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(54) Marine seismic survey vessel.

(57) The present invention provides a marine seismic survey vessel, which vessel includes at least one propeller for propelling the vessel, and driving means for driving the or each propeller, said driving means being capable of driving the seismic survey vessel at a selected surveying speed through the water (e.g. of up to nine knots) and the or each propeller being selected such that substantially no cavitation occurs adjacent thereto at said selected surveying speed. Preferably the marine seismic survey vessel includes a propulsion system comprising a first prime mover, and a second prime mover, the first and second prime movers being operably connected to the propeller(s) and the first prime mover being an electric motor or a diesel electric motor. Preferably, the propellor(s) of the marine survey vessel are highly skewed. Preferably, the hull form of the marine seismic survey vessel is arranged to produce low wake field turbulence, in particular by suitably streamlining a skeg(s) of the propeller(s) of the vessel.

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Description

MARINE SEISMIC SURVEY VESSEL

This invention relates to a marine seismic survey vessel.

Marine seismic survey vessels are known but up until now have generally been conversions from stern trawlers, mud boats, coasters etc. With such craft, little or no consideration has been given to minimizing "tow noise". Later vessels, even purpose-built, have not been able to reduce radiated hydro-acoustic noise significantly.

The high noise level which such vessels produce degrades the quality of acoustic information attainable using the vessel.

It is an object of the invention to provide an improved marine seismic survey vessel which produces low noise levels when surveying.

According to a first aspect of the present invention there is provided a marine seismic survey vessel, which includes at least one propeller for propelling the vessel, and driving means for driving the or each propeller, said driving means being capable of driving the seismic survey vessel at a selected surveying speed through the water and the or each propeller being selected such that, in use, substantially no cavitation occurs adjacent thereto at said selected surveying speed.

The said selected surveying speed will generally be up to about seven knots, depending upon the weight and drag of the surveying equipment to be towed by the vessel.

According to a second aspect of the present invention there is provided a method of conducting a marine seismic survey which method comprises employing a marine seismic survey vessel as hereinbefore defined, and conducting a said marine seismic survey under conditions such that substantially no cavitation occurs adjacent the or each propeller of the vessel.

Preferably, the marine seismic survey vessel includes a propulsion system comprising a first prime mover, and a second prime mover, the first and second prime movers being operably connected to the propeller(s) and the first prime mover being an electric motor or a diesel electric motor.

Preferably, the propulsion system for the marine survey vessel includes at least one highly skewed propeller.

Preferably, the hull form of the marine seismic survey vessel is arranged to produce low wake field turbulence, in particular by suitably shaping a skeg or skegs of the vessel.

Preferably, most or all of the driving or driven machinery of the marine seismic survey vessel is resiliently mounted to reduce effects of hull transmitted vibration.

By means of the present invention it is possible to achieve an on-survey noise level of no greater than 0.25 microbar at 200 m. range. Moreover noise in the frequency range 4-250 Hz is substantially less than has previously been the case.

An embodiment of the invention will now be described, by way of example, only, by reference to the accompanying drawings, in which:

Fig. 1 shows a graph of measured sound pressures (micro Bar) corresponding to wake field turbulence, against angular position (degrees), at different radii from the axis of revolution of a propeller, measured in relation to a model having the hull characteristics of Figs. 2 and 3;

Fig. 2 represent the profiles respectively of the fore and afterbody of an embodiment of a vessel in accordance with the present invention; and

Fig. 3 represent fore and afterbody half sections of the vessel of Fig. 2.

Referring to Figs. 2 and 3 of the drawings, there is shown the hull of a marine seismic survey vessel. It will be observed that the vessel is provided with two skegs, each for supporting a propeller. The hull is carefully designed to produce very low wake field turbulence. Details of the hull are given in the following table:

		Model	Ship
Length overall	(m)	4.922	78.75
Length on designed waterline	(m)	4.656	74.50
Length between perpendiculars	(m)	4.500	72.00
Breadth moulded	(m)	0.900	14.40
Breadth waterline	(m)	0.900	14.40
Draught at $L_{PP}/2$	(m)	0.300	4.80
Draught at FP	(m)	0.300	4.80
Draught at AP	(m)	0.300	4.80
Depth to main deck	(m)	0.484	7.75
Trim	(m)	-	-
Designed trim	(m)	0.075	1.20
Rise of floor	(m)	0.075	1.20
Tumble-home	(m)	-	-
Bilge	(m)	0.138	2.20
Volume of displacement	(m^3)	0.714	2925
Displacement	(ton)		3025
Prismatic-coefficient *		0.675	0.675
Block-coefficient *		0.588	0.588
Midship section coefficient		0.871	0.871
Longitudinal C.B. rel. to $L_{PP}/2$	(m)	-	0.115
Longitudinal C.B. rel. to $L_{PP}/2$	%	-	0.155
Wetted surface	(m^2)	5.156	1320

REMARKS: *Refers to L_{PP} (length between perpendiculars)
Appendage : Rudders
Turbulence stimulator : Turbulence Wire

More importantly however the propellers are selected to be of such a size, pitch and skew, and to have such a rate of rotation at a normal survey speed, that no cavitation occurs at the propellers.

Cavitation, i.e. the formation of voids occurs at the back of a screw propeller when water adjacent to the propeller is no longer able to follow the blades with the velocity due to its own head. This is dependent upon the thrust exerted by the propeller which is itself dependent upon factors such as blade area blade diameter, propeller speed and blade pitch. Recognised formulae exist for designing propellers and propulsion systems to prevent cavitation.

The vessel is preferably equipped with twin, four metre diameter, four bladed highly skewed propellers. Preferably, each propeller has a pitch to diameter ratio of approximately 1.3 to one. The propellers may be directly driven by diesel engines at 120 rpm, for example, for high speed cruising to and from survey areas or by diesel electric motors at 60 rpm for surveying (from e.g. 4-10 knots), with these two prime movers being connected to the propellors by a gearbox arrangement. In the low rpm electric drive mode, the basic blade frequency is reduced to 4 hertz and the propellers are designed not to cavitate or resonate at this frequency, thus reducing hydro-acoustic noise to a remarkable extent. The use of a diesel electric motor in itself reduces noise since diesel electric motors are considerably quieter than diesel engines.

For speeds up to 14 knots it is should not be necessary to drive the propellers at more than approximately 100 rpm.

Further to reduce noise, all engines, auxiliaries, pumps, compressors, etc. are preferably resiliently mounted to minimize any effects of hull transmitted vibration.

Moreover, reductions in propeller noise can also be achieved by reducing the thickness of the propeller blades and minimising thrust variation of the blades. It is for this reason that one or more skewed propellers are preferably used.

Preferably, with a twin propeller configuration, the propellers are arranged to be driven in an inwardly rotating mode, since less power is required for a given speed and less noise is produced.

Referring to Fig. 1 of the accompanying drawings there are shown respectively graphs as aforesaid at radii of 60 mm, 80 mm and 100 mm each at model scale. The model scale was 16. The hull was as shown in Figs. 2 and 3. Details of the propellers were as follows:

	Model	Ship
Propeller diameter (m)	0.25	4.00
Pitch ratio at 0.7R	1.28	1.28
Number of blades	4	4
Exp. area/disc area	0.55	0.55
Chord length of the propeller section at 0.7R (m)	0.0824	1.318
Max. thickness of the propeller section at 0.7R (m)	0.0032	0.051
Hub diameter (m)	0.050	0.800

It will be seen from the graphs of Fig. 1 that in each case the wake field pressures are extremely low, in all cases being less than 0.24 Bar. These results are scaled in accordance with the following equation:

$$P_f = P_m \times \frac{r_m \times D_f \times P_f}{r_f \times D_m \times P_m}$$

where:

P_f = fullscale noise (micro Bar)
P_m = mode scale noise (micro Bar)
D_f = diameter of full size propeller (m)
D_m = diameter of model propeller (m)
r_f = distance from hydrophone to shaft centre in full size vessel (m)
r_m = distance from hydrophone to shaft centre in full size vessel (m)
P_f = atmospheric pressure (1 Atm)
P_m = atmospheric pressure (1 Atm)

The results confirm that both the model and the vessel have extremely low noise levels, primarily because of the elimination of cavitation noise.

The invention may be performed otherwise than as has been particularly described, and the invention includes within its scope all modifications and changes which would be apparent to one skilled in the art.

Claims

1. A marine seismic survey vessel, which includes at least one propeller for propelling the vessel, and driving means for driving the or each propeller, said driving means being capable of driving the seismic survey vessel at a selected surveying speed through the water and the or each propeller being selected such that, in use, substantially no cavitation occurs adjacent thereto at said selected surveying speed.

2 A marine seismic survey vessel according to Claim 1, which includes a propulsion system comprising a first prime mover, and a second prime mover, the first and second prime movers being operably connected to the propeller(s) and the first prime mover being an electric motor or a diesel electric motor.

3. A marine seismic survey vessel according to Claim 1, wherein the or each propeller is highly skewed.

4. A marine seismic survey vessel according to Claim 1, wherein the hull form is arranged to produce low wake field turbulence.

5. A marine seismic survey vessel according to Claim 4, wherein the hull form is as hereinbefore described and as shown in Figs. 2 and 3 of the accompanying drawings.

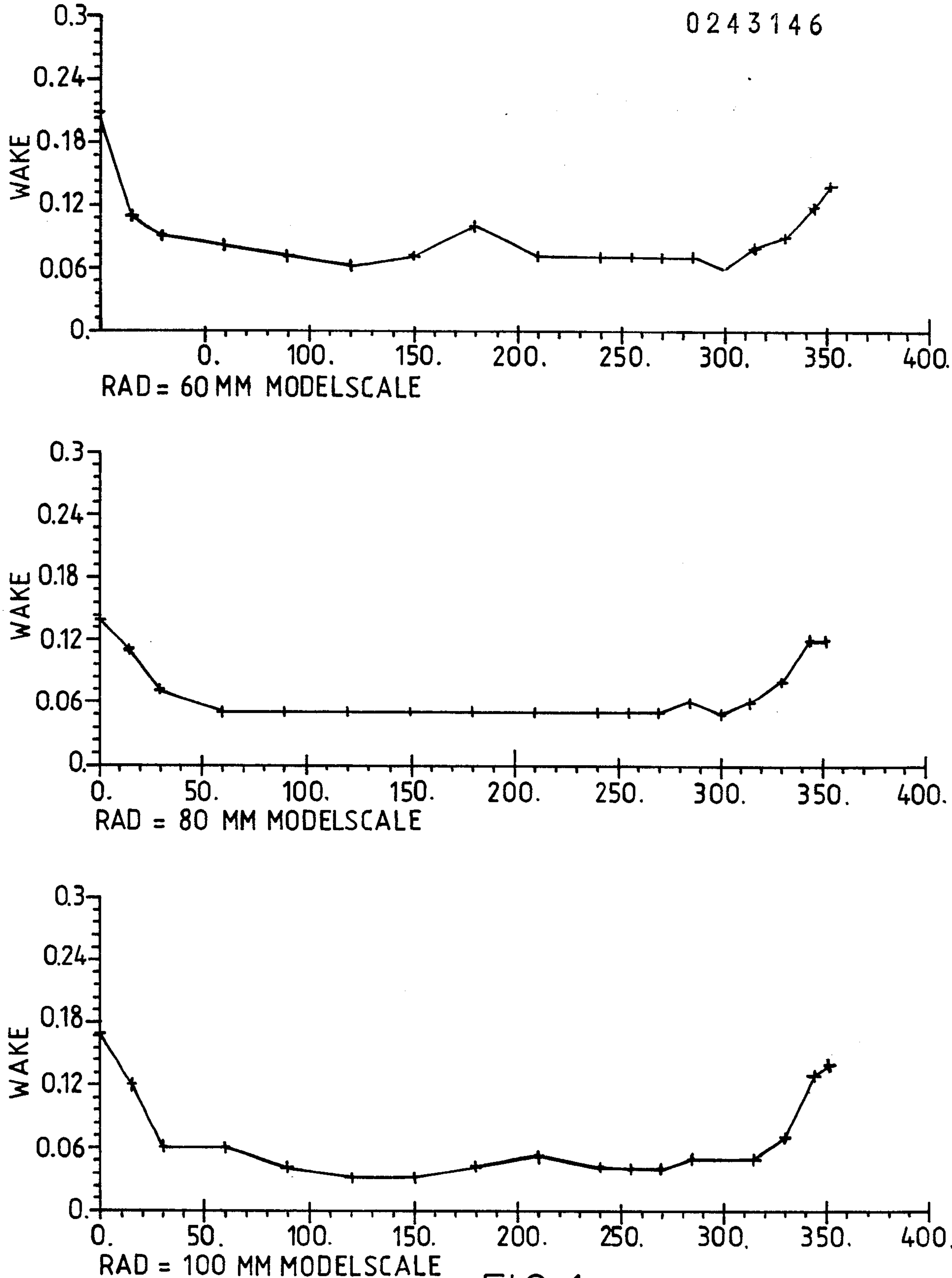
6. A marine seismic survey vessel according to Claim 1, having twin four-bladed propellers.

7. A marine seismic survey vessel according to Claim 6, wherein each propeller has a pitch to diameter ratio of 1.3 to 1.

8. A marine seismic survey vessel according to Claim 6, wherein the propellers are arranged to rotate at approximately 60 rpm to achieve a speed through the water of the vessel of up to 9 knots.

9. A marine seismic survey vessel substantially as hereinbefore described.

10. A method of conducting a marine seismic survey which method comprises employing a marine seismic survey vessel as claimed in any one of the preceding claims defined, and conducting a said marine seismic survey under conditions such that substantially no cavitation occurs adjacent the or each propeller of the vessel.



WAKE
0.3
0.24
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0.12
0.06
0.
0.
100.
150.
200.
250.
300.
350.
400.
RAD = 60 MM MODELSCALE
WAKE
0.3
0.24
0.18
0.12
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0.
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50.
100.
150.
200.
250.
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RAD = 80 MM MODELSCALE
WAKE
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0.18
0.12
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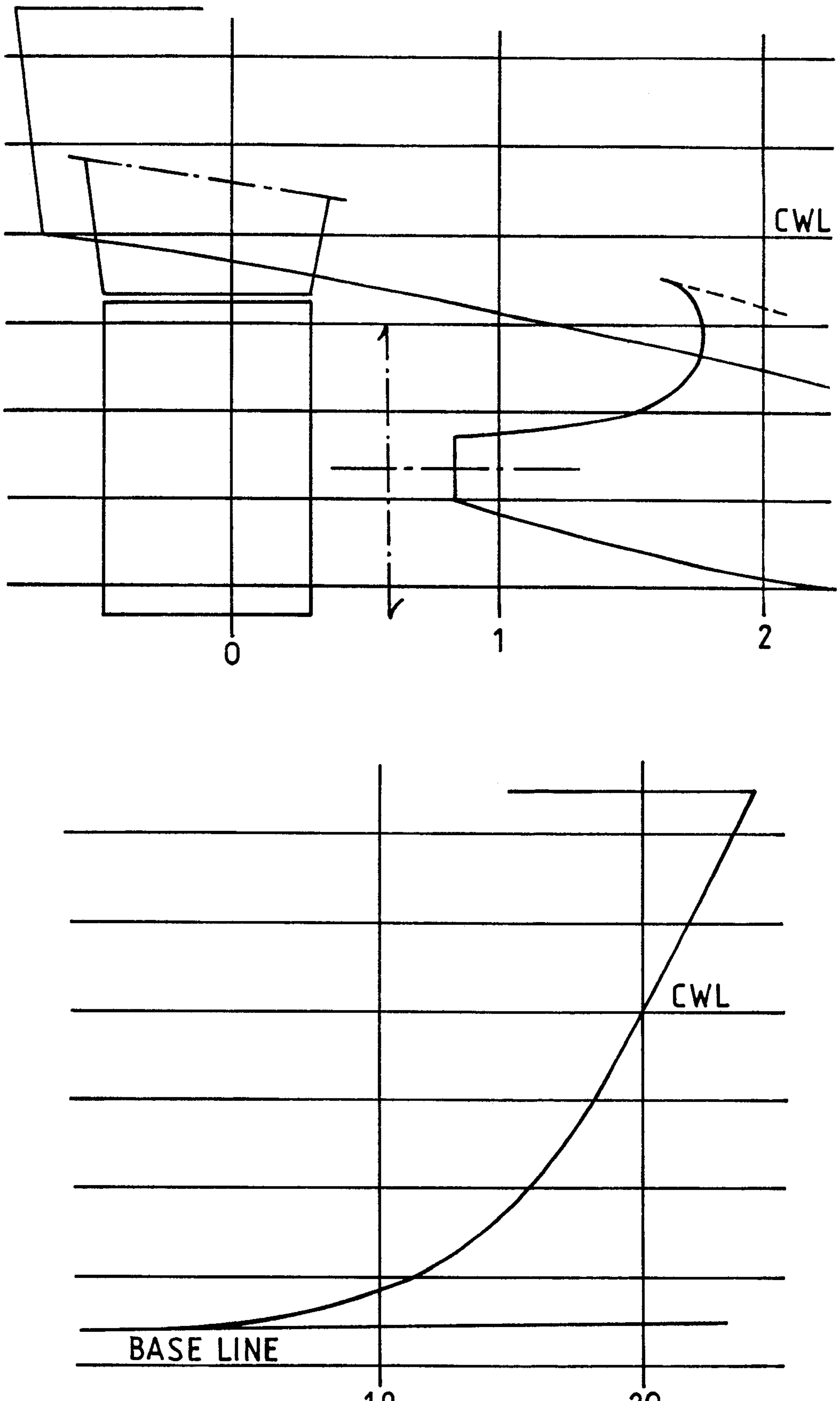
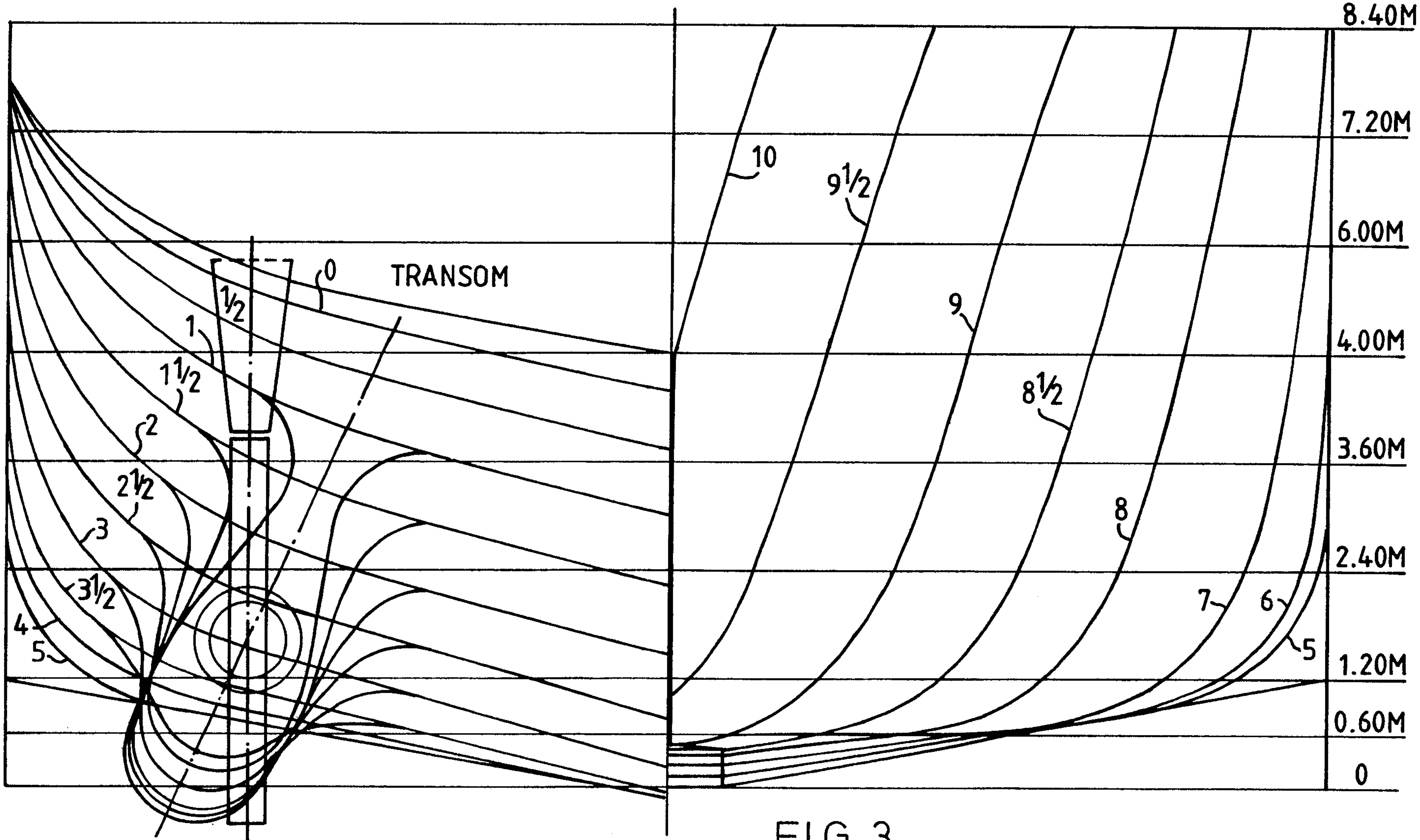
RAD = 100 MM MODELSCALE

FIG.1.



F I G. 2.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7
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5

FIG.3.