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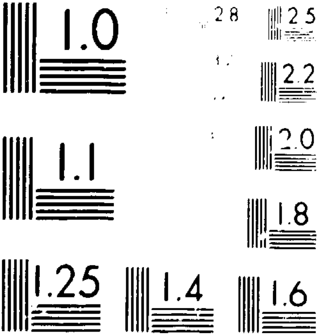
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APPLICATION OF WIND POWER IN THE SHIPBUILDING*

(USE OF SAIL IN THE MARINE TRANSPORTATION)

prepared by

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V. 83-51155

APPLICATION OF WIND POWER IN THE SHIPBUILDING
(USE OF SAIL IN THE MARINE TRANSPORTATION)

The cost of oil today is the single most expensive item of a ship's operating costs and high operating costs are having a negative effect on all phases of marine transportation. This, in turn, has caused severe problems among developing nations which look to the sea for survival.

Sail Freight International has been in the forefront of modern commercial sail since it first began to once again appear economical. Since that time we have made great strides in our effort to advance the technology of sail or sail-assisted power. The primary reason this concept has not become more commercially popular has nothing to do with the price of oil or high interest rates or modern technology. The main problem has been manpower. It seems that up to now, those countries that have had the money to invest in alternatives to oil, such as wind power, have not had the men willing and able to make the change successfully. In the industrialized nations of the world there are only a few sailors, men who understand a sailing ship; the rest are simply merchant seamen. On large ships owned by even larger companies the men on the ship feel very far removed from the decision making process. On smaller ships the men know the owner or the captain personally. They take an interest in the operation of the vessel and they feel a responsibility toward making the venture a commercial success. In today's market this means an interest in saving oil.

Unfortunately there is not time for me to address all of the specifics, technical or economic, concerning commercial sail. (Refer to the UNDP S/A Project Document for a macro-economic analysis.) Therefore, I will speak in general terms with the hopes that your specific questions will be addressed at a later date during private consultation

The best technique for the commercial utilization of sail assisted power will be decided on only after examining carefully six fundamental criteria for each potential situation:

1) the present oil price and expected price increase per annum.

2) the availability and reliability of oil supplies.

3) location of the trade route.

4) ship size.

5) type of cargo.

6) the sail assisted mechanism to be used (fig. 1 and 2).

Sail Freight International looks at all of these factors before deciding if sail power will work and if it will work which is the best scenario to follow. Even if oil returns to US$15/bbl. it does not make good sense to completely neglect the enormous amount of free energy available in the wind. This is especially true for smaller vessels of 5,000 dwt and below. These ships burn the lighter oils, marine diesel oil and gas oil. This fuel costs more and will be the first to dry up in the event of an interruption in oil supplies. Therefore, let us consider the most cost effective use of the wind's energy. Should we use a high technology sail power system like the Japanese, a low technology system like the Brittish or something in between.

In an effort to make this choice, first consider high technology: the 1600 ton Japanese sail assisted tanker. The Japanese represent a special case in that they are the only industrialized nation to commit large sums of money to the investigation of sail power as a commercial alternative to oil. The Japanese have used a high technology "wing sail" for several reasons:

1) They are looking toward the day when oil supplies begin to get scarce,

2) they realize there is little in the way of alternatives to oil for use at sea, regardless of the price,

3) the wind is free and should remain so,

4) Japan, like much of the Caribbean Basin, has to export most of its products to overseas markets and import most of its commodities such as grain, lumber and fertilizer,

5) the wing sail requires the least amount of training before the crew is fully able to utilize it.

The ship utilizes a semi-rigid, collapsible air foil which, when pushed into the apparent wind creates lift and in so doing reduces the required horsepower needed to maintain speed. By perfecting this technique for a marginal reduction in fuel consumption they hope to save enough oil with large ships on long voyages to justify the high capital costs of the high technology system. Large and expensive ships do not operate effectively within the Caribbean. Therefore, the wing sail system will not work for developing nations in this area. Under the best circumstances this type fo sail assisted system would take 10 years to pay for itself at todays oil price. Soft sails, on the other hand, can recover their initial investment in approximately one year.

The British are attempting another extreme: no technology. They are now considering the possibility of building a ship of 12,000 tons to carry wool from Australia. The ship will be completely traditional and will use none of the modern advantages available today. The ship will burn almost no oil and by utilizing free storage at sea the wool will be purchased when the market is down during the yearly harvest and kept at sea while the resale market rises as the first shipments arrive on high speed ships and are quickly bought. The concept may be good but one reason this idea will be slow to reach commercial fruition is because this vessel will have to be built new from the ground up which will require a great deal of money. Furthermore, there is no chance of modifying an existing ship for a traditional retrofit. If you did there is almost no chance of recouping your investment. Secondly this approach depends on free labor which will be supplied by young cadets from the merchant academies. Lastly, a sailing ship built in 1982 with no auxillary power has most of the disadvantages of a sailing ship built in 1882.

In order for sail assisted power to be successful some compromise between high technology and no technology has to be found. To do this a careful study must first be conducted which will consider:

1) the cost versus the savings with the sail assisted rig,

2) the use of "off-the-shelf" technology, thereby mininizing the developmental costs,

3) a type of sail assist system that can be easily retrofit onto existing vessels,

4) the optimum design of new sail assisted ships,

5) the learning curve associated with manning during construction and operation.

It is the latter which has presented the largest obstacle to the more industrialized nations of the world. Although the new age of sail power will use all of the modern technological advances available, the men on the bridge will still be required to understand windward theory and, more importantly, they will have to be willing to use it. Manpower is one of the primary reasons sailing vessels in the Caribbean will be successful.

Consider for a moment the historical record of a sailing ship from around the 1900 era. With the additions of only minor mechanical advantages such as steam winches to help the seamen hoist the sails, the crew size of the Thomas W. Lawson (Fig.3) was reduced from 32 to 12. Knowing what we do today about hull shapes, electronics, hydrallics, aerodynamics and diesel engines, a ship of similar size (Fig.4) could move at 8-10 knots and burn less than half of the oil of her conventional sisters. She could do this with no increase in crew size. All that need be added in addition to the modern sail assisted system would be the standard conveniences used on all modern ships today.

The Caribbean area has been chosen for start-up operations for four reasons:

1) Geographic - Most of the ports in the Caribbean have limitations on the size of the vessel they can handle and the economic advantages of sail assisted ships are inversely proportional to the size of the ship. Therefore, where external reasons warrent the use of smaller ships such as fishing vessels, inter-island traders and small bulk carriers, sail assisted mechanisms should be seriously considered.

2) Meteorological - As mentioned earlier, the proverbial trade winds blow with consistancy in the Caribbean and this makes it easier to calculate the amount of horse power available from the wind on a yearly basis. When this figure is available it becomes easier to predict the oil savings available by using sail assisted power.

3) Economic - The developing nations in the Caribbean depend heavily on marine transportation for three reasons:

   a - revenue: the export of raw materials,

   b - food: the import of food products,

   c - fishing: for both of the above reasons,

4) Manpower - The most important element of modern sail assisted operations.

In this day and age of men on the moon we certainly have the technology to make a ship move with the aid of sails. We have the knowhow but we do not have the men. In all of the cases where modern sail assisted power has not been successful, it has been solely as a result of manpower. The people of the Caribbean have the shipyards to build the ships and they have the men to operate the ships; they have the cargoes, they have the wind and like everybody else they have the need to reduce the cost of oil. Therefore, now is the time for the people of the Caribbean to begin looking very seriously at sail assisted power as a means of reducing operation costs.

By looking at the historical development of sail power and its eventual decline we can isolate the optimum modern sail assisted ship to begin the re-introduction of sail power. If sailing ships ceased operation for economic reasons then it will also be economic reasons which are responsible for their return. If bulk and neo-bulk commodities were the ones last carried by sailing ships then they shall also be the cargoes that will once again be carried by modern sail assisted ships. Most of the traffic in the Caribbean measured in ton-miles is in low value bulk commodities. These are cargoes in which oil is responsible for a larger proportion of the freight rate, especially in the case of fishing vessels. Therefore, any reduction in oil consumption will have a significant impact on these rates. (Refer to UNDP S/A Project Document)

The work Sail Freight International has done up to now has proven that sail assisted power works. We have installed o sail of 325 square meters on a 3100 t single deck bulk carrier. (Fig.5) She has been in operation in the Caribbean for over a year and the fuel savings have averaged approximately 25% with only one sail instead of the three sails which she was originally designed to carry. The block co-efficient of this ship is .8. If we had used a ship of finer lines or built a new ship specifically for sail she would have been able to sail at a cruising speed of 8-10 knots with no engines in only 15 knots of wind while carrying a full load of cargo. (The average wind speed in the Caribbean is approximately 15 Knots.)

We have also designed a fuel efficient fishing vessel which can operate on only 50% or less of the oil used by similar oil powered vessels. (Fig.6) Therefore, she can stay at sea longer, carry more fish in her hold due to the decrease in fuel storage and engine size, travel faster, operate more efficiently in heavy weather and in general make more money. This vessel will cost 10% more than a ship of the same type built without sails. There are literally hundreds, even thousands of these vessels in the Caribbean: Fishing vessels, inter-island traders (see appendix) small bulkers and general cargo vessels. With help from the local shipyards the same thing can be done for these ships as those mentioned earlier.

However, before considering a retro-fit for any ship or replacing existing vessels with ones of a new design, it is necessary to first look very closely at the cost/savings available to you. Sail assisted power will not work for all ships in all situations. For those of you who would like to begin a preliminary examination as to the net savings available for your ships do to sail assisted power we have developed a computer simulated model which can be made to test the vessel in question. In this way Sail Freight International can determine whether or not sail assisted power will offer sufficient return to justify further work. If you are interested in beginning this preliminary examination we have a simple questionaire you can take home with you. Fill it out and submit the information to Sail Freight International. We can then advise you as to the potential your ships may have for sail-assisted conversion or sail assisted new construction.

National fleets, both frieght and fishing, are suffering because of old, inefficient vessels. The answer to this problem could be the use of sail assisted power and the United Nations is one organization that could help to begin work in this area. Both UNIDO and the UNDP are willing to assist but only if the nations in the Caribbean demonstrate sufficient interest. UNIDO has invited me to this conference to speak to you. Last year the UNDP sent me to Trinidad to assist WISCO. If any of the nations present here today would like to see your cargoes again move on your own ships, expand your export markets, reduce the cost of imports and put your people back to work, then contact your UNDP or UNIDO representative, as a group or individually, and explain to them that you would like to begin investigation of the potential sail assisted power may have for your ships, for your shipyards and for your country. The ball is in your court. There is nothing I or anybody else can do for you until you request our services, directly or through the U.N. Together we can make sail power work.

Thank you very much for the opportunity to have spoken with you this morning.

APPENDIX

Figure 1

Stayed Fore and Aft Rig
Schematic Arrangement Sketch

<u>Key Items</u>

1. Mast
2. Head Stay
3. Back Stay
4. Lower Shrouds
5. Cap Shrouds
6. Main Spreader
7. Main Boom
8. Mainsail
9. Main Halyard
10. Main Furling Drive System
11. Main Luff Roller Extrusion
12. Main Clew Outhaul
13. Main Clew Outhaul Winch
14. Main Sheet
15. Main Sheet Winch
16. Main Sheet Traveller
17. Main Sheet Traveller Car
18. Main Sheet Traveller Winch
19. Main Topping Lift
20. Main Topping Lift Winch
21. Main Boom Vang
22. Main Boom Vang Winch
23. Main Boom Vang Traveller
24. Main Boom Vang Traveller Car
25. Main Boom Vang Traveller Winch
26. Staysail Boom
27. Staysail
28. Staysail Halyard
29. Staysail Furling Drive System
30. Staysail Luff Roller Extrusion
31. Staysail Clew Outhaul
32. Staysail Clew Outhaul Winch
33. Staysail Sheet/Vang
34. Staysail Sheet/Vang Winch
35. Staysail Sheet/Vang-Traveller
36. Staysail Sheet/Vang-Traveller Car
37. Staysail Sheet/Vang-Traveller Winch
38. Staysail Topping Lift (not shown)
39. Staysail Topping Lift Winch (not shown)

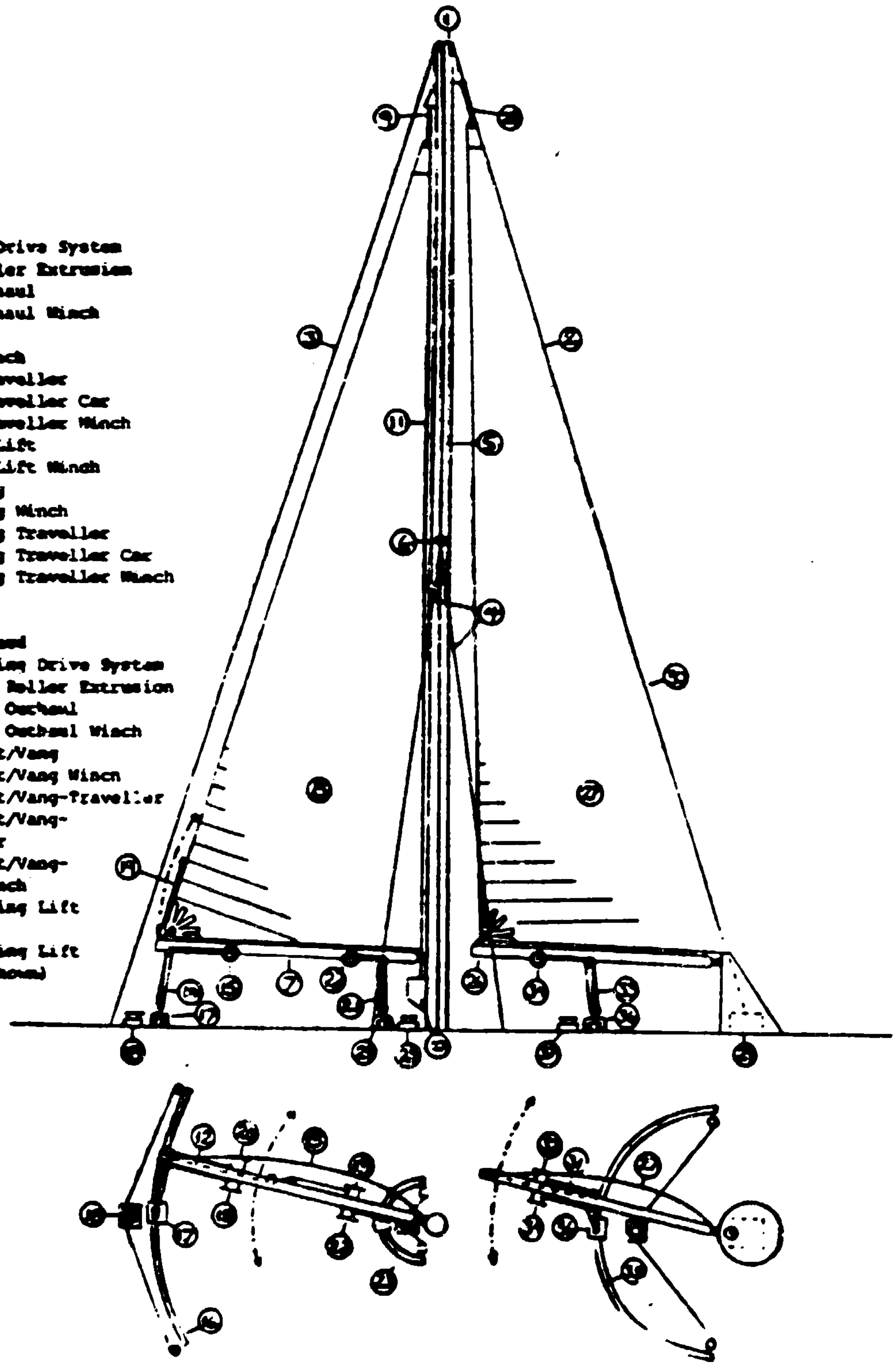
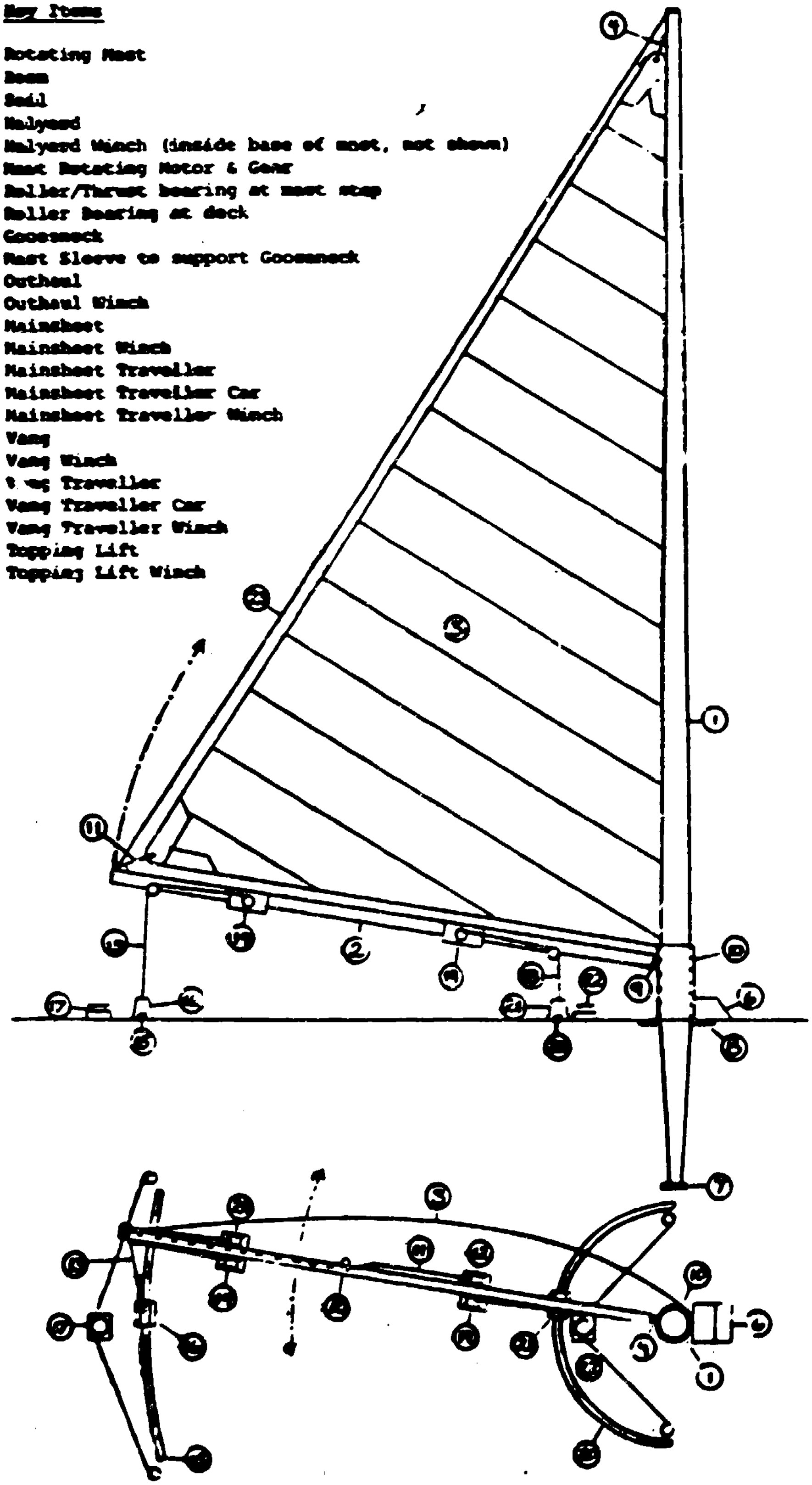


Figure 2

Unstayed Cat Rig
Schematic Arrangement Sketch

Key Items

1. Rotating Mast
2. Boom
3. Sail
4. Halyard
5. Halyard Winch (inside base of mast, not shown)
6. Mast Rotating Motor & Gear
7. Roller/Thrust bearing at mast step
8. Roller Bearing at deck
9. Gooseneck
10. Mast Sleeve to support Gooseneck
11. Outhaul
12. Outhaul Winch
13. Mainsheet
14. Mainsheet Winch
15. Mainsheet Traveller
16. Mainsheet Traveller Car
17. Mainsheet Traveller Winch
18. Vang
19. Vang Winch
20. Vang Traveller
21. Vang Traveller Car
22. Vang Traveller Winch
23. Topping Lift
24. Topping Lift Winch



by B.B. Crowninshield, dimensions: beam 50 ft.; depth of hold 22 ft. 9 in.; LOA 375 1/2 ft; draft 27 1/2 ft.; tonnage 5,218 gross, 4,914 net; carrying capacity 8,000 tons. The Lawson represented the most advanced stage of sailing cargo ships at the turn of the century. Although cumbersone in comparison to the vessels considered for modern use, the addition of simple ste. ı "girdles" allowed her entire 40,000 square feet of sail to be handled by only 12 deck hands. Her relatively streamlined sail plan contributed to the 15% average increase in voyage speeds from 6.5 to 7.5 knots but without auxiliary power her increased performance was overshadowed by the advent of cheap fossil fuel and steam propulsion. Today, vessels of less than half the Lawson's size are operating at 8 to 8.5 knots while burning US$1500-2000 per day in MDO or gas oil. (Compliments of Norman Brouwer Collection)

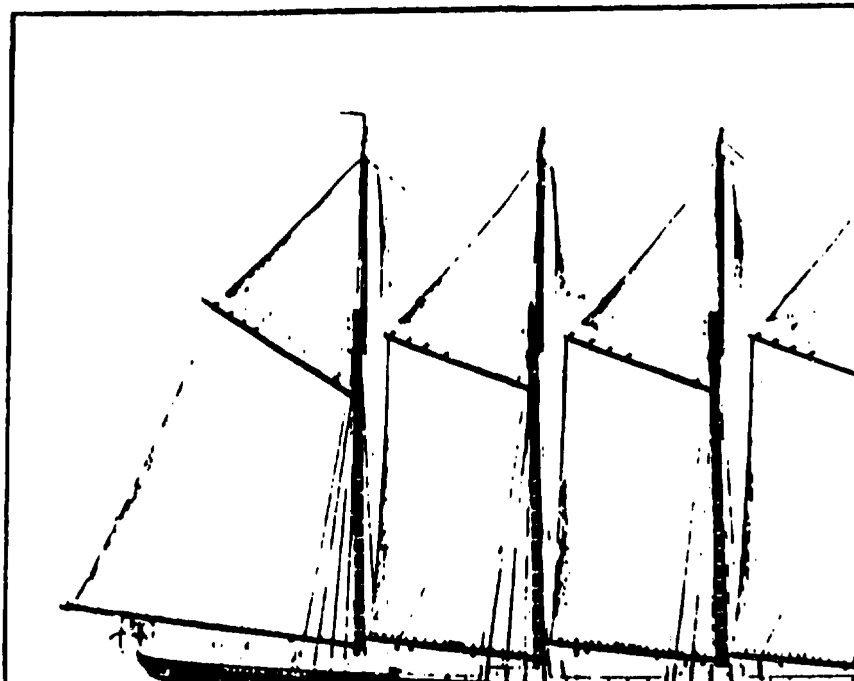


Figure 3

SAIL

No.		Mat	Wt	Area Sq Ft
[illegible]	Jib	Dac	26	5,000
2	Fore Staysail	Dac	26	2,500
3	Fore Tri Topsail	Dac	26	5,000
4	Main Staysail	Dac	26	2,500
5	Main Tri Topsail	Dac	26	5,000
6	Mizzen Staysail	Dac	26	2,500
7	Mizzen	Dac	26	5,000

27,500 Sq Ft
= 2,556 m² [illegible]

Figure 4

2,500 ton cdwt general cargo vessel designed by SFI, Inc. for use in the Caribbean Basin.

	English	Metric
LOA	330'	100 m
Beam	50'	15.2 m
Draft	17'	5.2 m
Depth	24.5	7.4 m
DWT	2,500	
No Masts	3	
Single Screw Diesel [illegible]		
HP [illegible]	2,900 HP	
Sail area	27,500 Ft²	2,556 m²
Bow Thruster Stern Thruster		

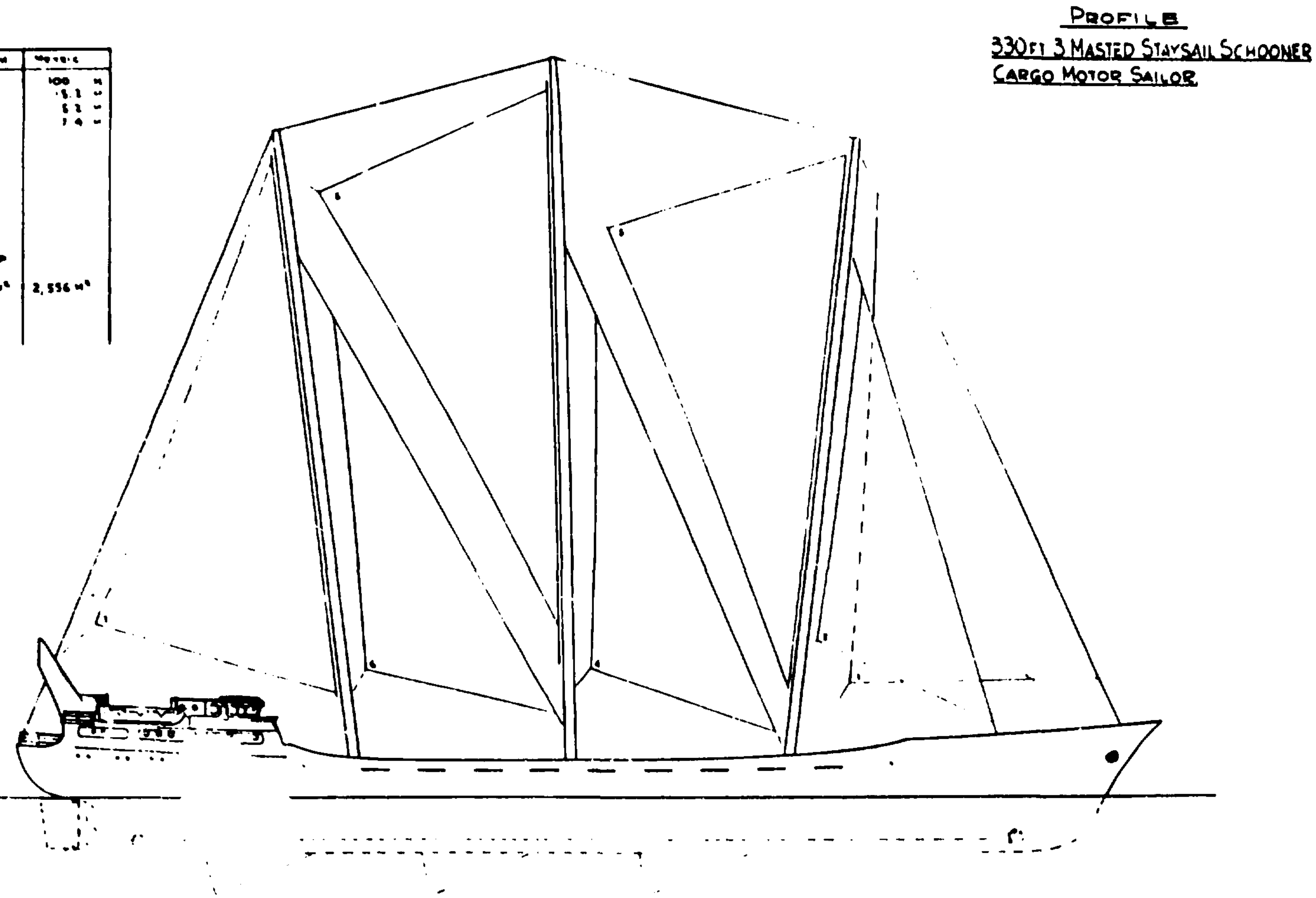
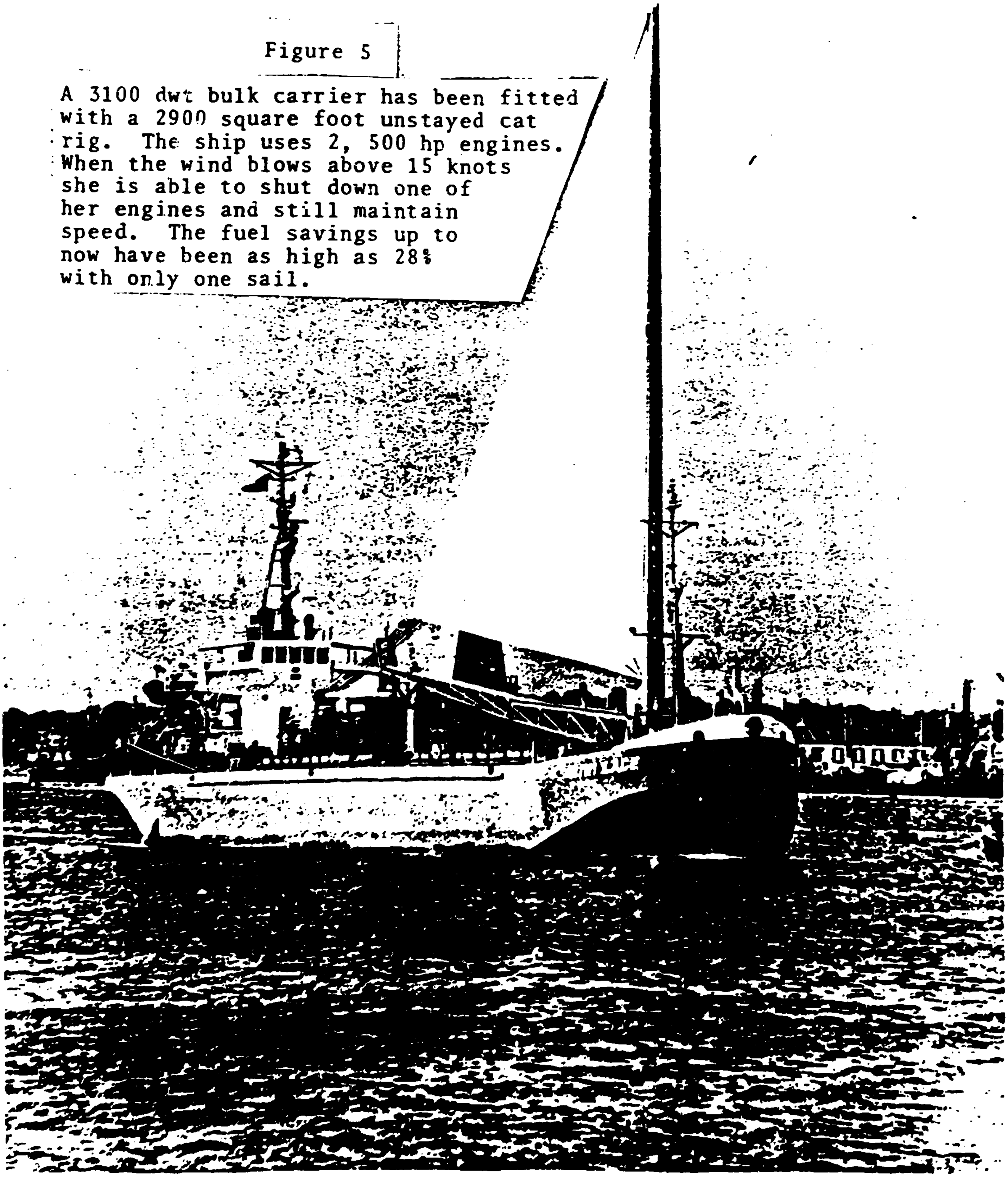


Figure 5

A 3100 dwt bulk carrier has been fitted with a 2900 square foot unstayed cat rig. The ship uses 2, 500 hp engines. When the wind blows above 15 knots she is able to shut down one of her engines and still maintain speed. The fuel savings up to now have been as high as 28% with only one sail.



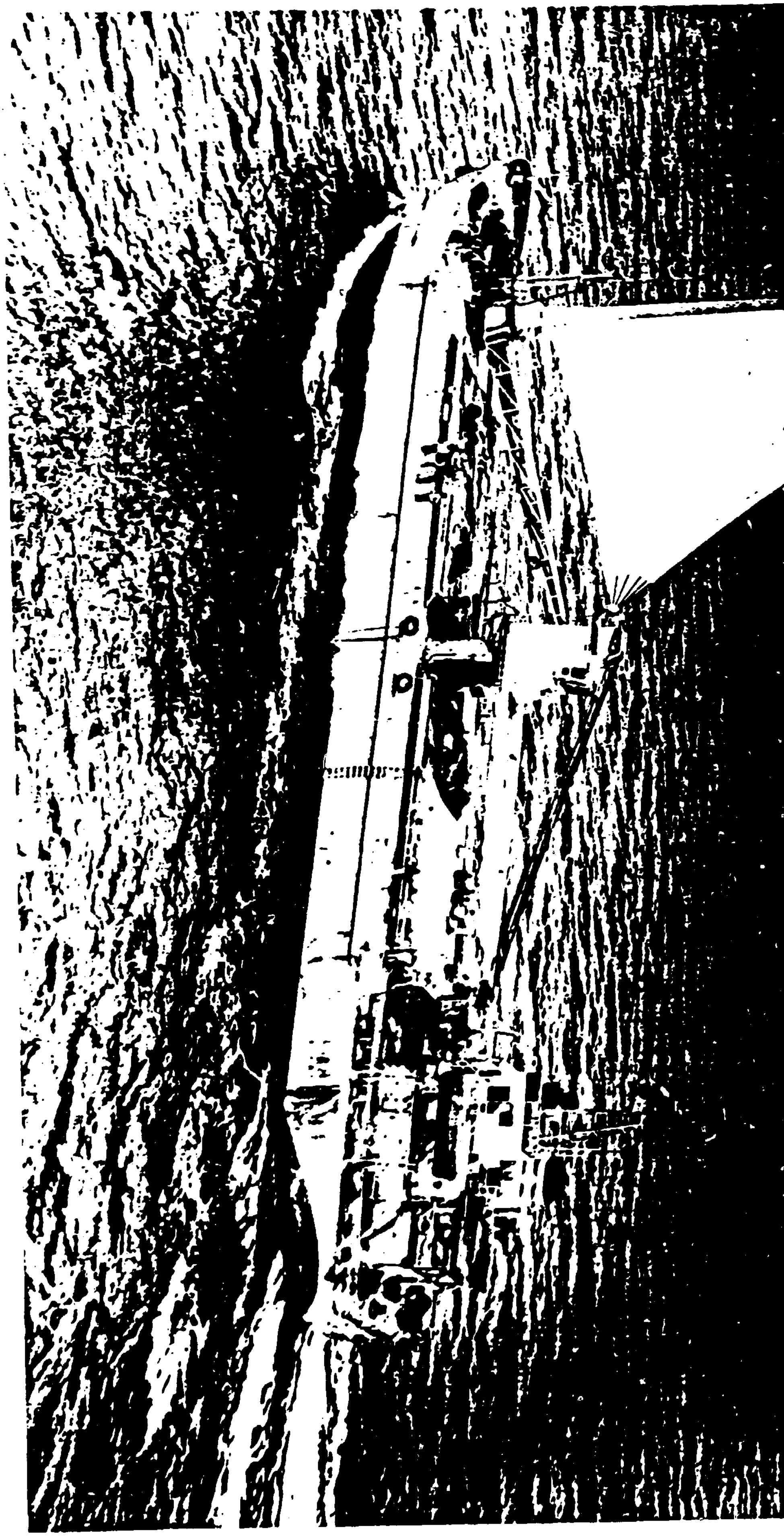


Figure 5a

The sail assisted mechanism for this ship was designed, constructed and installed in the United States. Except for the sail cloth, this entire project could be done in the local ship yards in the Caribbean.

Figure 6

Modern Sail Assisted (S/A) fishing vessel, approximately 100 tons cdwt. Molded hull allows construction in local yards.

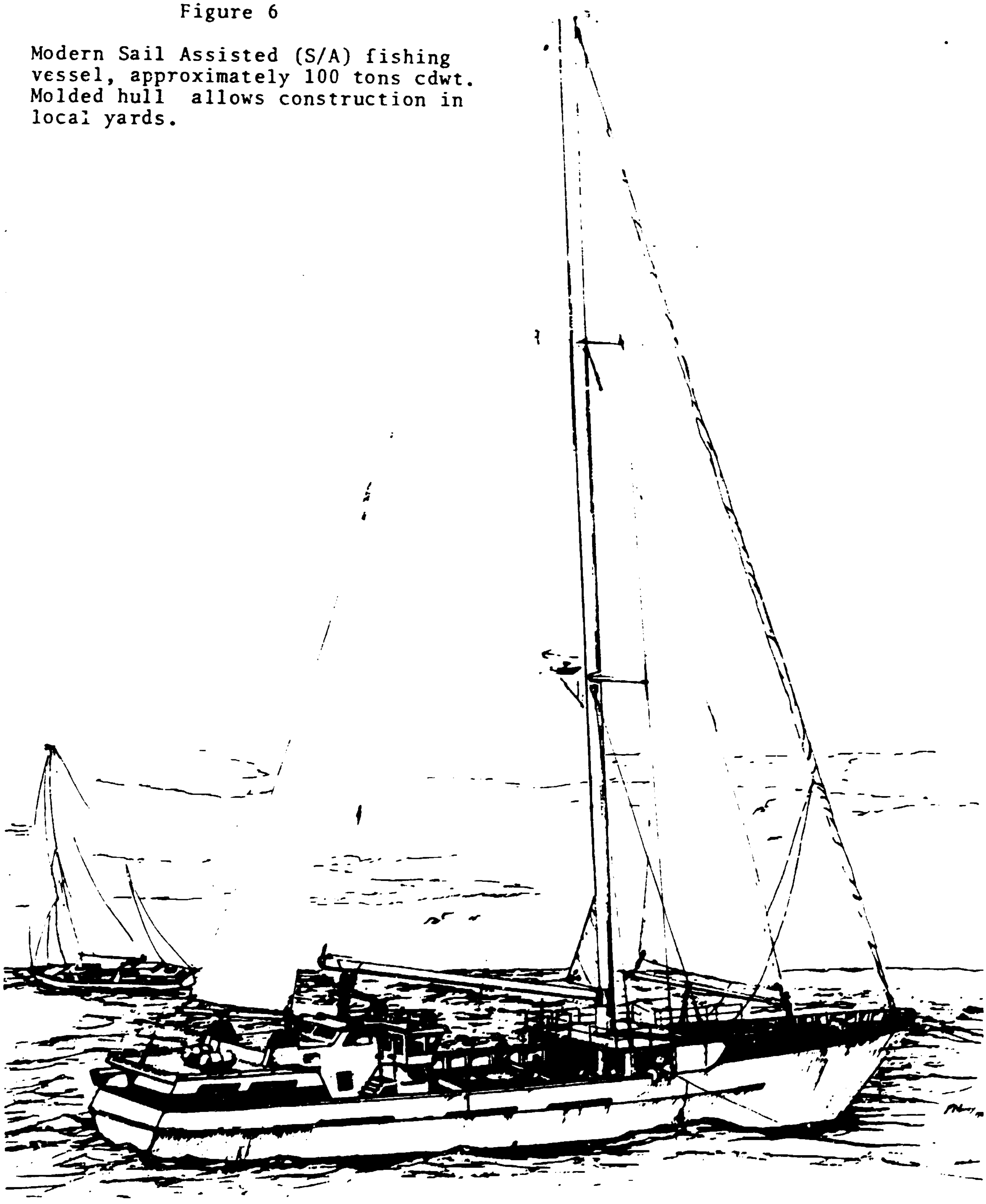


Figure 7

150 ton cdwt cargo vessel for use in the Caribbear Basin. To be constructed by a shipyard in the area.

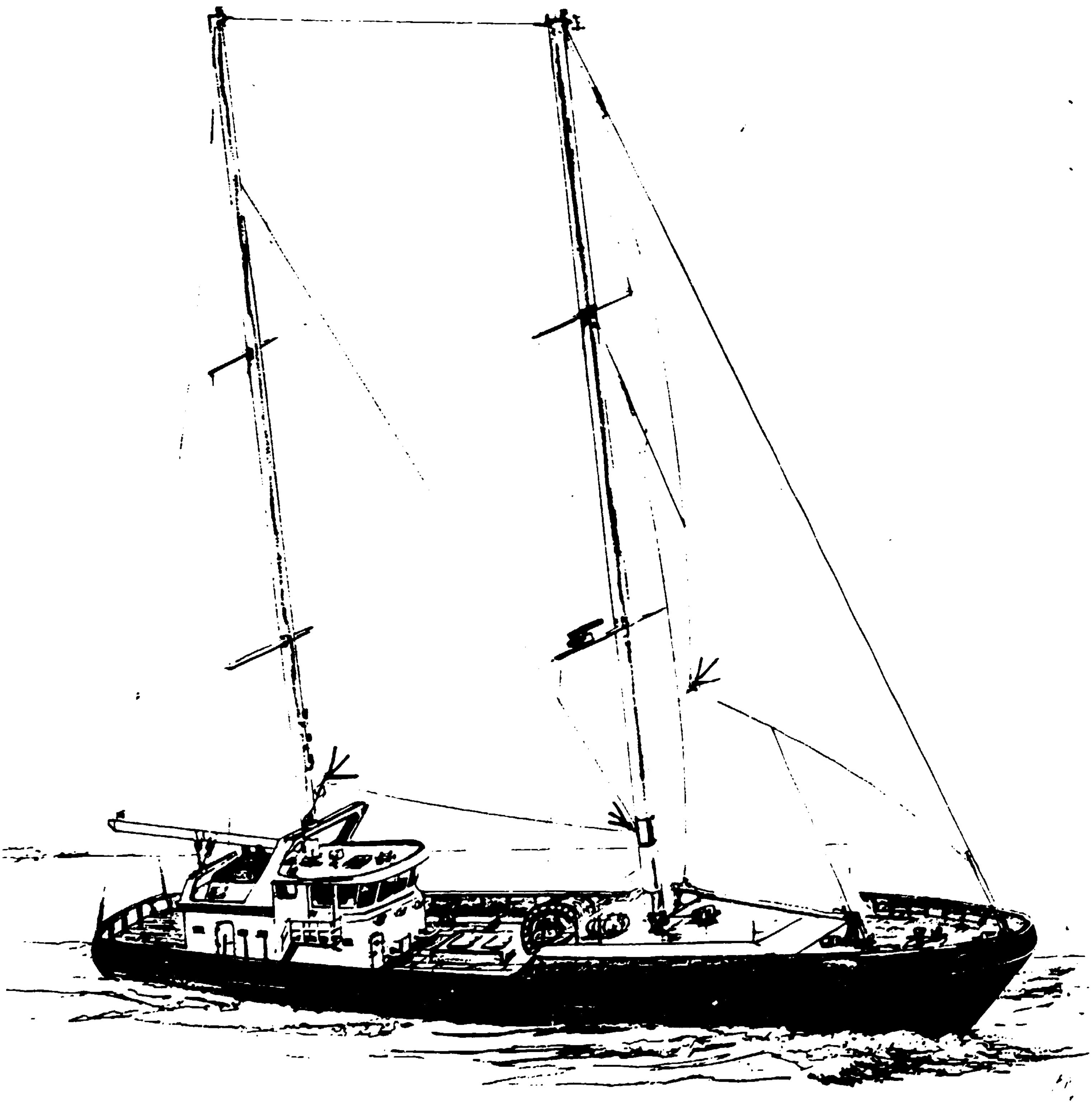
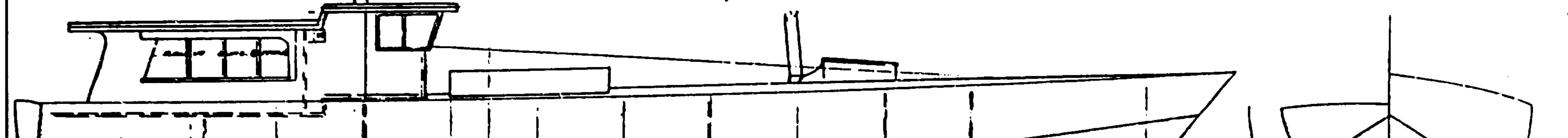
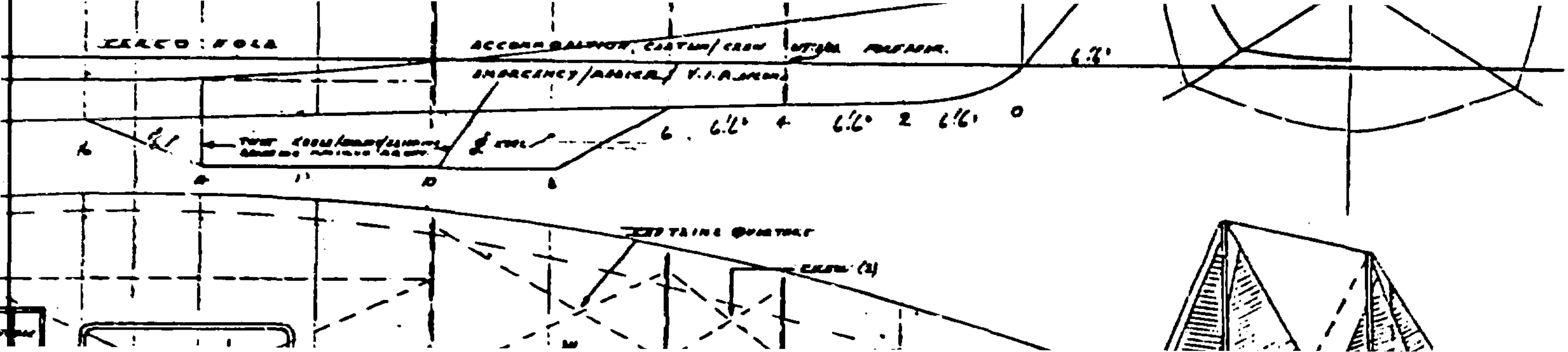


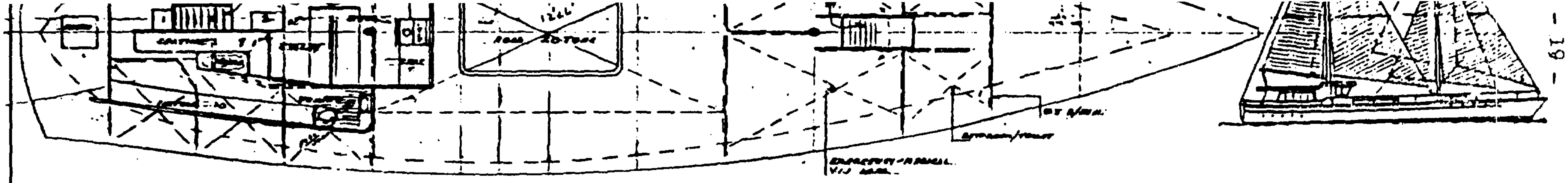
Figure 8

A 100 ton cdwt trading schooner presently under construction in the South Pacific for use between the Islands.





6'6"
0
2
4
6
CREW (2)



PRELIMINARY · DESIGN · STUDY · (A)

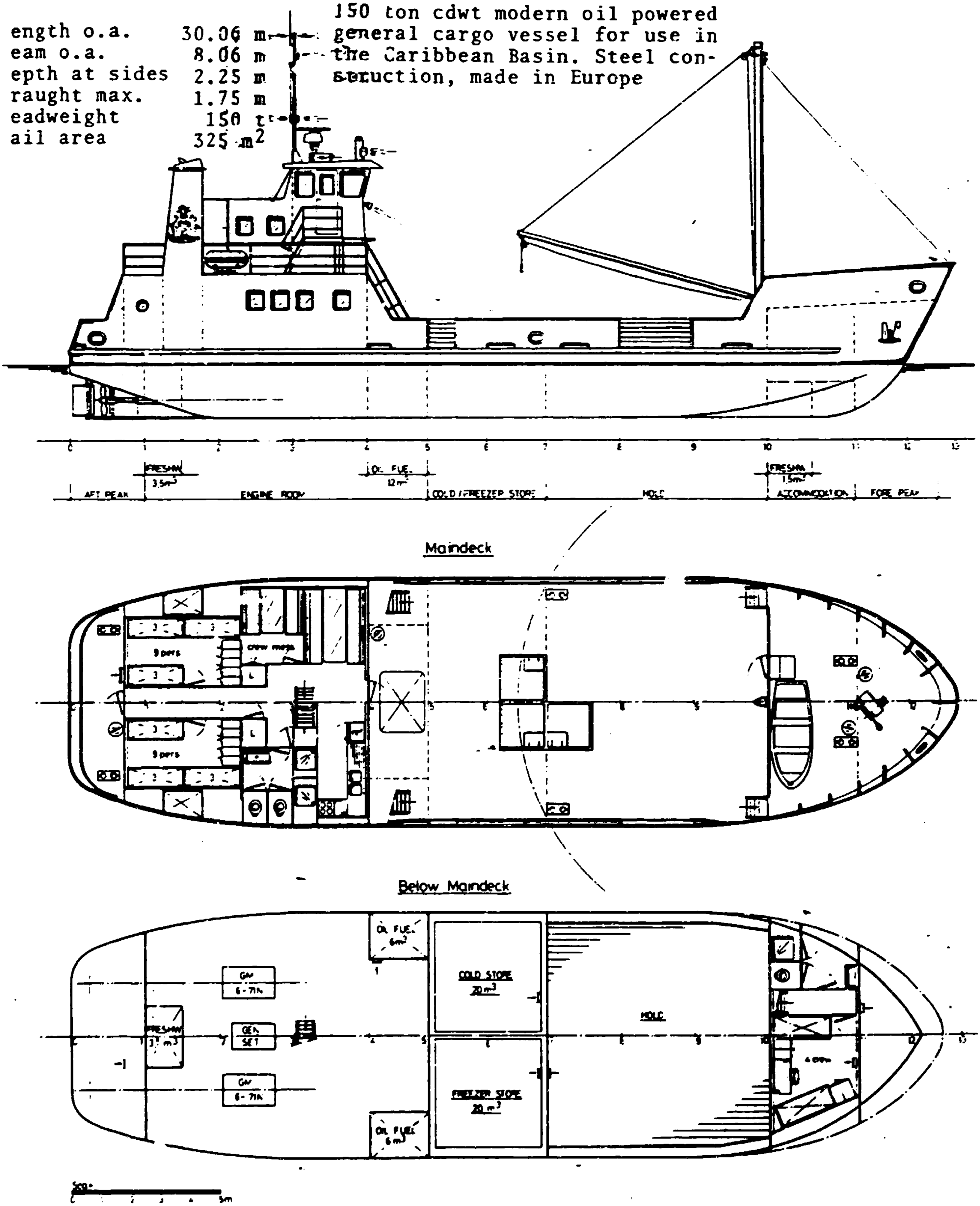
A BASIC APPROACH EASILY DRIVEN, LIGHT SAILING TYPE HULL

SAILING · DEISEL · POWERED · ISLAND · TRADING · VESSEL · SUITABLE FOR CARRYING PASSENGERS & CARGO BETWEEN ISLANDS;
APPLICABLE ANYWHERE, ABLE TO OPERATE UNDER SAIL ONLY FOR HIGH PROPORTION OF TIME & WITH AUXILIARY DIESEL POWER

Figure 9

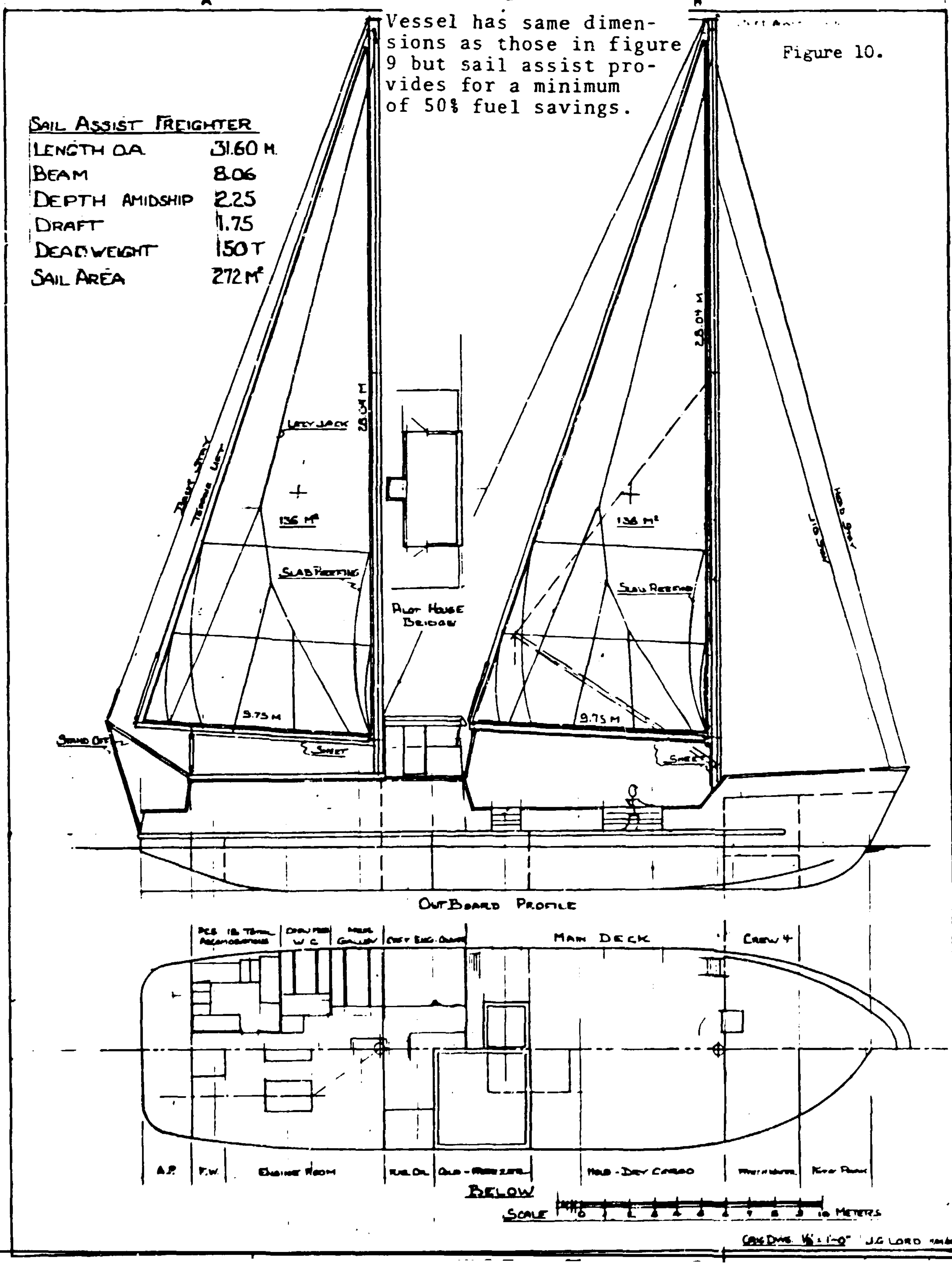
150 ton cdwt modern oil powered general cargo vessel for use in the Caribbean Basin. Steel construction, made in Europe

ength o.a.	30.06 m
eam o.a.	8.06 m
epth at sides	2.25 m
raught max.	1.75 m
eadweight	150 t
ail area	325 m^2



Vessel has same dimensions as those in figure 9 but sail assist provides for a minimum of 50% fuel savings.

Figure 10.



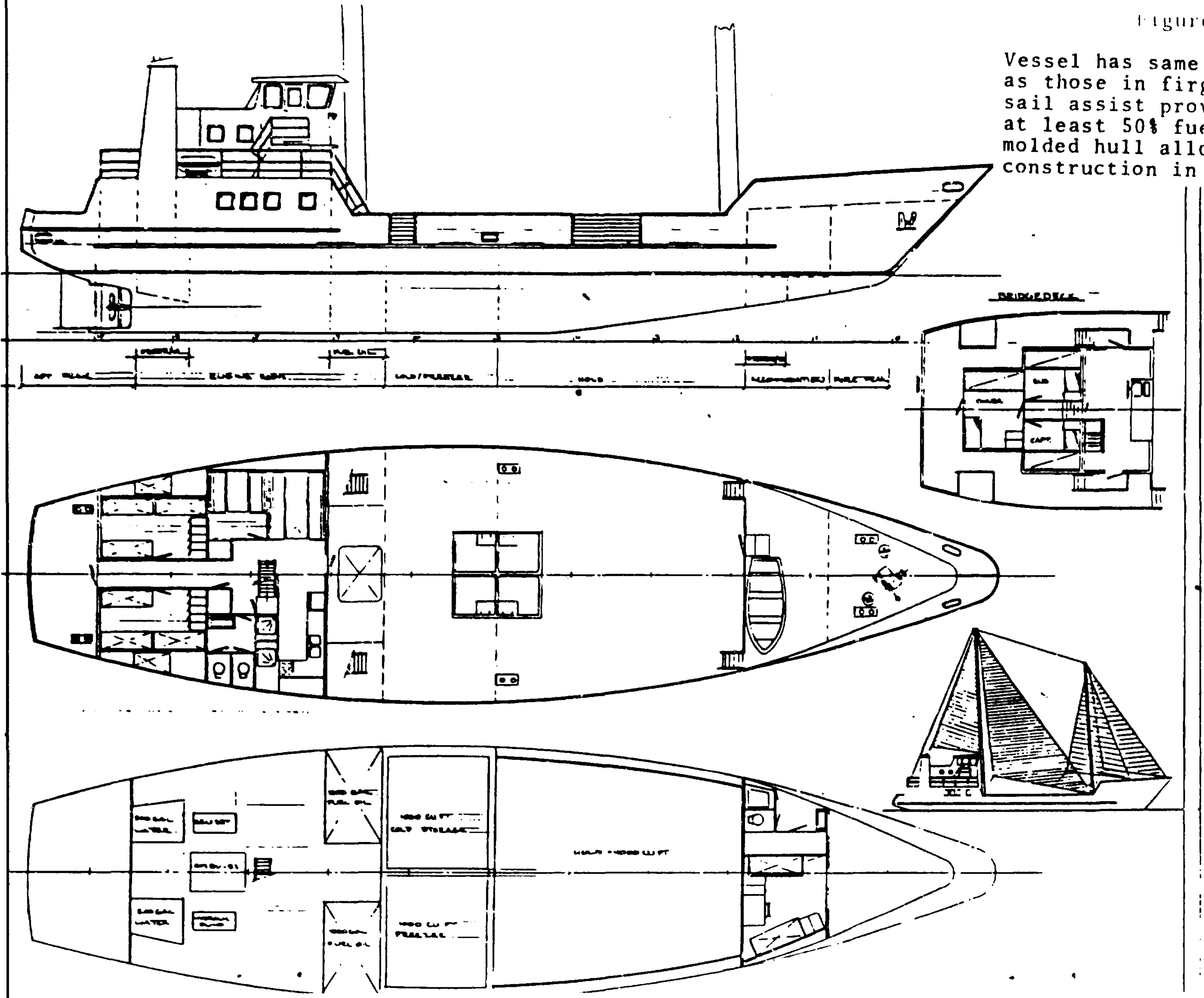


Figure 11

Vessel has same dimensions as those in firgure 9 but sail assist provides for at least 50% fuel savings. molded hull allows complete construction in local yards.