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SATURN ~~JUNO V~~ TRANSPORTATION FEASIBILITY STUDY (U)

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JUNO V TRANSPORTATION FEASIBILTIY STUDY (U)
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Juno V--Transportation
Jupiter--Transportation
Redstone--Transportation

The purpose of this report is to present an investigation to determine the most feasible, practical and economical method of transporting the JUNO V thrust unit. This includes the first phase of transporting between Fabrication Laboratory, Systems Analysis and Reliability Laboratory and to the test stand, as well as the later phases, onto the Redstone Arsenal loading docks and from there down the Tennessee, Ohio and Mississippi Rivers to Atlantic Missile Range, Florida.

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JUNO V TRANSPORTATION FEASIBILITY STUDY (U)

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This report contains 10 classified pages.

TRANSPORTATION AND PACKAGING SECTION
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ABSTRACT

The purpose of this report is to present an investigation to determine the most feasible, practical and economical method of transporting the JUNO V thrust unit. This includes the first phase of transporting between Fabrication Laboratory, Systems Analysis and Reliability Laboratory and to the test stand, as well as the later phases, onto the Redstone Arsenal loading docks and from there down the Tennessee, Ohio and Mississippi Rivers to Atlantic Missile Range, Florida.

Three transportation methods have been considered for the clustered thrust unit and are as follows:

A. Use presently designed REDSTONE and JUPITER transporters. This method would require disassembly of the thrust unit.

B. Use a large, specially designed transporter which would be capable of handling the assembled thrust unit from its early manufacturing stages through all phases of testing, checkout, and finally to the firing site.

C. Use a specially designed mammoth "barc type" amphibious vessel which would transport the assembled thrust unit from final checkout to the firing site.

Studies made to date, with emphasis given to cost, design and manufacturing lead time, and the fact that the assembled clustered version of the JUNO V thrust unit will be initially used, indicate that Method B should be employed as the transportation means. Some mandantory alterations to the Redstone Arsenal roads, utilities and bridges and possibly dock site modifications will be required.

Flat deck barges would be employed for river transportation between Redstone Arsenal dock site and the point where accomodations will be made for the ocean phase of the shipment.

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SECTION I. INTRODUCTION

Previously, in handling the REDSTONE and JUPITER thrust units, specially designed transporters were used Definite transportation requirements necessitated that these transporters have adjustable height and/or rear axle steering as well as minimum weight to facilitate air movement. Present study has been limited by the amount of available information on the exact configuration of the missile. As to date, proposals have simply been based on word of mouth, preliminary drawings and "guesstimates"

Experience gained in preliminary design and development of the REDSTONE and JUPITER transporters has enabled the proposals to progress to the state where certain basic fundamentals such as desired steering and suspension characteristics can be visualized.

The choice of actual transportation method greatly affects the overall economy of the proposed program. Three approaches to the transportation means will be considered in this report, with particular emphasis given to simplicity of design, economy, effect on missile reliability and utilization of existing off-the-shelf assemblies

The selected transportation method of the JUNO V thrust unit will affect the overall missile logistics, the modification of road and dock facilities at RSA, as well as a possible future design of a special barge and certain harbor features at Port Canaveral. It is felt that a realistic and practical approach must be maintained if the JUNO V program is to be contained within its monetary limitations.

SECTION II. DISCUSSION

The following discussion will attempt to point out the known merits and hinderances of each of the proposed methods of transporting the clustered thrust unit.

A. Method A: Shipment of the Disassembled Thrust Unit

During the initial consideration of a transportation scheme for the JUNO V, the proposal was made to use existing designed transporters for the JUPITER and REDSTONE diameter tankage (Fig. 1). Several points of merit for this approach are immediately apparent:

1. The design presently exists.
2. Engineering and manufacturing lead times would be considerably shortened as the required modifications would be of a somewhat minor nature.
3. Very little R&D and proof testing would be necessary as these designs have been proved.

4 It is possible to utilize the existing air transportation characteristics of these transporters, thus, simplifing and lessening the transportation time

The following points are to be considered:

1 Present cost of existing tactical REDSTONE thrust unit transporter is $20,500 or $164,000 for eight. The tactical JUPITER thrust unit transporters are $175,000 each. The total cost of transporters (tactical version) to ship a disassembled JUNO V booster assembly will approach $399,000, including the modification costs.

2 However, these figures can be considerably reduced if the available R&D prototype transporters, both REDSTONE and JUPITER, are employed. Shuttle shipments of the REDSTONE transporter will reduce the number of transporters at no appreciable increase in transportation cost. In-house modification cost should not exceed $30,000.

3. The disassembled versions will require eleven C-124 air shipments to transport a single JUNO V booster assembly. This will accommodate the movement of the nine tank sections. Two planes will be required for air shipment of the segmented thrust ring engine manifold. The air transportation per flight is estimated at $10,000 each or a total of $110,000 per JUNO V booster assembly.

4 Overall missile reliability suffers considerably upon disassembly of the thrust unit into its component REDSTONE and JUPITER tankages.

5. Additional assembly jigs and facilities will be required for reassembly and checkout at both RSA test stand and at Atlantic Missile Range (AMR) firing site.

6. If aircraft transportation is utilized it is estimated that the total cost for the first movement will be approximately $150,000 when employing shuttle shipments of a REDSTONE prototype transporter. (This does not include the cost of additional assembly jigs and for their transportation)

B. <u>Method B: Shipment of a Fully Assembled Clustered Thrust Unit</u>

A large transporter to carry the assembled thrust unit from the early stages of manufacturing and assembly through all phases of checkout and testing, including road movement to the firing site, would have the following features:

1. Utilization of Fabrication Laboratory's assembly jigs as the main forward and aft missile supports.

2. These assembly jigs would be interconnected during the transportation phase by two removeable side trusses

3. Both front and rear axles would be capable of braking and independent steering. These axles would be provided as a major assembly which could readily be attached to the lower portion of the Fabrication Laboratory's assembly jigs (Fig. 2). As a transporter, it would be pulled by an aircraft tug connected to a forward tow bar. In an effort to provide the required steering in a simple and readily available

manner, an M-52 tractor with a front mounted pintle hook could provide the steering power necessary to the rear axle The M-52 would be connected to the axle by a telescopic towing bar, which would enable the vehicle to supply steering effort and yet impose no forward thrust into the transporter. This telescopic feature would tend to attenuate the transfer of any undesirable longitudinal torques into the rear support during steering. (See Figure 3)

The transporter in utilizing the forward and aft assembly jigs would virtually eliminate excessive torque from being projected about a longitudinal centerline into the thrust unit. These jigs will be so constructed that the thrust unit can be rotated about the longitudinal axis during manufacture, through use of the aft end assembly ring which is attached to the fuel and propellant tank thrust frame and the forward end assembly collar attached to the inner JUPITER diameter tank. Since a cylindrical tank is a very rigid torsional member and the transporter is less rigid torsionally, the transporter will deflect more torsionally during transportation than the missile. It is therefore very desirable to utilize this swiveling effect by not fastening the missile rigidly to the transporter. However, the missile would be rigidly restrained vertically to the transporter but not rotationally. This can be accomplished by a metal band installed over the assembly collar and attached to the forward assembly jig. The forward assembly collar would allow a predetermined amount of longitudinal "play" to prevent the possibility of undesirable loads. The principal longitudinal restraint would be derived by securing the rear assembly ring into its assembly jig.

The suspension system attaching under the assembly jig, would consist principally of a "walking" beam supported by tandem aircraft tires. It is felt that a more elaborate suspension is not required, as this transporter will only be moved at walking speeds or a maximum of three to five miles per hour over known and selected routes.

The following are the desirable merits of shipping by this method:

1. Reliability of the thrust unit is considerably enhanced by transporting as an assembled unit.

2. Assembly difficulties at RSA test stand and AMR firing site are considerably lessened

3. It is possible to utilize in-house design labor and manufacturing facilities within ABMA, which would considerably decrease liaison time This work could be phased in as the JUPITER project approaches the descending slope of required work

4. The overall cost of developing and manufacturing the axle assemblies for the JUNO V thrust unit (clustered version) are estimated not to exceed $30,000 per unit.

5. From available information, the transportation cost per thrust unit would approach $40,000 This cost includes the transportation phase from the Redstone docks to Port Canaveral and onto the firing site.

The total estimated cost of a transporter, including assembly jig, is $130,000. This brings the overall transportation cost for the first movement to $170,000.

The following statements are considered negative points when shipping the thrust unit by this method.

1. Certain road and utility modifications would be required within the limits of RSA and also some minor modifications would be required at AMR.

2. It is estimated that the total modifications within RSA only would not exceed $30,000, if the existing bridge on Dodd Road can be utilized without further modifications. This bridge at present has a weight limitation of 12,000 pounds per axle load and a gross load limit of 65 tons. Shoring of this bridge to facilitate a few movements has been estimated to cost $15,000. A permanent bridge capable of carrying the loaded transporter is estimated to cost $105,000. (See Figure 4).

SECTION III. PROCEDURE

The following are steps in the sequence of assembly and transportation between Fabrication Laboratory, Systems Analysis and Reliability Laboratory (SA&R), test stand and finally to AMR:

A. Fabrication Laboratory, Bldg. 4705, to SA&R, Bldg. 4708:

1. Attach truss frame between assembly jig and elevate to proper height.
2. Attached axle assemblies.
3. Lower and disconnect Fabrication Laboratory floor jacks.
4. Maneuver and attach towing and steering vehicles.
5. Tow to Building 4708.
6. Maneuver to desired location.
7. Position and elevate SA&R floor jacks.
8. Remove axle assemblies.
9. Remove towing and steering vehicles.

It is estimated that the handling and transporting between Bldg. 4705 and 4708 could be accomplished in approximately four hours with a handling crew of six men, utilizing an aircraft towing tractor and a 5-ton M-52 tractor with a front mounted pintle hook to steer the rear axles.

B. SA&R, Bldg. 4708 to the Test Stand:

1. Attach axles to properly elevated assembly jigs.
2. Maneuver and attach towing and steering vehicles.
3. Lower and disconnect SA&R floor jacks.
4. Tow from Bldg. 4708 over proposed road to west extension of Martin Road and then south on Dodd Road to test stand access road. (See Figure 4).

5. Tow to test stand and position for removal by test stand crew.

Five hours is estimated to perform this movement and would require a working crew of six men, utilizing an aircraft towing tractor and an M-52.

Road modifications to accomplish this phase of transportation would cost approximately $20,000.

C. <u>From Test Stand to SA&R, Bldg 4708</u>:

This is the reversal of Step B

D. <u>From SA&R, Bldg. 4708 to RSA Loading Dock</u>:

After missile has been cleaned, serviced and reinspected by SA&R, missile preservation and protective covers would be applied to properly desiccate and vent the missile tanks to prevent damage during the water phase of the transportation.

1. From Bldg. 4708, proceed over proposed road to extension of Martin Road and south on Dodd over modified bridge to intersection of Shield Road and then south to RSA river docks.
2. Move gantry crane to the west end of dock, position transporter, follow by 40-ton mobile truck crane and rig transporter for hoisting.
3. Hoist transporter to previously positioned river barge. Secure transporter to barge.
4. Place and attach rigid metal covering over loaded barge. (See Fig. 5).

It is estimated that a crew of six men would be required during the road phase of this transportation and an additional crew of 10 men during the hoisting and loading operation. It is estimated that this task could be accomplished in one day.

E. <u>From RSA to Port New Orleans via Tennessee, Ohio and Mississippi Rivers</u>:

1. Position and secure river tug to barge and proceed to Port New Orleans, where Navy dock facilities are available. (See Figure 6).
2. The time required would be a maximum of twelve to thirteen days. The cost of river transportation is approximately $20,000.

F. <u>From Port New Orleans to AMR</u>.

1. At the Port of New Orleans, several approaches are being investigated to effect the ocean and/or intercoastal movement to AMR. These approaches are:

a. Use ocean-going barge and pick up ocean-going power tug at New Orleans and proceed to AMR by either the intercoastal route or the open water route.

b. Use landing ship tank (LST) or beach discharge lighter (BDL), transfer missile on transporter from river barge to the deck of either of these vessels at New Orleans and proceed open water route to AMR.

c. Use a landing ship dock (LSD) at New Orleans which will take river barge with missile on transporter aboard and transport these to Port Canaveral where the barge will be out-floated and towed to dock.

2. The LSD offers the better protection from harmful environments and shipping characteristics and will be considered the method for this phase of the movement.

3. Estimated maximum time is four to five days at a cost of $20,000.

G. <u>From Port Canaveral to Proposed Launch Site</u>

1. Remove missile and transporter with existing gantry crane and 40-ton missile truck crane to roadway.

2. Attach aircraft towing tractor to transporter and M-52 with front mounted pintle hook to rear steering and proceed to proposed launch site.

3. It is required that modifications be made to existing overhead electrical lines and one gateway between the Port Canaveral dock and the firing site. The cost of this clearance will be borne by Patrick Air Force Base. Time required to reach launch site is six hours. Six men exclusive of dock handling crew would be required.

SECTION IV METHOD C SHIPMENT OF THE FULLY ASSEMBLED VERSION BY AMPHIBIAN

A proposal has been made and investigated as to the feasibility of using a large "barc" type vessel (Fig. 7). This vessel was initially envisioned to be capable of navigating both inland rivers and waterways as well as the high seas. This vessel would receive the thrust unit at the Fabrication Laboratory building and would transport it from there to SA&R, to the test stand and finally launch itself into the Tennessee River and on through the inland rivers and waterways and finally beach itself at AMR and deposit the missile at the base of the launching table.

The following are points of consideration when contemplating the use of a large amphibious barc type vessel.

1. A design does not presently exist for such a vessel.

2. From preliminary contacts with the office of Chief of Transportation, the following "ball park" information was given.

a. Development cost of a "Barc" type amphibious vessel would be approximately $5,000,000

b. Estimated dimensions are 110 feet long by a 32-foot beam width, with a weight of 690 tons.

c. Estimated development time is four years.

3. This vessel would certainly have to have some type of cradle within itself to support the thrust unit. This cradle would, in all probability, have to have almost the same features as described for the transporter in Method B

4 The dimensions and maneuverability of the vessel alone would tend to prohibit its entrance into any of the existing buildings without major modification and would, therefore, require some type of transportation means for the thrust unit within the building as well as movement to and from the test stand

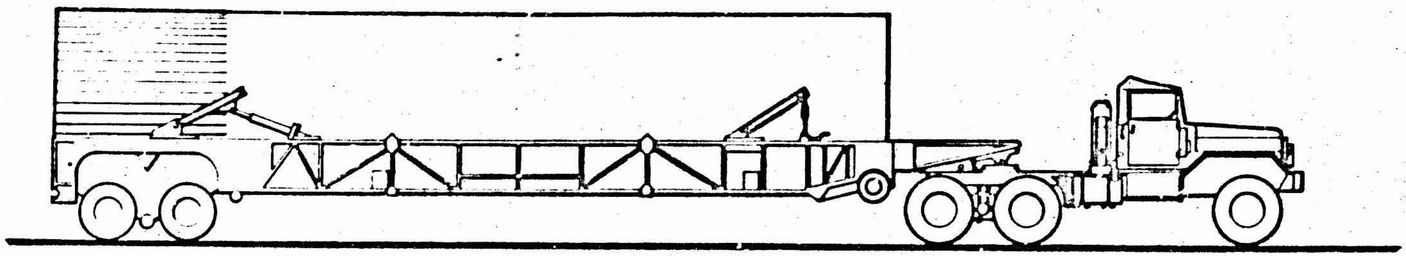
5. It is furthermore pointed out that any amphibious vessel is generally not seaworthy due to its shallow draft and rather awkward steering and propulsion means when afloat. The draft of this vessel would be limited to nine feet to be capable of inland waterway transportation on the Tennessee, Ohio and Mississippi Rivers.

6. Such a vessel on land would require special roads and paths which must be preliminarily cleared and prepared. A rather common complaint of these vessels is their poor handling characteristics when on land and are not normally recommended for inland operations greater than three to four miles

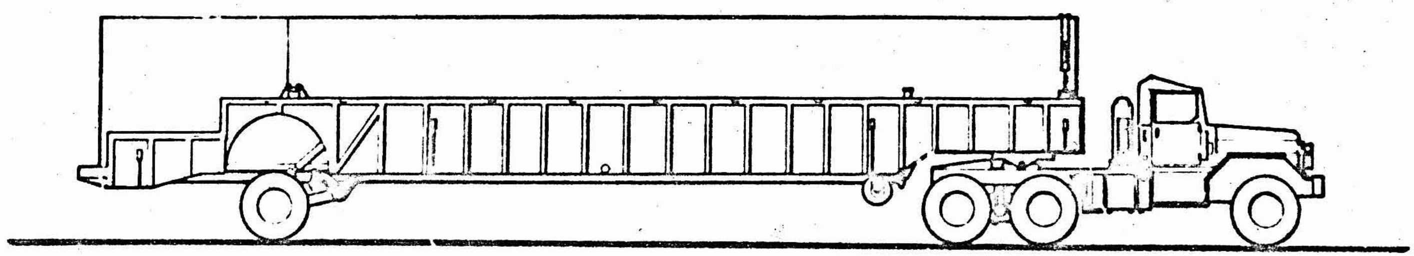
SECTION V. CONCLUSIONS AND RECOMMENDATIONS

From the aforementioned discussion, it is concluded that Method B--the utilization of a specially developed transporter which carries the thrust unit assembled--should be employed, as this presents the most reliable and economical approach. For the transportation method and routing, it is recommended that routings by roads be prearranged and modifications be made to facilitate the road configuration both at RSA and AMR That the routing by water utilize a barge and river tug to move the thrust unit on transporter to Port New Orleans over the river route and there load barge into LSD to be transported over open water to the Port Canaveral docks. It will be necessary at Port Canaveral to discharge the barge from the LSD and tow it to the docks for unloading operations Once the thrust unit has been discharged from the transporter, the transporter may be broken down into four or six main sections which allows trans-shipment by rail or road back to ABMA for future deployments

1 TRANSPORTER REQUIRED



8 TRANSPORTERS REQUIRED



DISASSEMBLED TRANSPORTERS

FIG. 1

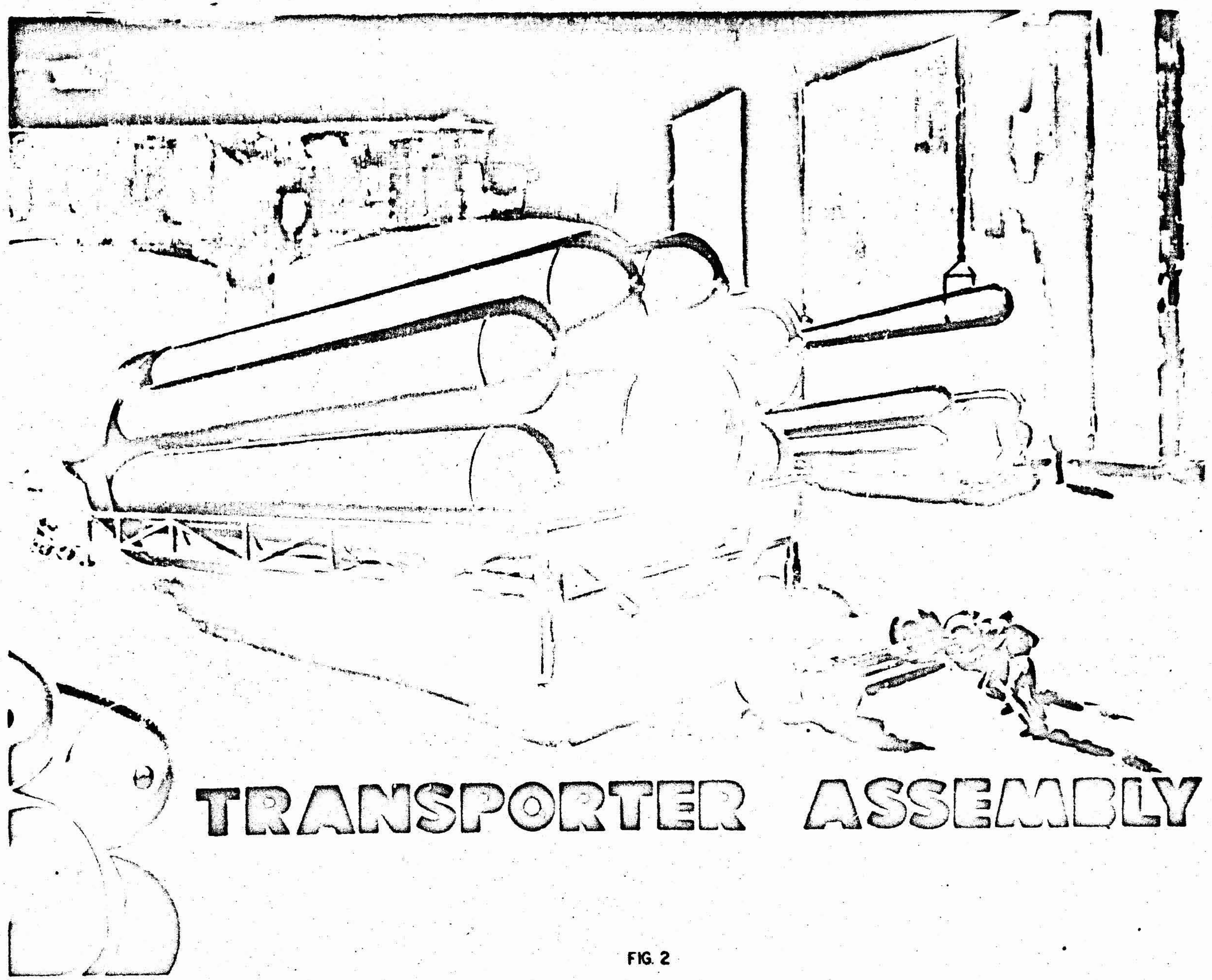


FIG. 2

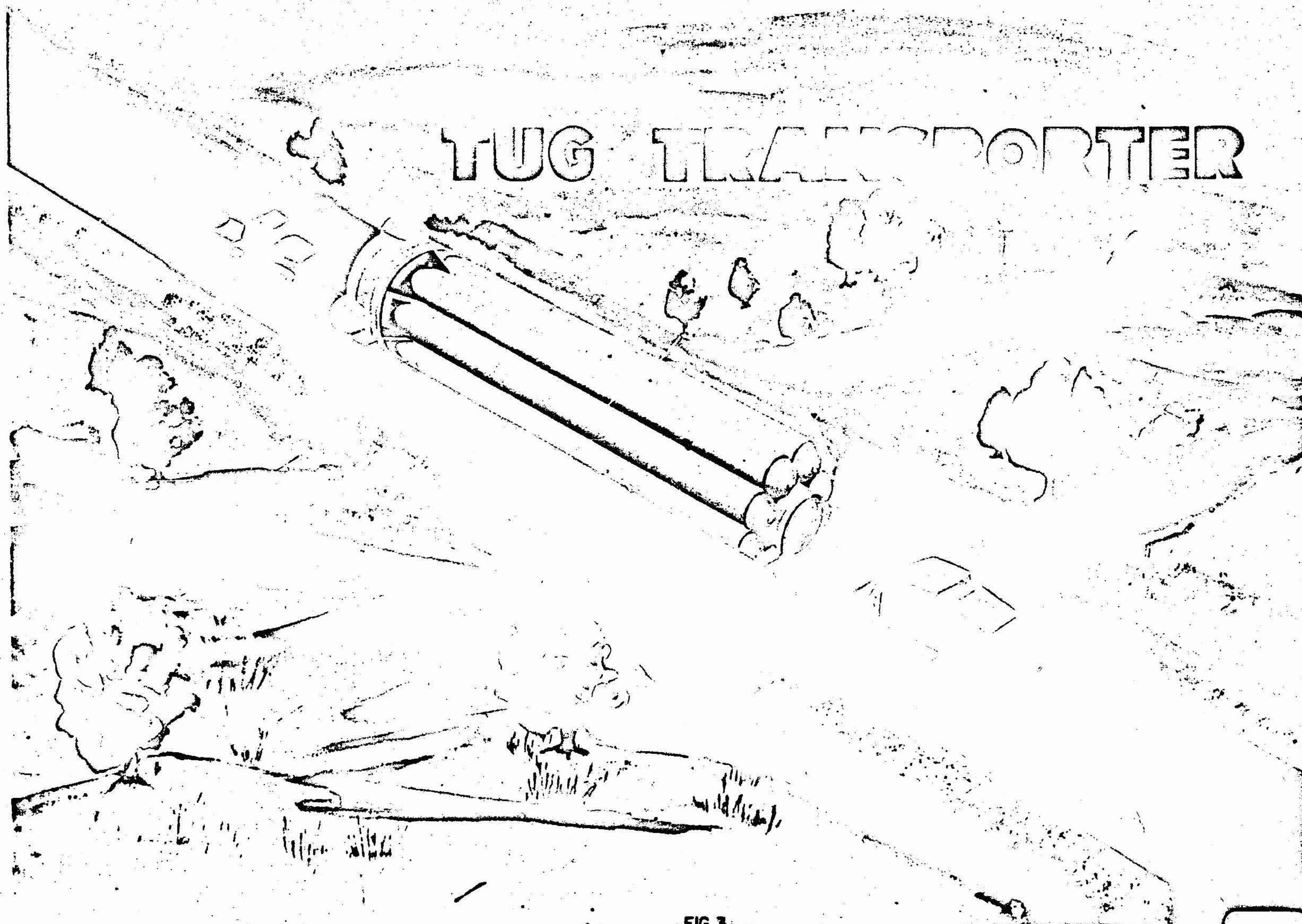


FIG. 3

ROUTE MODIFICATION
(FABRICATION BLDG. TO RIVER DOCK)

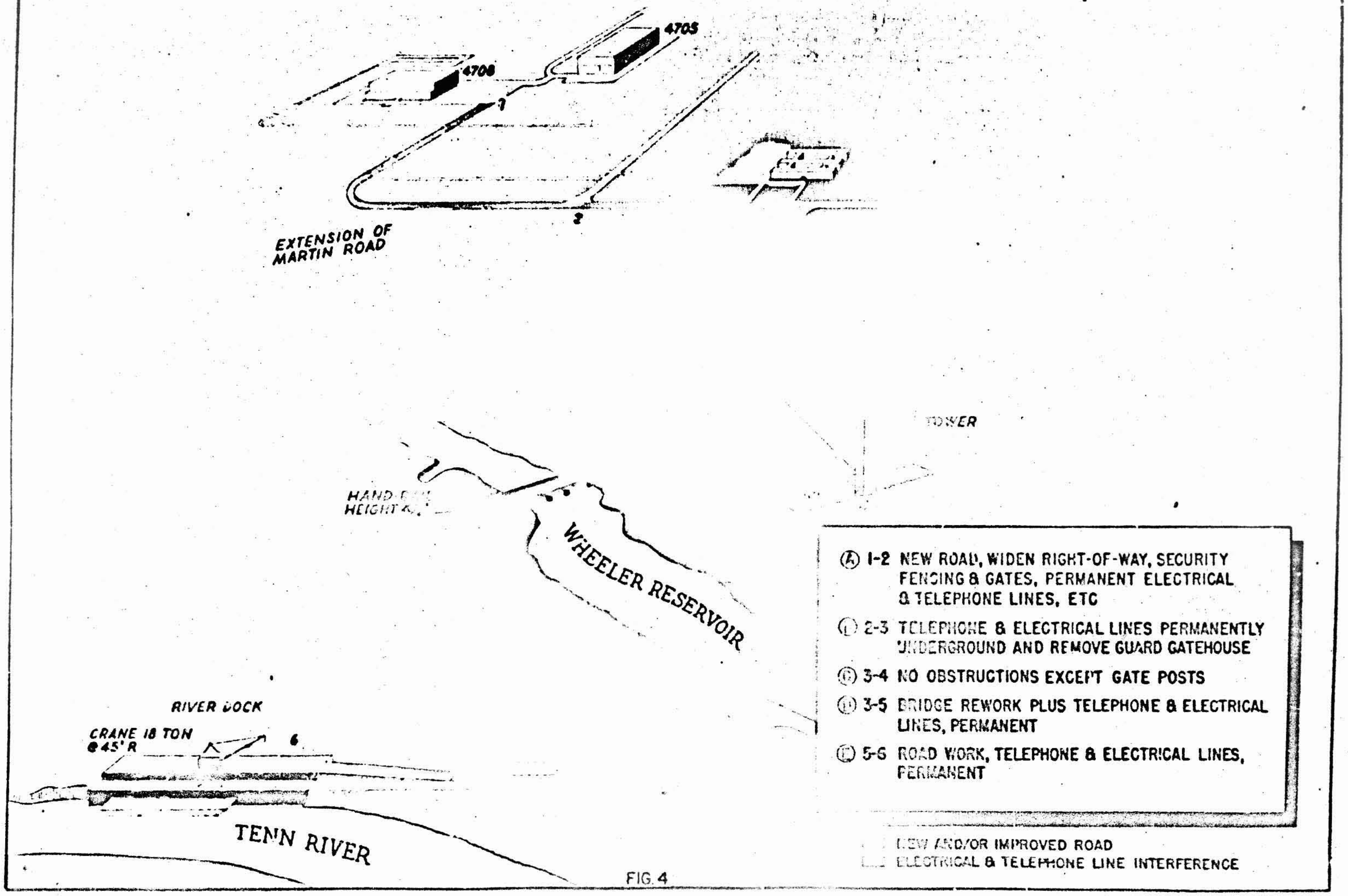


FIG. 4

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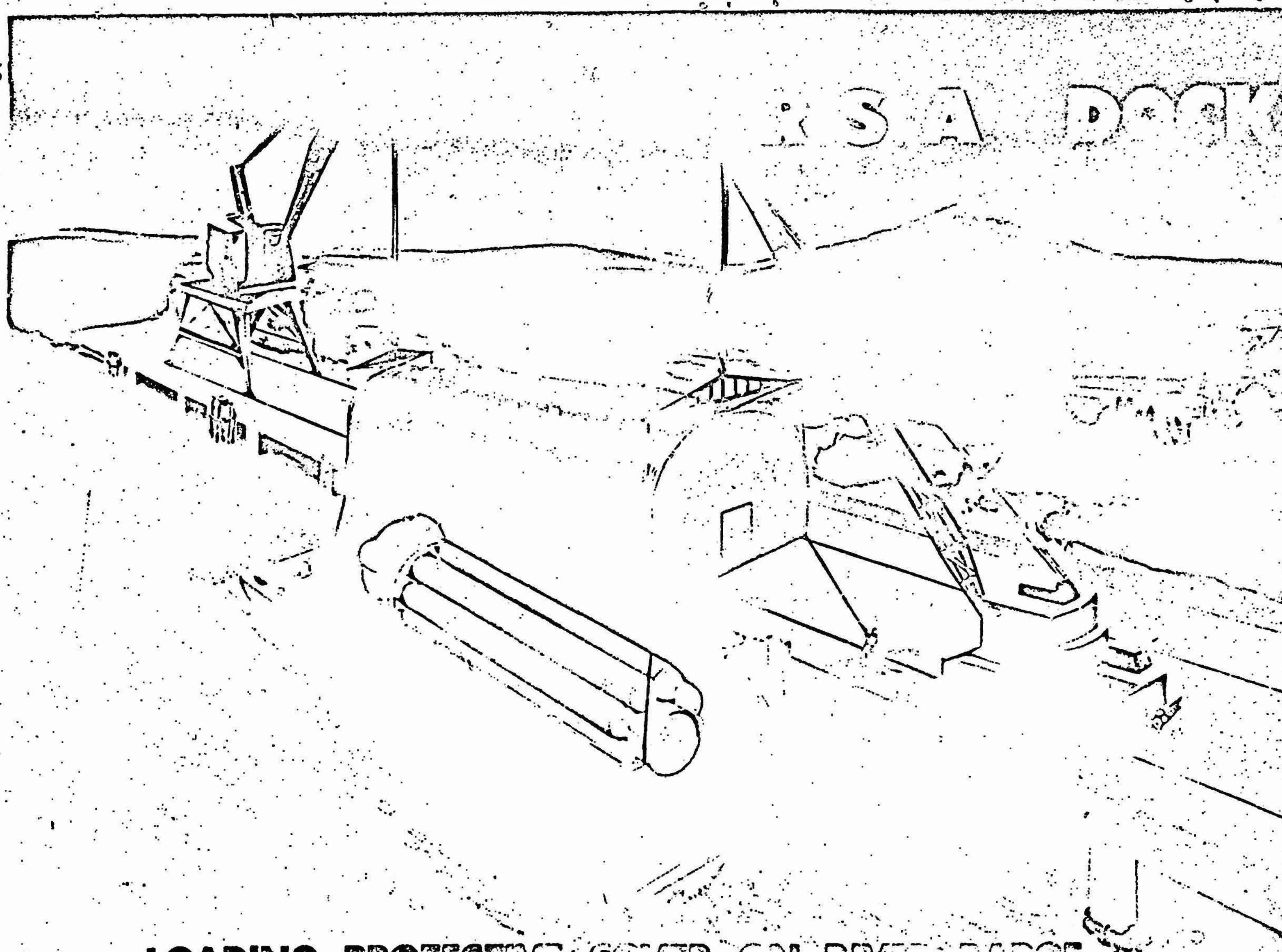

LOADING PROTECTIVE COVER ON RIVER BARGE

FIG 5

FIG. 7

F-9

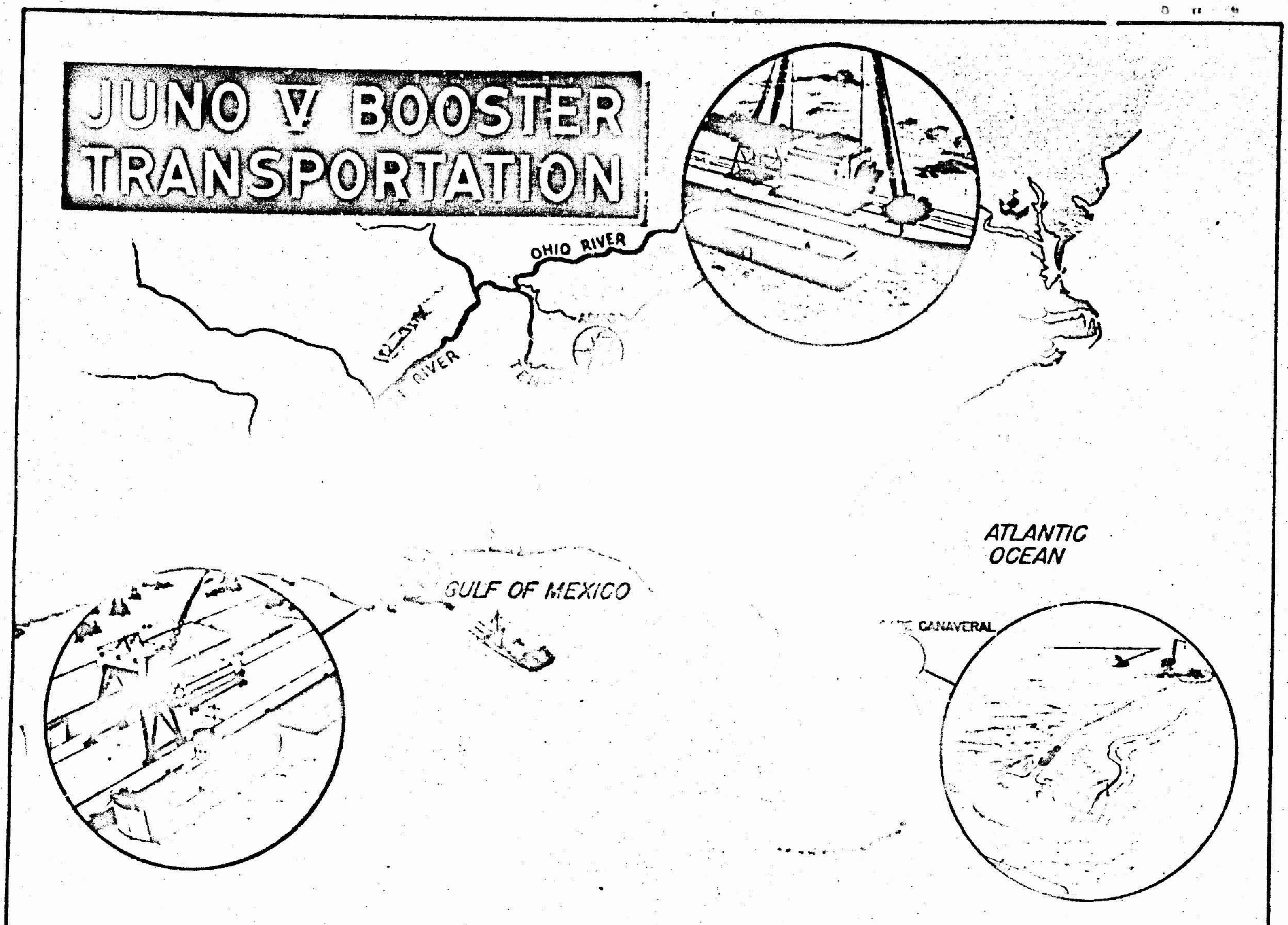
JUNO V BOOSTER TRANSPORTATION
OHIO RIVER
GULF OF MEXICO
ATLANTIC OCEAN
CANAVERAL

FIG.6

[redacted]

APPROVAL

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