the different auxiliary devices, which make it possible for ekranoplanu to

10-09-76

hzhzh 24

build up housing above water earlier than it will achieve cruising skrostey flight.

A similar device it used in one of T. Kaaric its last/latter apparatuses (photo and diagram below to the left). Its machine with the arranged/located in front tractor propellor it supplied with two supplementary wings one of which bygone rotary. During acceleration/dispersal, this wing overlapped the slot between the upper supplementary and basic wings of ekranoplana, directing to under the latter part of the powerful flow from screw/propeller. In this case, the air cushion obrzovyvalas' under wing at comparatively low speeds, and resistance from contact with "runway" decreased. But after the apparatus of vysodil on the mode/ccnditions of ekranoplana, pivoting wing returned to horizontal position.

"pressurization/supercharging" from the screw/propellers of engines for the acceleration of the formation/education of the air cushion of ispol'zoali in its apparatus and the students of the Odessa institute of marine fleet (diagram to the right).



10-09-76

hzhzh 25 ~~33~~

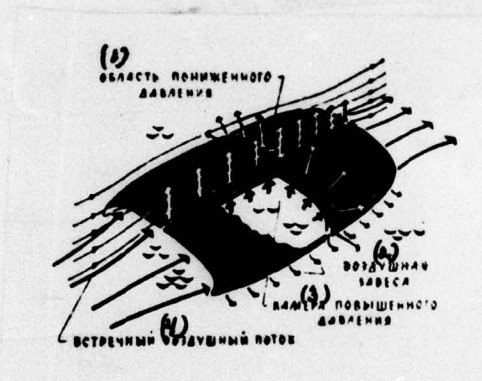
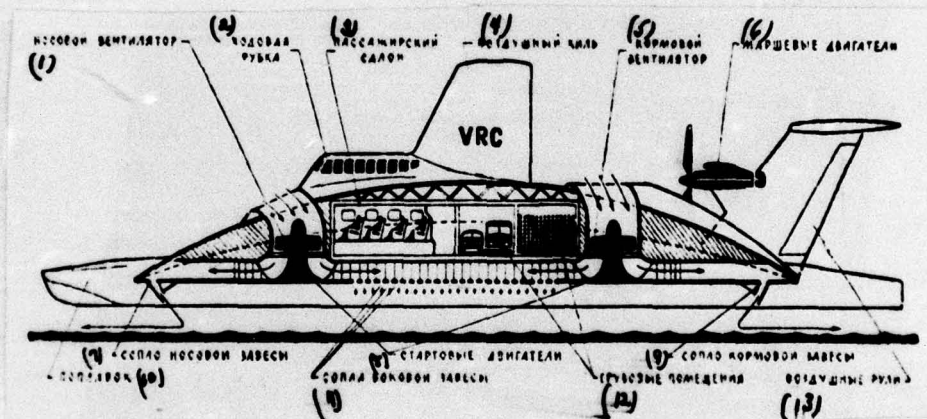


Diagram of the launch-cranoplane, created by the group of the students of the Odessa institute of marine fleet under the management/manual of N. Sviridenko, V. Farvarshchuka and instructor of Yu. Budnitskiy.

Key: (1). Area of reduced pressures. (2). Air curtain. (3). Plenum. (4). Contrary air flow.

Transatlantic cargo and passenger ekranoplan of "Kolumbiya": below - the general-arrangement diagram of apparatus; to the right - the diagram of the flow of air flow about the housing-wing during motion under the conditions of ekranoplana.

Key: (1). Forepart/nose fan. (2). Cargo chopping. (3) /. Passenger salon. (4). Air fin. (5). Feed fan. (6). Sustainer engines. (7). the nozzle of the noscvoi of curtain. (8). Booster engines. (9). the nozzle of the kormovoi of curtain. (10). float.) (11). the nozzle of the bokovoi of curtain. (12). cargo pomeshchniya. (13). to vzdushnye contrcls.



10-09-76

hzhzh 27

They created light/lung launch-3kranoplan which is driven by two motorcycle motors of K. Motory's ~~zh 60~~ "are cut into" to the leading edge of the main wing of apparatus hearth which enters part of the air, compressed by screw/propellers. Apparatus weighs a total of 350 kilograms and easily slips above water at a distance several dozen centimeters.

Of all apparatuses examined above exists one common deficiency/lack: to the discharge of air from under wing in them impede zhestike devices either in the form of floats or in the form of endplates. In order to bring together the pcyeri of air to the minimum, these "enclosure/protections" they must be arrange/located as close as possible to the surface of water. But hence unavoidable "collisions" with the waves whose impact/shocks will disturb the comfort of the passengers. To avoid this it is possible only in one manner - to supply the underwing air chambers of ekranoplanov with elastic "enclosure/protection". And here the locks of many designers turn to the principle which found wide application during the design of aerokhodov, to the principle of air curtain.

The tendency to organically connect up one machine the better/best qualities of aerokhodov and ekranoplanov is most vividly evident in an example of the transatlantic passenger apparatus of the "Kolambiya" whose project develop/processes the American firm of the "Viikl of Riserch" (diagram below). Apparatus is performed by the diagram of catamaran snesushchin wing-shaped housing, from ends of which down depart narrow floats. housing-wing they pierce two

10-09-76

hzhzh *28*

circular tunnels, in which are established/installed the fans, which feed air into circular slot on the perimetru of housing. During start this air forms under ship the air cushion which heaves the floats above water. Then in "work" are included march propeller engines, and ship it begins motion similar to usual aerokhodu. In this case, the escape/ensuing of circular slot vzdukh plays the role of curtain to the preventing air losses from under wing.

With the acceleration/dispersal of apparatus, high-speed/velocity naporvstrechnogo air otoka gradually reaches this value, which makes it possible "to turn off" the forward section of the air zaesy. The rear part of the curtain is retained still for a while, providing the accelerated filling of air chamber, but the vmoment of output/yield to cruise setting is disconnected and it. After this the power of ventilator setting up is expended only on the podderzhniye of the lateral curtains, which prevent the discharge of the compressed by wing air into sides, and apparatus it holds above water only the lift of its housing.

At first glance it can be shown that the ekranoplan of "Kolombiya", equipped with the special system of the formation/education of air cushion, differs little from its rivals - aerokhodov. On the matter itself this not thus. The power of ventilator setting up in this ship considerably less than it would be required for the osushchestveniya of the chistoaerokhodnogo principle of flight. in kreiserskcm mode/conditions use of the lateral curtains

10-09-76

hzhzh 29

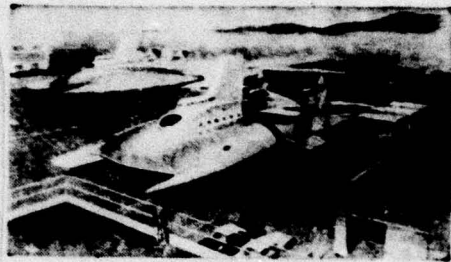
makes it possible to reduce to a minimum of the loss of air and thereby substantial to increase the thickness of the vozduy of the poduki of odes by wing. and one additicial advantage of this diagram: because of that created by fans to the air cushion of the ekranoplan of "Kolambiya" it will be able to emerge to dry land on inclined concrete flooring and to accomplish "landing" at those which were arrange/located sufficiently far from water of loading "moorages", where to it they will be are not terrible voleneniya at sea (Fig. on page of 40).

The Ekranoplan of "Kolambiya" is design/projected taking into account transportation 150 passengers or 36 tons of the load through the ocean with the speed of the 185-220 hzh of kilometers of hour.

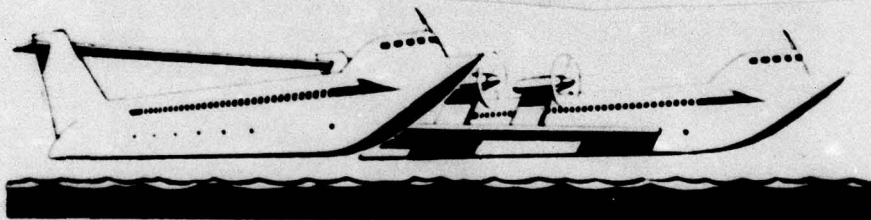
10-09-76

hzhzh 30 ~~2~~

Page 40.



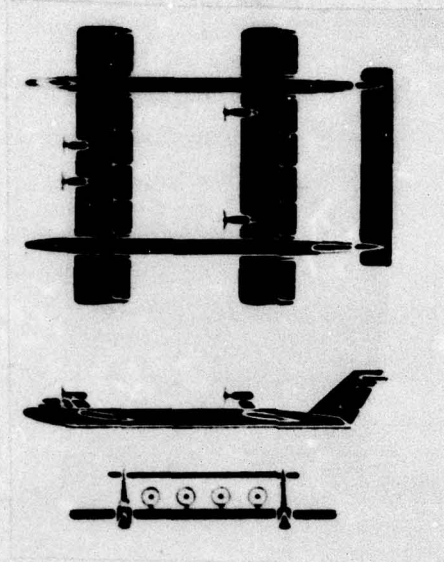
Ekranoplan of "Kolambiya" during loading of dry "moorage". On the second plan/layout - "Kolambiya" it enters in part on the concreted inclined flooring (project).



Above - transcontinental ekranolet "Veylandkraft" in flight above the ocean (project). ^[on the following pg] - the diagram another of the odnog of the version of the flying ktamarana of Veylanda (with the wings, which protrude for hull designs).

10-09-76

hzhzh 31



10-09-76

hzhzh 32~~0~~

Apparatus by length about the ~~55~~ of meters and shirinoyu approximately the ~~24~~ of meter will weigh with load of approximately 100 tons and it will be able to move above water at the height/altitude of the ~~2.7~~ of meter. The specialists of the form of the "Viikl of Riserch" assume that the latter can be increased to the ~~3.6~~ of meter, if by it it were possible to carry out new principle of producing the lateral curtains. The engine plant of ekranoplana will consist of the ~~6~~ of turboprop engines power on the ~~2270~~ of horsepower each, two of which will rotate the tractor propellers of apparatus, and four - the fans, which create cushion and curtains. In the construction of machine, will be used light aluminum alloys and fiberglass laminate. To Dal'nosst' the "obesposadochnogo" flight of ekranoplana - the ~~800~~ of kilometers.

, until now, the discussion concerned the ekranoplanakh in which the designers attempted to maximally utilize principle of air cushion and they abstract/removed to two remaining dynamic phenomena, causing the "effect of the effect of screen", only secondary role. On another way went Swiss engineer Kh. Veyyland, known abroad as designer of a series of high-speed/velocity machines on vzdushnoy cushion. As the basis of his new machine, he placed the phenomena of the disturbance/breakdown of tip vortexes and decrease in the downwash of the priizhenii of wing of screen, leading to a significant improvement in the aerodynamic characteristics.

The proposed by Veylandca intercontinental cargo and passenger apparatus of "Veylandkraft" is detayushchiy catsaran whose floats are

10-09-76

hzhzh 33 28

connected with two comparatively narrow and long wings (Fig. below). The already appearance of apparatus indicates that during its development the use of an air cushion was not provided for. This machine in essence is the low-flying aircraft and unlike winged apparatuses on air cushion can be called ekranoletom. In difference from aircraft it will heave approximately five times more the load.

Remembering about the failures, connected with the flight of aircraft of the Earth, Veyland focused special attention on the vprosy of stability and controllability. It is known that one of the disadvantages in the wing, which slides of screen, is the excessive "mobility" of the point of the application/appendix of resulting lift. During motion, this point can unexpectedly be displaced back/ago, forcing machine to peck by nose, and then just as unexpectedly it returns forward, and machine begins to be sccred. Moreover all this occurs so rapidly which requires constant stress from pilot, his sverkhmgnovennogo interference.

Veyland attempted to solve this problem sufficiently original, after placing the wings of its machine one after another (diagram to the left). In this case, each wing seemingly had been the control device, which parries the errors of its "neighbor". If as a result of the displacement of the point of the application/appendix of resulting lift machine begins to nose down, then front/leading wing approaches a screen, and lift on it increases, forcing apparatus to return to normal position. But when machine is dumped on it zhvost, the "effect

10-09-76

hzhzh 34 ~~28~~

of the effect of screen" increases lift nz rear wing.

The heavy ekranoplan, proposed by Veylandcm, will weigh about the 1000 of tons and it will be able to move above the ocean at the height/altitude of the 6 of meters with speed about the 185 of kilometers in hour, having aboard of the 3000 of the passengers. It is natural that thus far this machine exists only on drawing plates, its less brothers already attempted to leave into journey.

10-09-76

hzhzh 35 ~~27~~

Page 41.



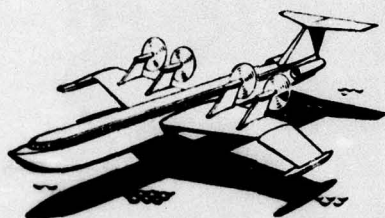
Experimental ekranolet the Lippish of X-1/2. On photo from bottom to top: apparatus during acceleration/dispersal; apparatus during motion under the conditions of ekranoplana; apparatus in flight.

10-09-76

bzhzh 363

Key: (1). Hypothetical. (2). the figure of ekranoleta. (3).
transport.

(1) Гипотетический (2) рисунок (3)
экранолета. транспортного



10-09-76

hzhzh 37

In 1963 to the year of Veyland concluded contract with the American firm "West It Kcust" for joint development and the construction of ekranoplana. Is first bygone is constructed the small model which was experience/tested in aeyaodinamicheskoy tube and in free-air conditions above hollow hangar. Model flew on straight line and in circle, retaining stability even with the gusts of "wind" which artificially were created in agar. When on the sex/floor of tale are established/installed the wooden racks, which imitate waves, model it did not reveal/detect the wish to follow their inequalities.

Soon after these tests the researchers constructed the experimental apparatus, controlled by pilot, outwardly similar to "large Veylandu". During March 1964 on the lake of Solton, in California, the machine completed its first and, unfortunately the last/latter flight. The motion-picture frames, removed from helicopter, show that first the machine easily was built up above water and sufficiently confidently flew above the screen at height/altitude about meter. But then the nose of machine unexpectedly began to tear upward, and it took off to height/altitude about the 7.5 of meter, that it is considerably more the rated altitude of flight. After the pilot discarded gas, apparatus fell to water it broke. The reasons for emergency establish/install could not, money of firm ended and thus far concerning the continuation of the investigations of this question there is no information.

The use of an "aircraft" principle of flight of screen, it is natural, could not but strike the designers against the idea of

10-09-76

hzhzh 38

producing apparatuses, capable of combining in itself the advantages of ekranoplana and aircraft. under the investigation of the problems of producing this universal machine in the USA it is occupied firm "Collins Reydio". It constructed and conducted the test series of the eksperimenta'nogo ekranoplana of the Lippish of X-112, capable brief time to fly similar to aircraft (photo to the right). This apparatus and outwardly in by mngom reminds it saolet. At the ends of its omitted downward wing, are fastened the holding machine on water floats, which play simultaneously the role of endplates. On these floats the apparatus accomplishes acceleration/dispersal, then emerges to mode/conditions ekranoplana and vzmyvae into air. With the aid of this machine the scientists and the designers study the possibilities of designing of large apparatuses of this type, capable of accomplishing the overland flights of one water basseyna in another or supply/delivering the passengers and the loads of the places, arrange/located in certain removal/distance from the basic water routes (Fig. below).

It is bygone to erroneous confirm that by its "reactivation" the idea of ekranoplanov is due only to the tendency to reduce the time of the transportation of the passengers and loads. The requirements for ccntemporary saving takovy, chto force to estimate in a new way pros and cons in the cargo vehicles. With ecm the speed becomes one of the basic indices of high cost-effectiveness/efficiency, kharakterzuya of its kind the high labor productivity of the cargo vehicles: the higher the speed, the more the voyages it can complete apparatus for

10-09-76

hzhzh 39

one and the same time. From these positions of ekranoplany and ekranolety, capable of achieving the speeds of the order of hzhzhzh and even hzhzhzh of kilometers in hour, are some of the pspektivnykh transport apparatuses.

Bibliography

1. С. Адаминский. ТРАНСПОРТНЫЕ МАШИНЫ НА ВОЗДУШНОЙ ПОДУШКЕ. Издательство «Наука», 1964 год.
2. Ю. Бенуа, В. Корсаков. СУДА НА ВОЗДУШНОЙ ПОДУШКЕ. Судиремги, 1962 год.
3. Е. Ружницкий. ВОЗДУШНЫЕ ВЕЩЕХОДЫ. Издательство «Машиностроение», 1964 год.
4. Т. Стимсон. ЛЕТАЮЩИЙ КАТАМРАН. «POPULAR MECHANICS» № 1, 1965 год.
5. А. Чернышев. КАТЕР ПЛЫВЕТ НАД МОРЕМ. «Юный техник» № 9, 1965 год.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FD-ID(RS)T-1432-76 ✓	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EKRAANOPLANS ARE WINGED SHIPS OF THE FUTURE		5. TYPE OF REPORT & PERIOD COVERED Translation
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) D. Pipko	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Foreign Technology Division Air Force Systems Command U. S. Air Force		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE 1966
		13. NUMBER OF PAGES 39
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) 01		

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE	ORGANIZATION	MICROFICHE
A205 DMATC	1	E053 AF/INAKA	1
A210 DMAAC	2	E017 AF/RDQLR-W	1
B344 DIA/DS-4C	8	E404 AEDC	1
C043 USAMIIA	1	E408 AFWL	1
C509 BALLISTIC RES LABS	1	E410 ADTC	1
C510 AIR MOBILITY R&D LAB/FIO	1	E413 ESD	2
C513 PICATINNY ARSENAL	1	FTD	
C535 AVIATION SYS COMD	1	CCN	1
C557 USAIIC	1	ETID	3
C591 FSTC	5	NIA/PHS	1
C619 MIA REDSTONE	1	NICD	5
D008 NISC	1		
H300 USAICE (USAREUR)	1		
P005 ERDA	2		
P055 CIA/CRS/ADD/SD	1		
NAVORDSTA (50L)	1		
NAVWPNSCEN (Code 121)	1		
NASA/KSI	1		
544 IES/RDPO	1		
AFIT/LD	1		

FTD-ID(RS)T-1432-76

PRECEDING PAGE BLANK-NOT FILMED