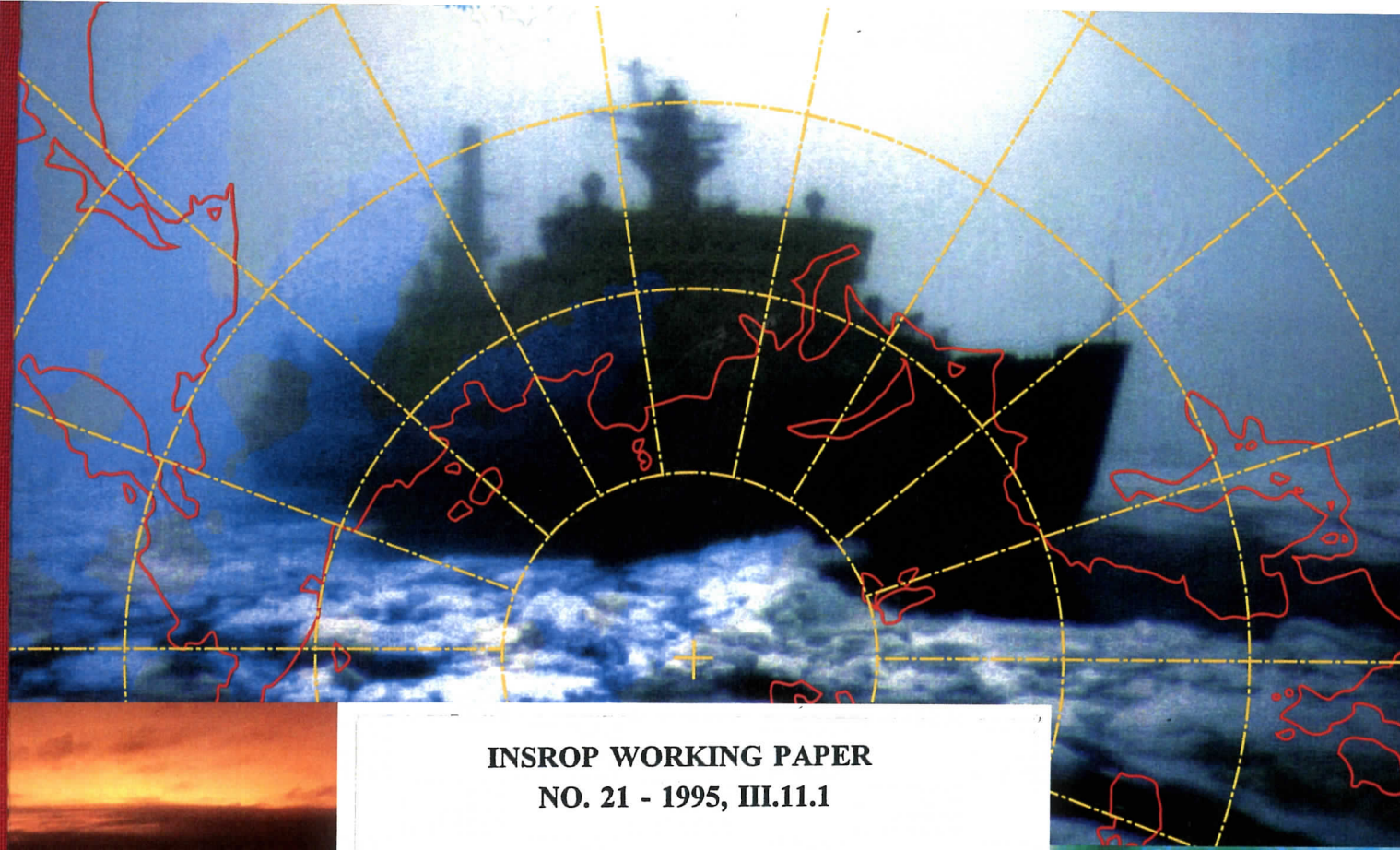
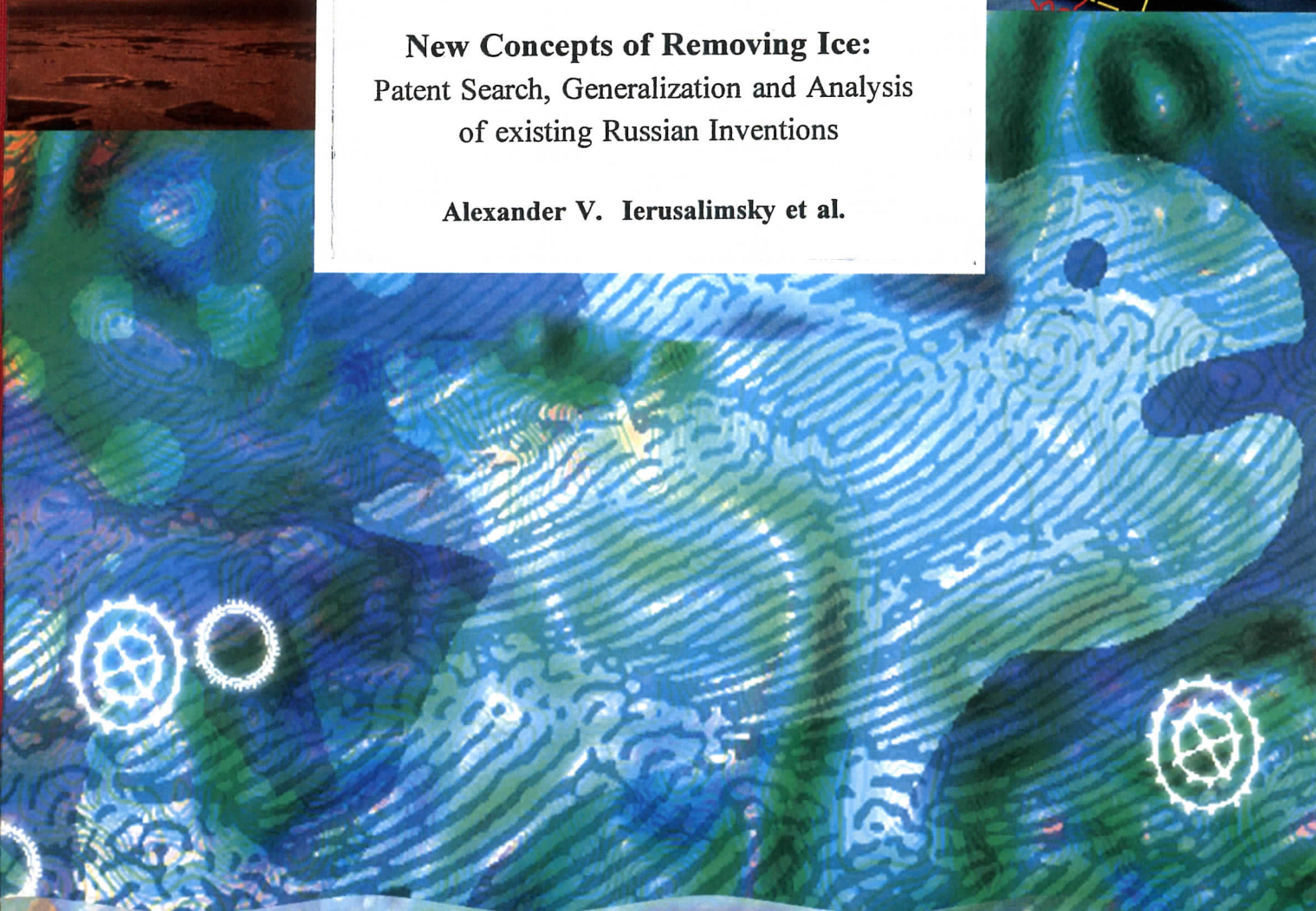


INSROP WORKING PAPER
NO. 21 - 1995, III.11.1

New Concepts of Removing Ice:
Patent Search, Generalization and Analysis of existing Russian Inventions

Alexander V. Ierusalimsky et al.



INSROP International Northern Sea Route Programme

Central Marine Research & Design Institute, Russia

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International Northern Sea Route Programme (INSROP)

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INSROP WORKING PAPER NO. 21-1995

Sub-programme III: Trade and Commercial Shipping Aspects.

Project III.11.1: New Concepts of Removing Ice: Patent Search, Generalization and Analysis of the Existing Russian Inventions.

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Date: 11 October 1995.

Reviewed by:
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FOREWORD - INSROP WORKING PAPER

INSROP is a five-year multidisciplinary and multilateral research programme, the main phase of which commenced in June 1993. The three principal cooperating partners are **Central Marine Research & Design Institute (CNIIMF)**, St. Petersburg, Russia; **Ship and Ocean Foundation (SOF)**, Tokyo, Japan; and **Fridtjof Nansen Institute (FNI)**, Lysaker, Norway. The INSROP Secretariat is shared between CNIIMF and FNI and is located at FNI.

INSROP is split into four main projects: 1) Natural Conditions and Ice Navigation; 2) Environmental Factors; 3) Trade and Commercial Shipping Aspects of the NSR; and 4) Political, Legal and Strategic Factors. The aim of INSROP is to build up a knowledge base adequate to provide a foundation for long-term planning and decision-making by state agencies as well as private companies etc., for purposes of promoting rational decisionmaking concerning the use of the Northern Sea Route for transit and regional development.

INSROP is a direct result of the normalization of the international situation and the Murmansk initiatives of the former Soviet Union in 1987, when the readiness of the USSR to open the NSR for international shipping was officially declared. The Murmansk Initiatives enabled the continuation, expansion and intensification of traditional collaboration between the states in the Arctic, including safety and efficiency of shipping. Russia, being the successor state to the USSR, supports the Murmansk Initiatives. The initiatives stimulated contact and cooperation between CNIIMF and FNI in 1988 and resulted in a pilot study of the NSR in 1991. In 1992 SOF entered INSROP as a third partner on an equal basis with CNIIMF and FNI.

The complete series of publications may be obtained from the Fridtjof Nansen Institute.

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SUMMARY

The information gathered on methods of breaking the ice and structures proposed was analysed and systematized according to the purpose and principle of action. Analysis was made also of auxiliary technical means improving the efficiency of ice breaking by the ship's hull, including washing, heeling and other systems. While selecting inventions and other publications, concepts were taken into account which may be used for purposes of navigation and which may be structurally implemented on icebreakers and ice strenthened transport ships.

KEY WORDS: METHODS, BREAKING ICE, AUXILIARY TECHNICAL MEANS, EFFICIENCY, SHIP, HULL, ICEBREAKER.

CONTENTS

INTRODUCTION

The realization of the Project "New Concepts in Removing Ice" should enable, in our opinion, determination of the efficiency of various concepts of ice-breaking and means to augment ice-breaking capability, as well as to elaborate recommendations on their use in icebreakers and commercial ships designed for Arctic navigation depending on their purpose, area and season of navigation.

The objectives pursued by this Paper are as follows:

- to collect and sum up information on new means of ice-breaking contained in patents, inventions, papers, monographs, scientific works, published in Russia;

- to classify new engineering solutions in terms of their purpose and operating principle;

- to analyze fundamental differences between the main concepts of ice breaking;

- to ascertain a degree of practical use of different engineering solutions.

One of the important objectives of the survey and classification of new means of ice destruction is also to prevent in future efforts directed toward the reinvention of already known methods and constructions.

Based on the above objectives, a patent and information search was done. Main concepts were compared with one another and with traditional means of ice-breaking. Auxiliary technical means improving the efficiency of breaking the ice with the ship's hull were also covered by the patent and information search. In choosing patents, inventors' certificates and other publications, consideration was given to the proposals which can be used for shipping needs and realized in the construction of icebreakers and commercial ships designed for navigation in ice.

A large group of patents and ideas now available for the protection of fixed offshore drilling units in ice conditions, for ice clearing of part and other hydraulic-engineering structures, etc. was also studied, but only some few engineering solutions, the application of which is theoretically possible on board ships, were chosen for the purpose of analysis.

Based on the patent and information search done, more than 100 engineering solutions were chosen and grouped by purpose and operating principle. That enabled suggesting the classification of new concepts of breaking the ice and clearing the created channel for shipping. All the concepts chosen were also subdivided according to the degree of their realization.

It should be mentioned that, as stated in the assignment, only Russian patents (including foreigners' patents granted in Russia) and inventors' certificates, as well as information on realization of different concepts in Russia were reviewed.

Authors of the report gratefully acknowledge the reviewer, Mr. Devinder S. Sodhi of the U.S. Army Cold Regions Research and Engineering Laboratory, for useful comments.

The final version of the report takes account of practically all comments of the reviewer and the review proper to the preliminary report is found in its final wording in Appendix 2.

1. REFERENCE TO PATENT AND INFORMATION SEARCH

Descriptions of patents, inventors' certificates, as well as articles, monographs and scientific conference materials dealing with non-traditional means and methods of ice breaking, clearing of channels made by the ship from the ice and auxiliary means of improving ice-breaking capability of ships, published in Russia (former Soviet Union) were included in the search.

For this purpose, inventors' certificates and patents of the following classes were studied:

- means of ice breaking by ship's hull (icebreakers) - class B63B 35/08;
- ships fitted with ice cutting (destruction) devices - class B63B 35/12;
- clearing of open water basin surfaces from ice - class EO2C 15/02;
- tools and machines for ice crushing, removal and collection - class F25 5/02.

All the above classes are in line with the fifth revision of the International Patent Classification, 1990, developed by the World Intellectual Property Organization.

The patent search covered the period from 1940 until 1993. Special attention was given to the inventions from 1980 to 1993. The information search included literary sources from 1890, i.e. from the beginning of using icebreaking technologies in Russia. A total of more than 300 engineering solutions were studied, of which only about 100, being the most typical and theoretically suitable for realization on icebreakers and commercial ships, were chosen for further analysis. Included in this number were

mostly inventions referring to classes B63B 35/08 and B63B 35/12. Only a few inventors' certificates were chosen out of classes EO2C 15/02 and F25C 5/02.

Brief information containing illustrations and texts to explain the basic idea, on all the engineering solutions chosen is summarized in the table in Appendix 1.

2. CLASSIFICATION OF NEW CONCEPTS OF ICE BREAKING AND CLEARING OF ICE IN BROKEN CHANNEL

The analysis of the engineering solutions chosen as a result of the patent and information search allowed subdividing them into several basic groups according to purpose and operating principle, and proposed for a classification scheme of means for ice destruction and removal (Fig.2.1). Given below is a brief description of basic groups according to this scheme.

2.1 Concept of Ice Breaking by Ship's hull.

The overwhelming majority of icebreakers and icebreaking commercial ships have so-called conventional hull lines. The distinctive feature of the conventional hull shape is a wedge-like forebody with a raked stem. In this case, an underlying principle is employed of breaking the ice sheet in bending by vertical forces arising in the area of interaction of the bow with ice and breaking the ice downwards. The concepts using other principles of ice-breaking by ship's hull, namely by utilizing non-conventional hull lines, are considered below. These concepts can be reduced to three types of non-conventional hull lines.

2.1.1 Hull lines breaking the ice downwards in bending

There are a lot of engineering solutions that cause, in contrast to traditional methods, the ice to be broken mainly in the direction of the ship's movement, which is attained by the use of side cutting structures limiting the size (width) of ice segments broken. This ice breaking scheme permits to minimisation of energy consumption through a reduction of the volume of the ice being broken.

Typical examples of such hull lines are an icebreaker proposed by G.M.Tekuchev (Fig.2.2) in 1959 or an icebreaking attachment proposed by G.Ja.Serbul in 1969 (Fig.2.3). As it is evident from the descriptions of these inventions and Figs 2.2 and 2.3, show the side knives cut the ice cover and a flat raked bow breaks the ice plates cut in the direction of the ship's movement.

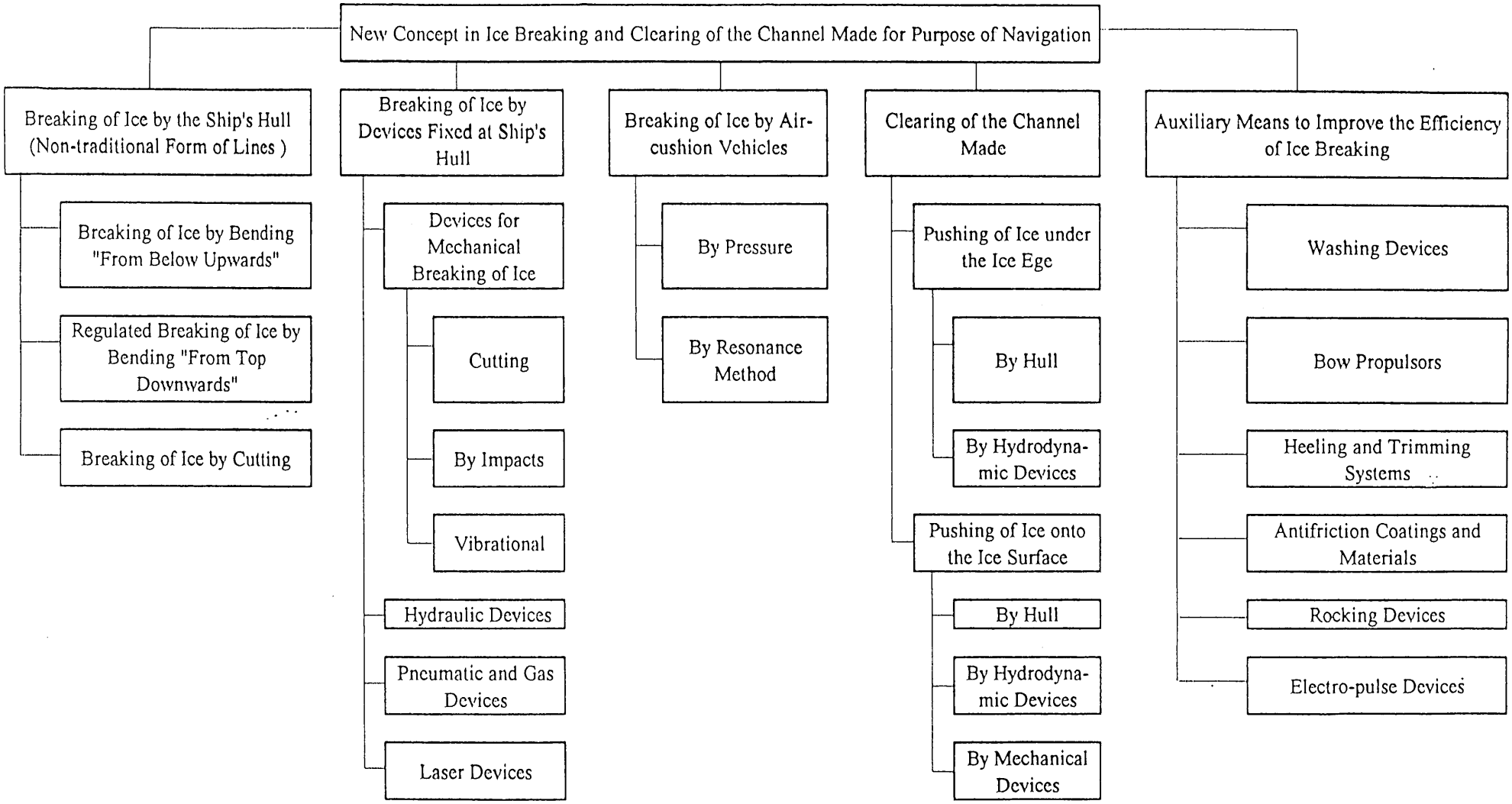


FIG.2.1. SCHEME OF THE CLASSIFICATION OF MEANS TO BREAK THE ICE COVER AND CLEAR THE CHANNEL

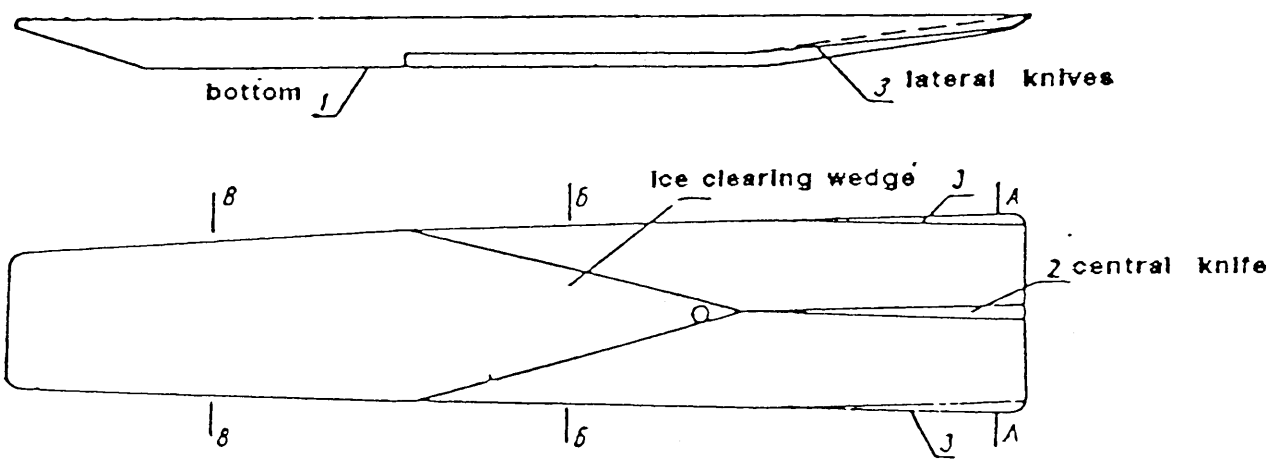


Fig. 2.2 Icebreaker of G. M. TEKUCHEV

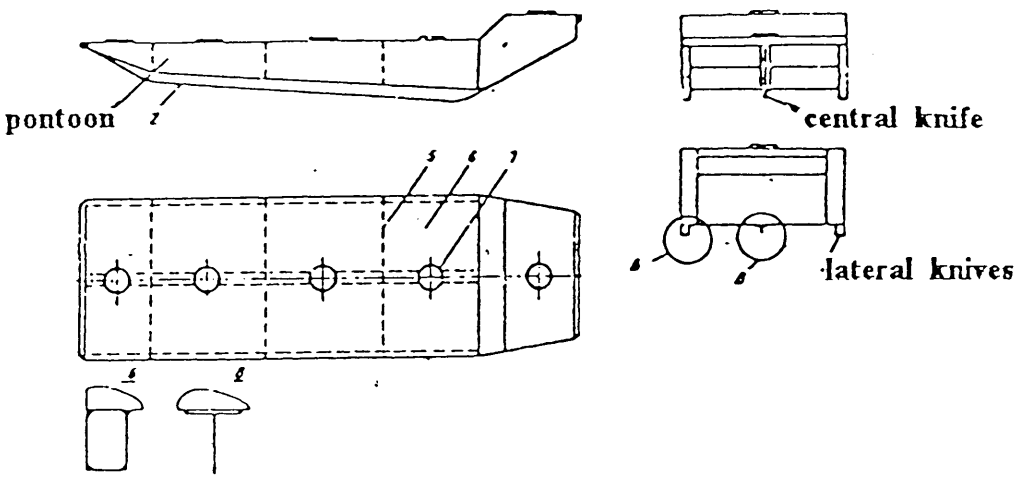


Fig. 2.3 Icebreaking attached bow of G. J. SERBUL

Another distinctive property of non-traditional methods of breaking ice by ship's hull pressing downwards is that the stem does not cut the ice and thus saves energy consumption that would otherwise go to the crumpling and crushing of a rather small volume of ice. According to some estimates, such consumption can amount to as much as 25% of the total energy required to overcome the ice resistance to the ship's movement /10 /. Therefore referred to this group are hull lines without cutting side structures but not having a stem in the centre line. Such lines are often close to conventional ones, but a cylindrical, conical or flat shape of the forebody is used instead of a stem. An experiment with icebreaker "Lenin" fitted with a ski-like attachment at the stem (Fig.2.4) can be cited as an example of such solution. The experimental operation of the icebreaker "Lenin" with a flat attachment showed that the idea worked, but revealed grave drawbacks of the structure (pushing broken ice, reduced manoeuvrability in ice, etc.). The experiment was considered not wholly satisfactory.

2.1.2 Hull lines breaking the ice upwards in bending

Such lines differ from conventional lines by stem inclination in the opposite direction, which creates during interaction with the ice an upward vertical force. Icebreaker "Ivan Vazov" (Fig.2.5) converted in 1953 provides an example of such design. This concept and other similar concepts are based on the fact that the underside of the ice is not as strong as the upper surface and therefore less energy for breaking the ice cover upwards is required. The broken ice is then forced upwards and sideways due to the plow-like lines of the bow. One more point in favour of breaking the ice upwards is a reduction of friction resistance between the ice and the hull. This is attained because of water lubrication being always present on the underside of the ice and absence of snow cover there. The trials, however, showed that the ice resistance with these lines appeared to be higher than in the case of conventional hull lines.

2.1.3. Hull lines breaking the ice in shear

This concept suggests creation in the area of the ship's sides of vertical forces breaking the ice cover in shear. As it takes place, the ice is longitudinally broken in bending as stated, for example, in G.M.Tekuchev's inventor certificate No. 125735 and

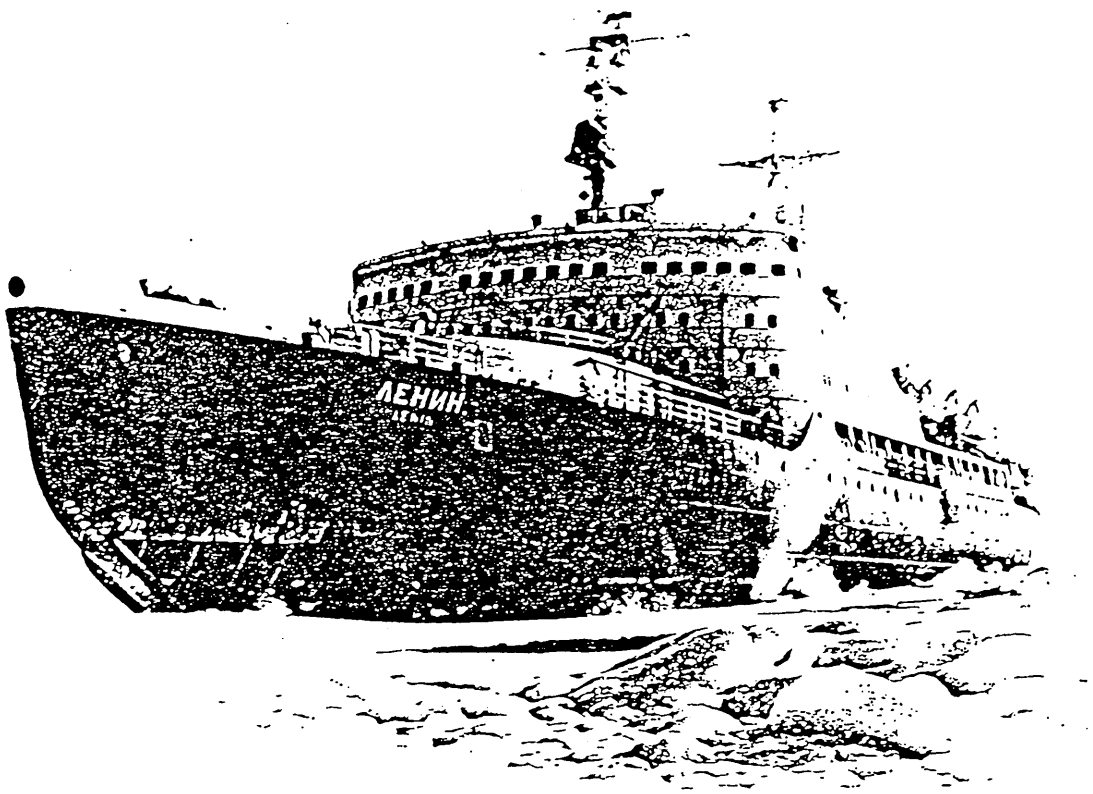


FIG. 2.4 Forebody of the nuclear icebreaker LENIN with the ski-shaped attachment

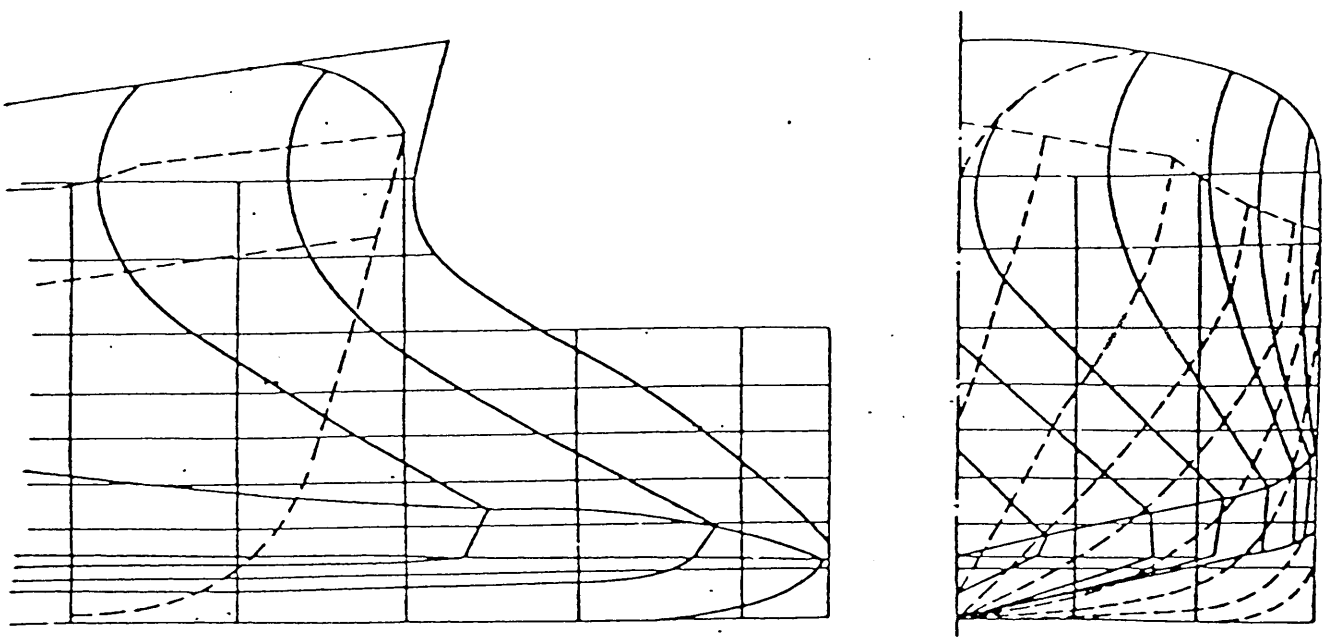


Fig. 2.5 Icebreaker IVAN VAZOV

G.Ja.Serbul's certificate No. 1340722/27-11 (see Figs 2.2 and 2.3). A typical solution was also proposed by V.A.Gussev and V.T.Sklar (Fig.2.6). It is well known that the ice strength in shear is lower than in buckling or bending. The idea of ice cutting is based thereupon. In actual practice, however, shear conditions cannot be generally created due to the fact that also ice buckling, crushing and partially breaking in bending are always present. Besides, a considerable amount of energy is consumed in this case also for submerging broken ice pieces and pushing them sideways.

2.2 Concept of Ice Breaking by Special Devices Attached to the Ship's Hull

This group of concepts can be subdivided into three main types,

2.2.1 Devices for mechanical ice breaking

The devices of this type form one of the most numerous groups of patents and inventors' certificates. Both mechanical ice cutting devices, and impact and vibration devices belong to this group. Proposed for cutting are rotating devices (disc saws, mills, rotors, etc,) and scissor-, cutter- and knife- like devices. This can be illustrated by an icebreaking device in the form of a pontoon with mills (Fig.2.7) proposed by F.N.Sergeev in 1940.

The idea of using various impact tools is quite widely accepted. For example, V.V.Kovryzhkin's invention, etc. (Fig.2.8).

A more limited number of engineering solutions is proposed using mechanical vibrators, such as in the invention of T.G.Mukhin and others (Fig.2.9).

2.2.2 Hydraulic ice breaking devices

Use can be mainly made in these devices of a water plume under pressure as proposed

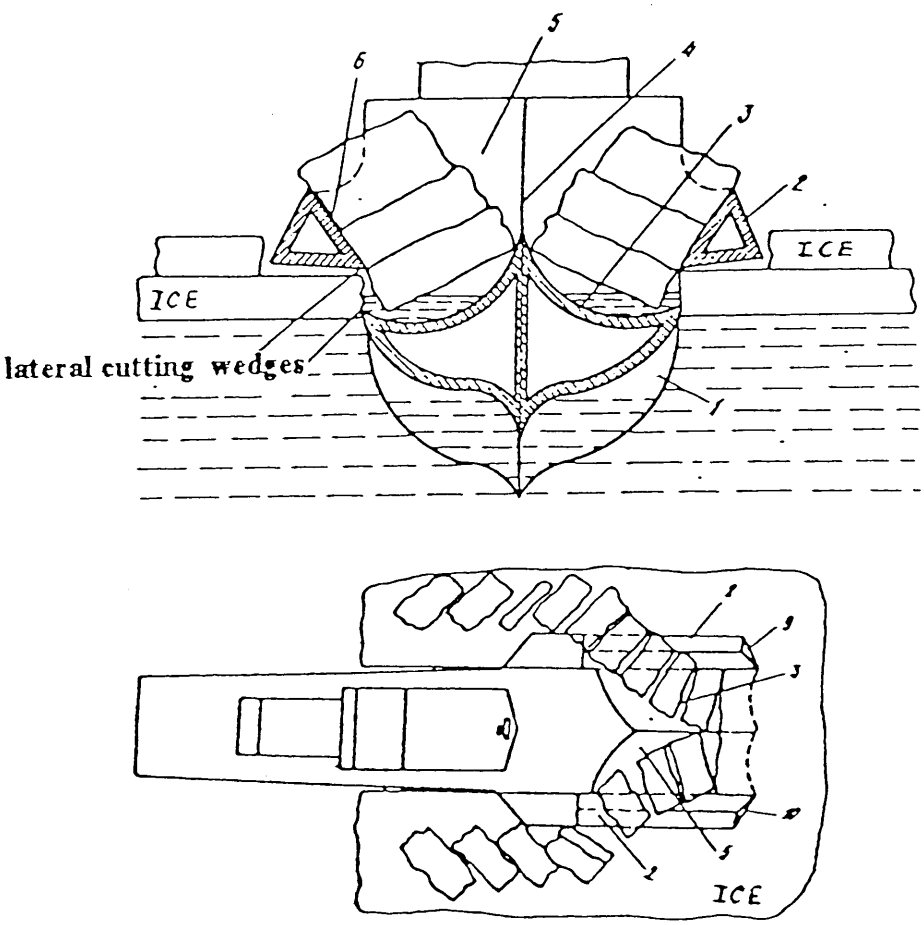


Fig. 2.6 Icebreaker of V.A. Gusev and V.T.Sklar

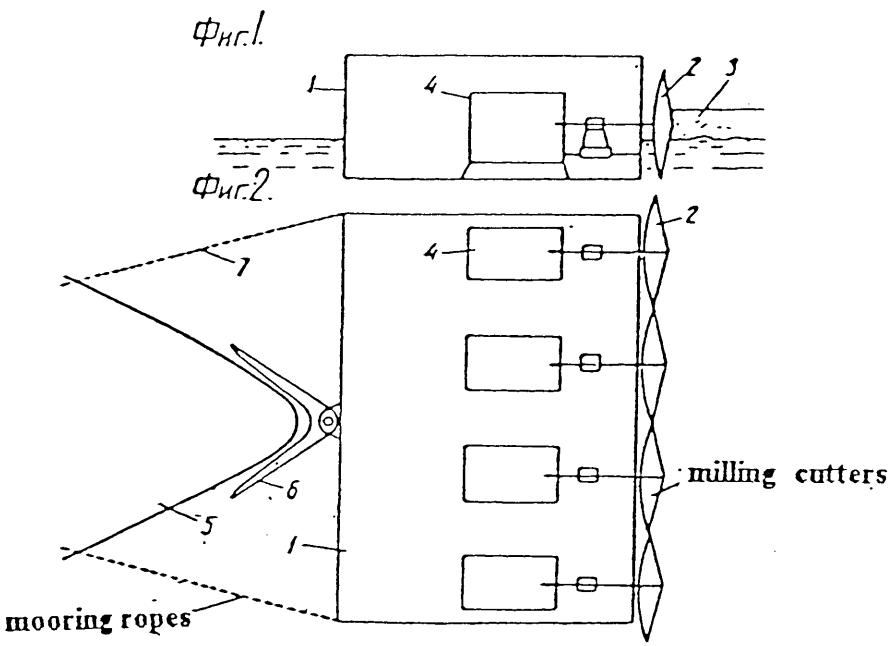


Fig. 2.7 Icebreaking device

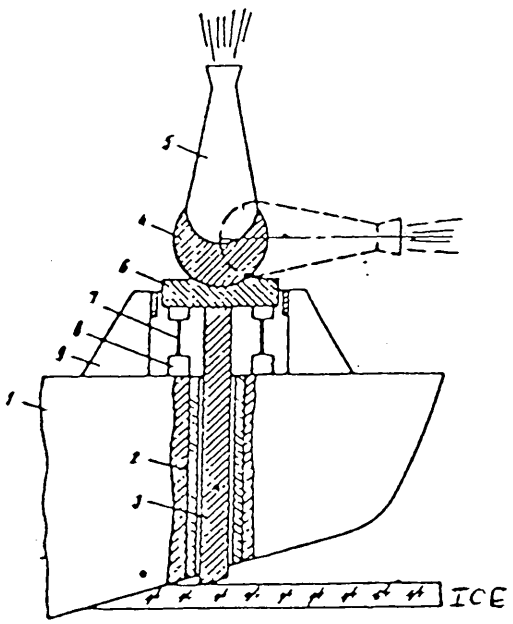


Fig. 2.8 Icebreaking device

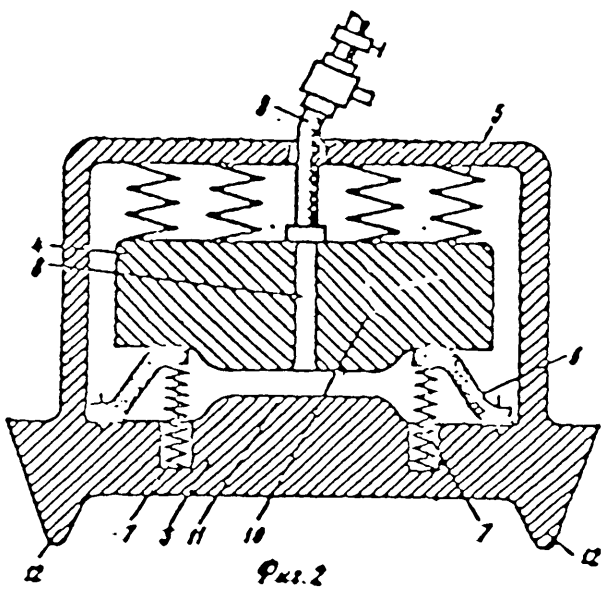


Fig. 2.9 Icebreaker with mechanical vibrator

by S.V.Belyaev (Fig.2.10).

2.2.3 Air-and-gas devices

These devices are few in number and are based on the use of explosive gases as in Ju.V.Kushke and V.N.Timofeev's invention (Fig.2.11). Such air-and-gas devices are more often proposed as auxiliary means to improve ice breaking capability (See Section 2.5).

2.2.4 Laser devices

The use of laser has now been introduced in various fields of engineering. It is also proposed to use lasers as an instrument for the cutting of ice cover. This idea is illustrated by the scheme in fig. 2.12.

2.3 Ice Breaking by Air-Cushion Vehicles (ACV)

This method of ice breaking was studied in sufficient detail in Russia. The results of research were published to date in many works /4, 5,7,11/.

Two methods of breaking the ice by ACV are known:
- by pressure (sometimes designated "low-speed")
- resonance (when moving at critical speeds).

Both these methods, as well as methods of calculating icebreaking ACV parameters were published in V.A.Zuyev's book /1 / and are illustrated in Figs 2.13 and 2.14.

2.4 Means and methods of Clearing Channel of Ice

A channel made in the ice or water area can be cleared of broken ice by lifting the ice

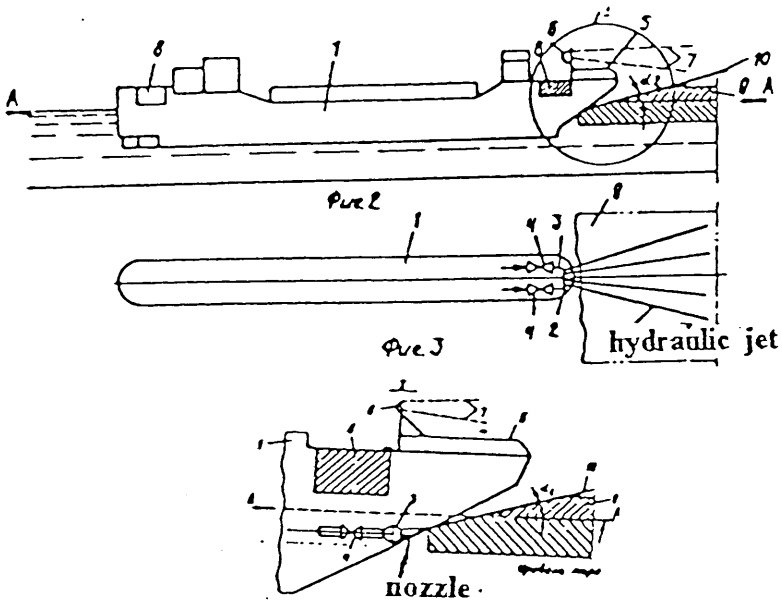


Fig. 2.10 Icebreaking device

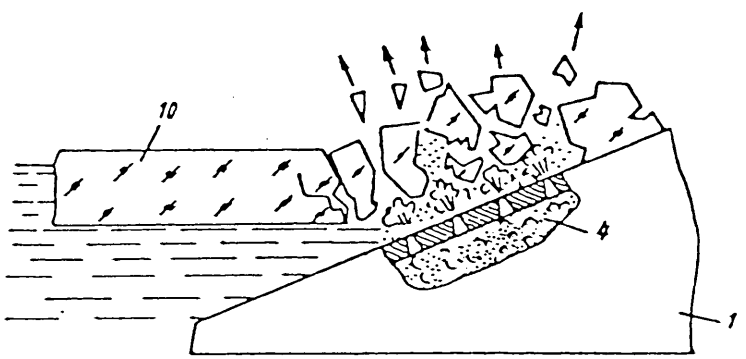


Fig. 2.11 Icebreaking attached bow

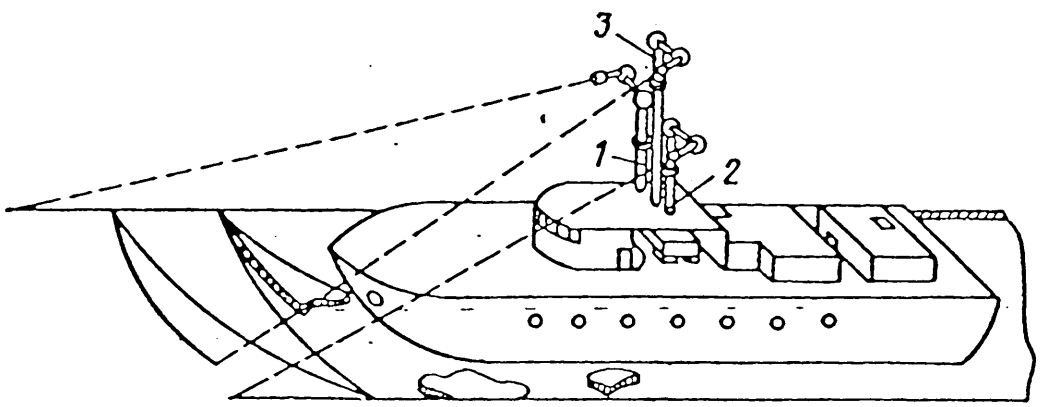


Fig. 2.12 Ice destruction by Laser

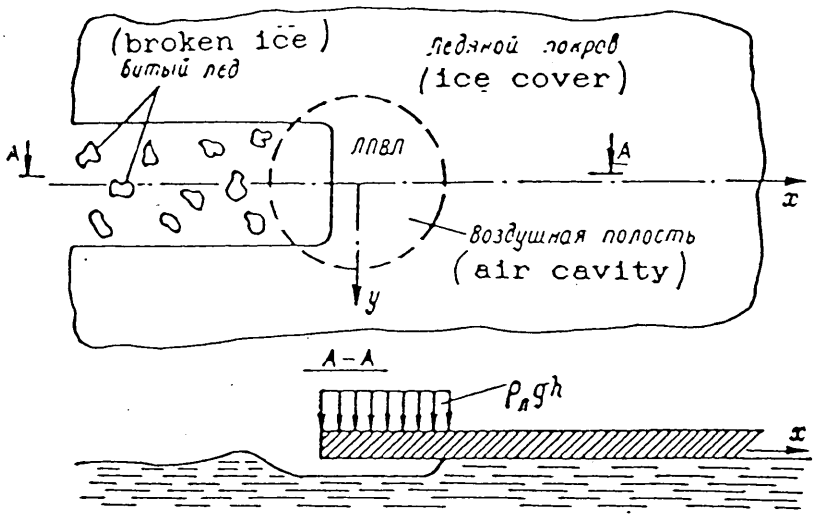


Fig. 2.13. Scheme of the Destruction of Ice by Pressure

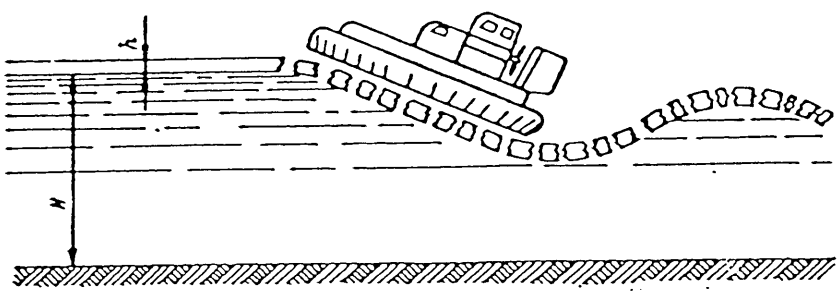


Fig. 2.14. Scheme of the Destruction of Ice by Resonance Method

pieces on top or pushing them underneath an ice sheet. Therefore both alternatives are offered in practically all concepts. Thus, for example, the concept of clearing of ice by ship's hull is realized by attachments of a type proposed by B.D.Vyatcin and G.S.Nikitin (Fig.2.15), which is designed to force the broken ice under the edges of the channel, and by devices of V.V.Bogdanov's attachment type, having a shape which removes the ice from the channel and onto the ice surface alongside (Fig.2.16).

For the purpose of clearing the channel by removing the ice underneath the edges of the channel, use can be made of a water plume. In 1966 "an injector-type ice remover" was designed in the St.Petersburg Institute of Waterways, the operating principle of which is shown in Fig.2.17. Along with this, various ice removing machines are suggested for lifting broken ice pieces onto the ice surface at the channel edges. A vessel designed by V.N.Pikul fitted with conveyor belts which transport the broken ice on top of the solid ice (Fig.2.18).

2.5 Auxiliary Means to Increase Ice-Breaking Capacity

Use of various means on icebreakers to improve the efficiency of breaking the ice by ship's hull is a common practice. Heeling and trimming systems, for example, have already been used on icebreakers for years /10/. Many new engineering solutions have been proposed in this field in the last 15-20 years. They can be subdivided into several groups.

2.5.1 Washing devices

This group comprises chiefly systems and devices mainly using plumes of water or water and air plume (water or air bubbling). M.A.Ignatyev's invention (Fig.2.19) or an air bubbling system according to inventor's certificate No. 1092093, granted to Ju.V.Bykov and others (Fig.2.20) can provide examples of such systems. The basic idea of bubbling systems is to reduce friction between the ice and the ship's hull and to drag the broken ice pieces away from the ship's hull.

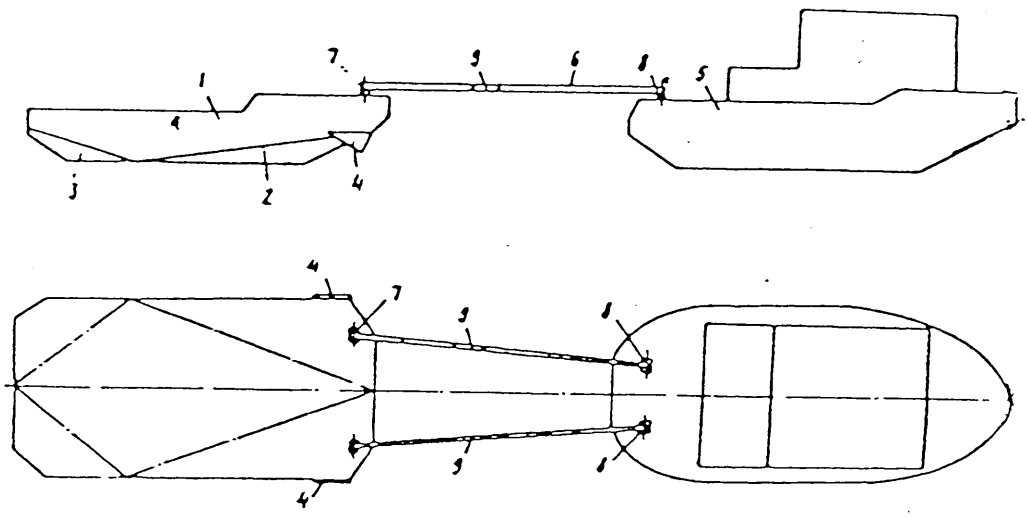


Fig. 2.15 Ice-removing attached bow

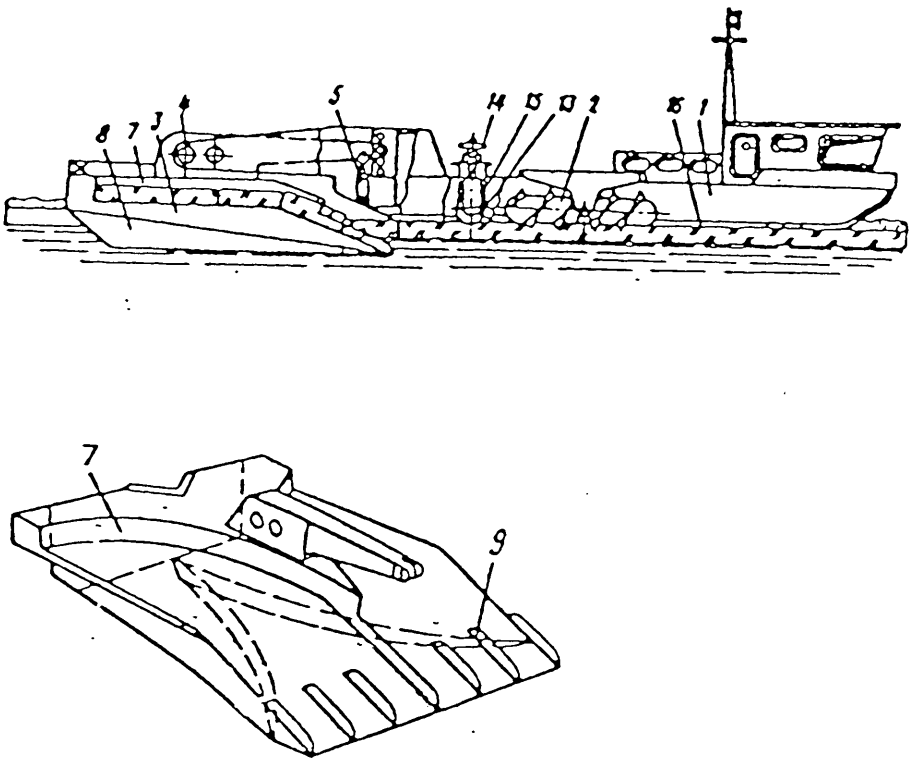


Fig. 2.16 Icebreaking and Ice-removing device

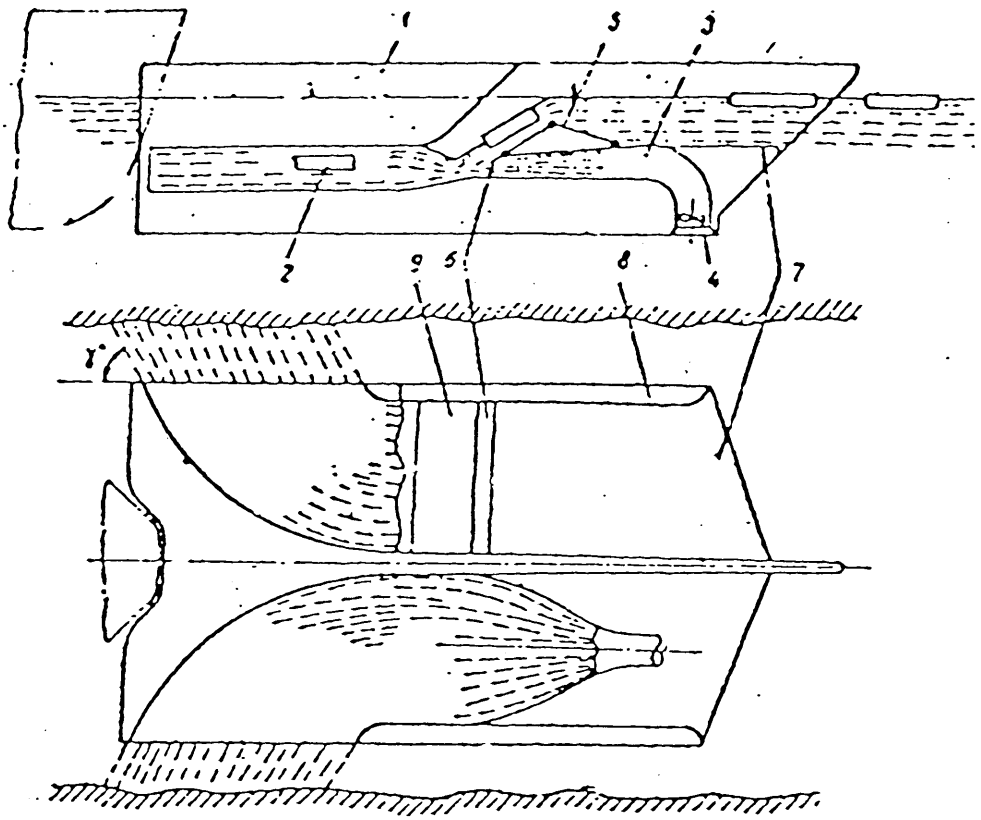


Fig. 2.17 Ejector ice—removing device of the Leningrad Institute of Water Transport according to author's certificate No 220070.

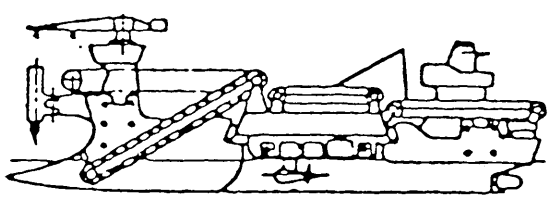


Fig. 2.18 Icebreaking and Ice-removing Ship

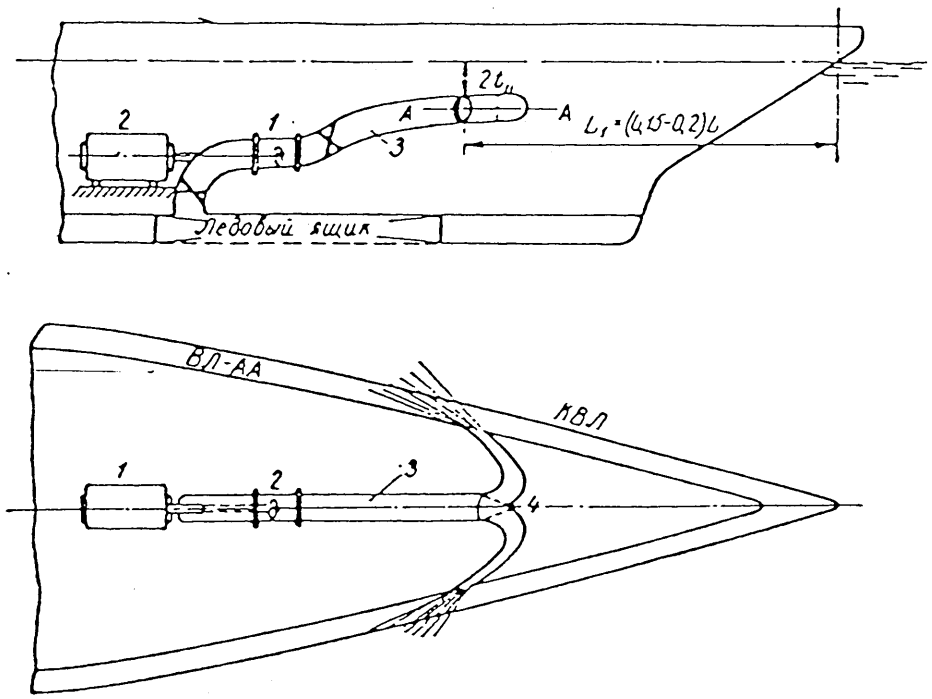


Fig. 2.19 Hydraulic washing device of M. A. IGNATIEV

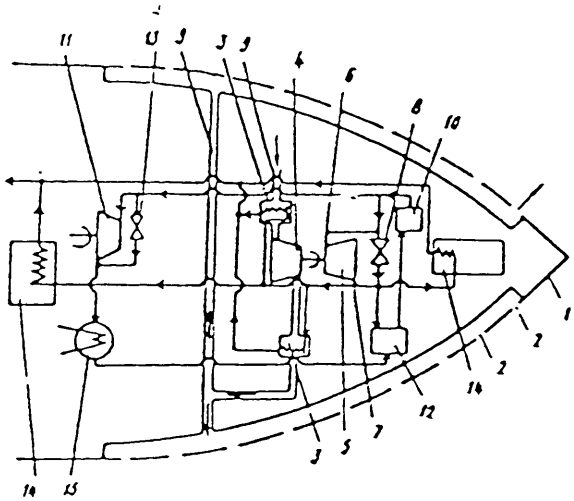


Fig. 2.20 Ice Ship with Heated Air-bubbling System

2.5.2 Bow propellers and other auxiliary propellers

Bow propellers were a quite widely used means to increase icebreaking capacity in 50s-70s, but because of their vulnerability in Arctic ice conditions they are no longer used. However, proposals exist to realize this concept using enclosed bow propelling complexes of a novel type as, for example, described in patent No. 1515579 granted in 1992 in Russian Federation (Fig.2.21).

2.5.3 Antifriction paints and materials.

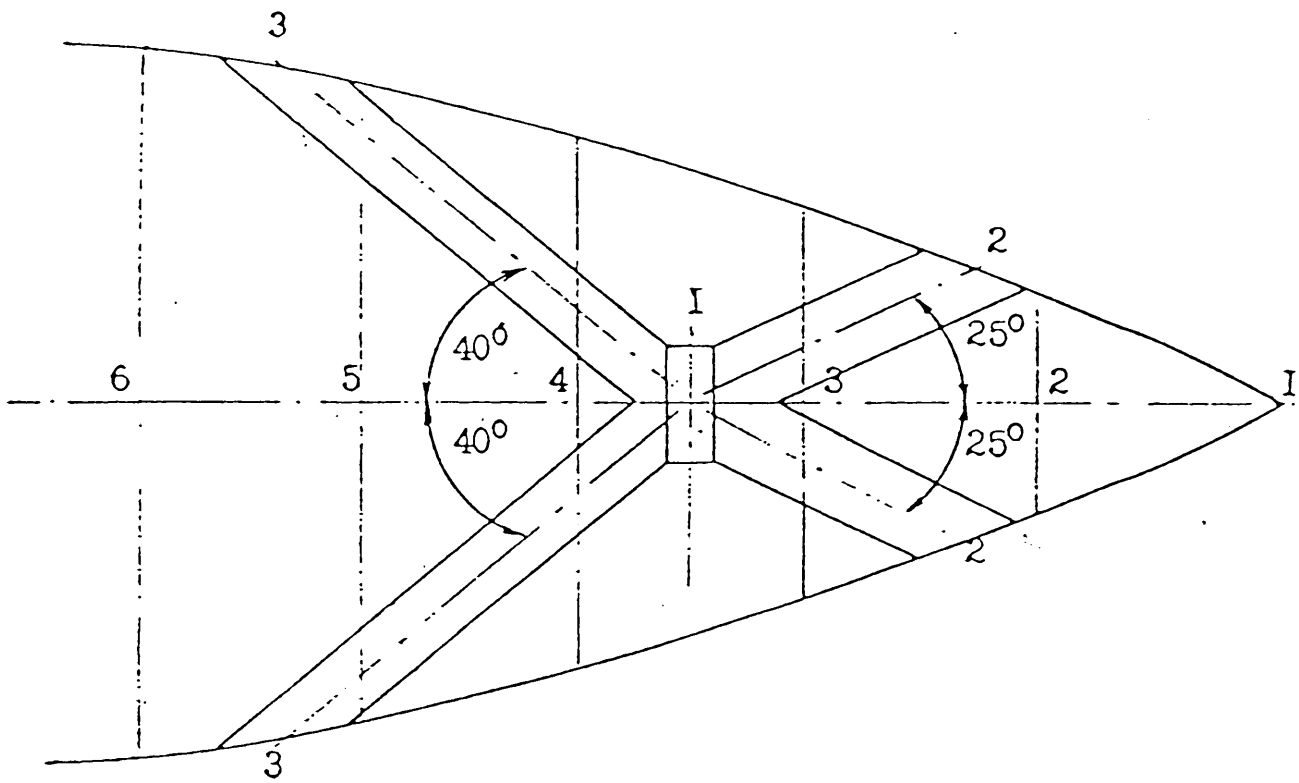
In Russia antifriction hull paints of "Inerta 160" type produced in Finland, as well as Russian ice-resistant epoxy-based paints /1,9/ have found wide application. Along with this, experiments and theoretical studies of the efficiency of using stainless steel for shell plating of the hull have been conducted since the beginning of the 80's. Icebreaker *Kapitan Nikolayev* having a shell plating strake of two-layer steel with a cladding stainless layer in the forward part of the ship at the waterline has been in service since 1990.

2.5.4 Swinging devices

The operating principle of these devices is based on creating oscillatory motions of the ship's bow generally due to eccentric rotation of masses. The schemes of such devices can vary as shown in Fig.2.22.

2.5.5 Electropulse devices

The author's idea suggests that electromagnetic pulses create in the shell plating elastic alternating strains reducing friction resistance. This can be exemplified by invention No. 889527 granted to J.A.Levin in 1977 (Fig.2.23), according to which electromagnetic inductors installed on the shell plating affect it by pulses thus reducing the statical friction coefficient down to dynamic friction values and also decrease adhesion of ice to the ship's surface.



1 - bow propeller chamber;
2 - bow nozzles;
3 - stern nozzles

Fig. 2.21 Scheme of the bow propulsion system of new type in accordance with R.F. patent No 1515579

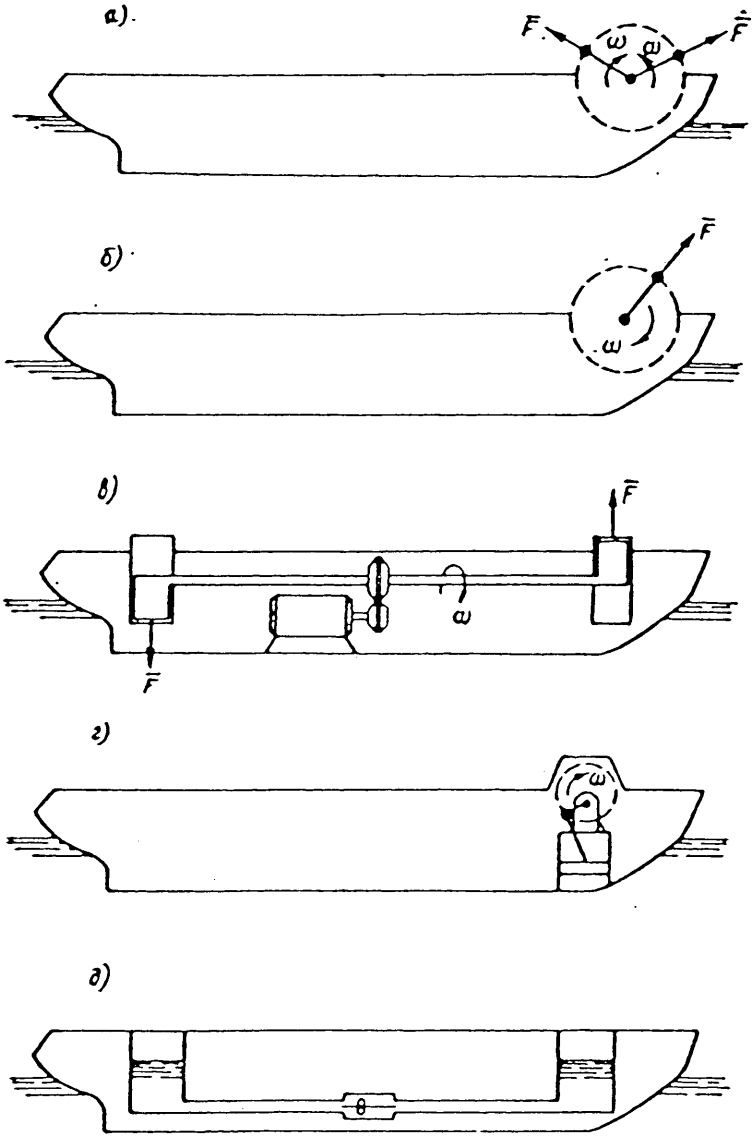
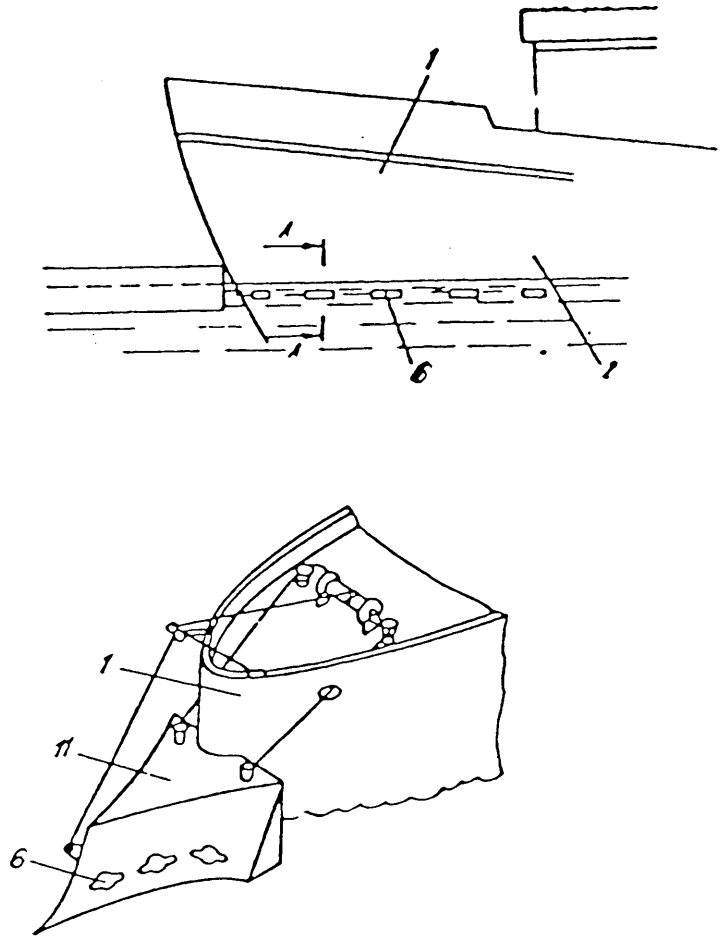


Fig. 2.22 Scheme of swinging devices



6 - electromagnetic inductors of eddy currents

Fig. 2.23. Electrical Pulse System of I.A. Levin

3. REALIZATION DEGREE OF VARIOUS NEW ICE BREAKING CONCEPTS

Not all of the ice breaking concepts reviewed in the previous section found practical application. As a whole, several degrees of their realization can be differentiated:
- those used in ships in service; those realized for experimental operation; those tested at a level of model or full-scale experiments; those not realized.

3.1 Engineering Solutions Realized in Icebreakers and Icebreaking Commercial Ships

New concepts of breaking the ice by the ship's hull, clearing the channel made and auxiliary means of increasing icebreaking capacity found their practical application first. Thus, icebreaker "Kapitan Nikolayev" with "conical" (practically without stem) bow, as well as icebreakers "Mudyug" and "Kapitan Sorokin" with THYSSEN-WAAS System bows (see patent No. 1308188 in Appendix 1) are now operating in the Russian icebreaking fleet. Besides, icebreaking and ice clearing attachments, close in design to the attachment invented by G.Ju.Serbul (see Fig.2.3), and described above, have been operate successfully on rivers of Russia ever since the mid-70s. The attachments and icebreakers with THYSSEN-WAAS system bows are in operation and used for clearing the created channel or water area from ice. Of auxiliary means increasing the efficiency of icebreaking, bubbling systems and antifriction paints and materials are widely used in operation. The majority of icebreakers now operating in Russia are fitted with air and water bubbling systems. On nuclear icebreakers of "Rossia" type use is made, in particular, of the system designed according to inventor's certificates No 1092093, 1125151(App. 1). An air bubbling system is installed on icebreaking commercial ships such as those of *Norilsk* type having ice category ULA in the class notation. All icebreakers and icebreaking commercial ships operating in the Arctic are regularly coated with ice-resistant anti-friction epoxy paints. The icebreaker *Kapitan Nikolayev* has a shell plating strake with stainless cladding which possesses a low friction resistance.

3.2 Engineering solutions Realized for Experimental Operation

Of new concepts of icebreaking by ship's hull an idea of ice breaking upwards was tested in experimental operation on I/B *Ivan Vazov* (see Fig.2.5). Icebreaker *Lenin* with a ski-line flat attachment operated during the whole navigation period in 1963 (Fig.2.4).

3.3 Engineering Solutions Tested at a level of model or Full-Scale Trials

Extensive experimental studies of breaking the ice using air-cushion vehicles have been going on ever since the mid-70s. They include both model tests and full-scale trials. Model tests were carried out of breaking the ice by a high pressure water plume as proposed in inventors' certificate No203494 (App. 1). Full-scale trials of swinging devices (see Section 2.5) were conducted in Russia on icebreaker *Smerch*, tug *Portovy-1* and ice-breaker of the P-47 type. The main characteristics of these ships are given in table 3.1.

Table 3.1

Characteristics of Icebreakers with swinging devices (SD)

Characteristic	SMERCH	PORTOVY - 1	P - 47
Length, м	17,5	27,0	27,0
Breadth, м	3,7	7,7	7,7
Draft, м	1,6	1,88	1,88
Displacement, т	54	200	182
Power, kW	220	441	442
Power of SD, kW	42	80	
Thickness of level Ice broken through without SD, м	0,2-0,25	0,25-0,3	0,25-0,3
Thickness of level Ice broken through with SD, м	0,4	0,3-0,5	0,45-0,5

Though the analysis of the results of investigations and operation of new technical means is not an an objective of this stage of work it should be noted that a positive effect of the swinging device on the icebreaking capability was revealed. Thickness of the level ice broken through in continuous movement has increased by 1.5-2.0 times(see table 3.1) The probability of sticking of the icebreaker decreased and the manoeuvrability improved. At the same time operation experience has shown that jolting arising during the action of the swinging device substantially worsens the habitability conditions. Besides, in the course of time fatigue damage to certain structures occurs. These shortcomings are main obstacle to a widespread use of swinging devices.

3.4. Non-Realized Engineering Solutions

The devices for mechanical or air-and-gas icebreaking as well as the concept of clearing the created channel by lifting the broken ice on to solid ice edge did not practically generate any interest among scentists, designers or operators.

4. LIST OF FURTHER RESEARCH ON THE PROJECT

Patent searches, selection and classification of new icebreaking concepts allows to turn us to comparison of the efficiency of various engineering decisions and elaboration of recommendations on their development and application. The scope of theoretical, experimental studies, operational data on a number of technical means available permit the assessment of scopes of application, and merits and drawbacks of various icebreaking concepts, primerly concerning non-conventional icebreaking lines and auxiliary means of increasing icebreaking capacity.

In the year 1994-1996, the following works may be completed within the frame work of Project III.11.1:

- Extension of patent and information search and analysis of new icebreaking concepts published in USA, Canada, Finland, Sweden, Germany, Norway, Japan and other countries.

- Investigation of the efficiency and advisability of using non-conventional hull lines for icebreakers and icebreaking commercial ships for Arctic navigation.

- Determination of rational field of using aircushion vehicles and icecutting attachments for breaking the ice sheet.

- Examination of the prospects for improving conventional hull lines of icebreaking ships on the basis of operational experience and experimental investigations.

- Research on technical means of improving icebreaking capacity and keeping it at the specification level in the course of operating ships in various navigation conditions (air and water bubbling systems for ship's hulls, anticorrosive iceresistant paints and other antifriction materials).

- Formulation of recommendations on application of various icebreaking and channel clearing concepts, as well as means of increasing icebreaking capacity of icebreakers and commercial ships for Arctic navigation depending on their purpose, area and season of navigation.

The above works provide for both summing up and analysis of the results of the studies thus far finalized and new developments, including model and full-scale experiments. In order to perform these studies, a procedure should be developed for comparison of various engineering solutions on the basis of modelling operation of icebreakers and ships in actual conditions of the Northern Sea Route.

CONCLUSION

The work done allows to draw the following conclusions:

1. No fundamentally new icebreaking concepts have been published in Russia during the last 15-20 years. A number of concepts developed earlier were realized and tested in operation by means of full-scale trials. During this period, means of increasing the efficiency of icebreaking and augmenting icebreaking capacity of ships received wide recognition. It refers first of all to air bubbling systems and to hull antifriction paints or materials.

2. In order to assess the prospects for the new icebreaking and channel clearing concepts proposed, it is necessary to make a comparative analysis of the effeciency of these concepts on the basis of operational experience and the results of theoretical and experimental studies.

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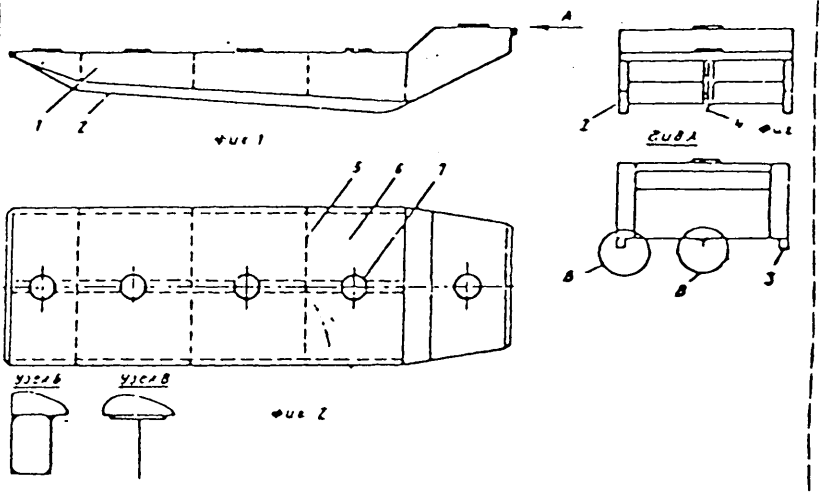
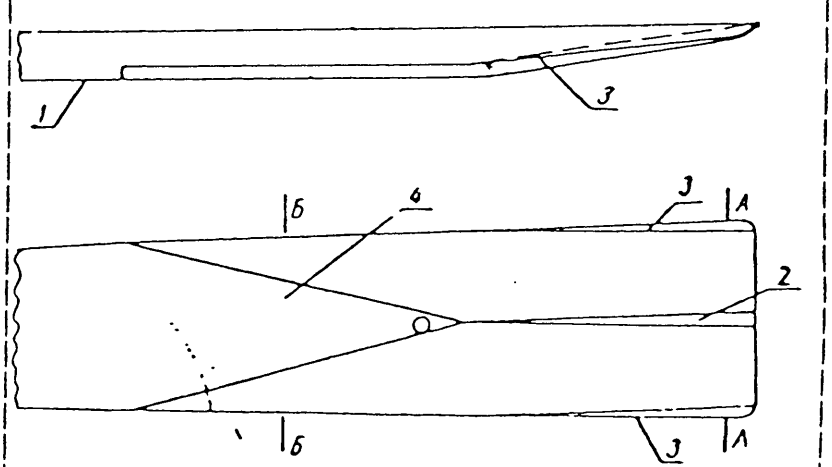
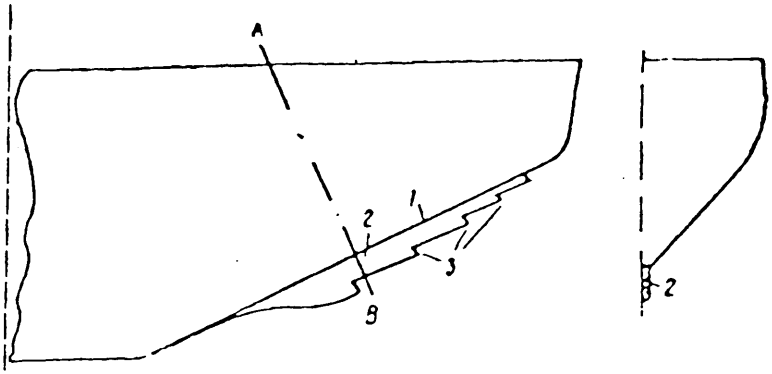
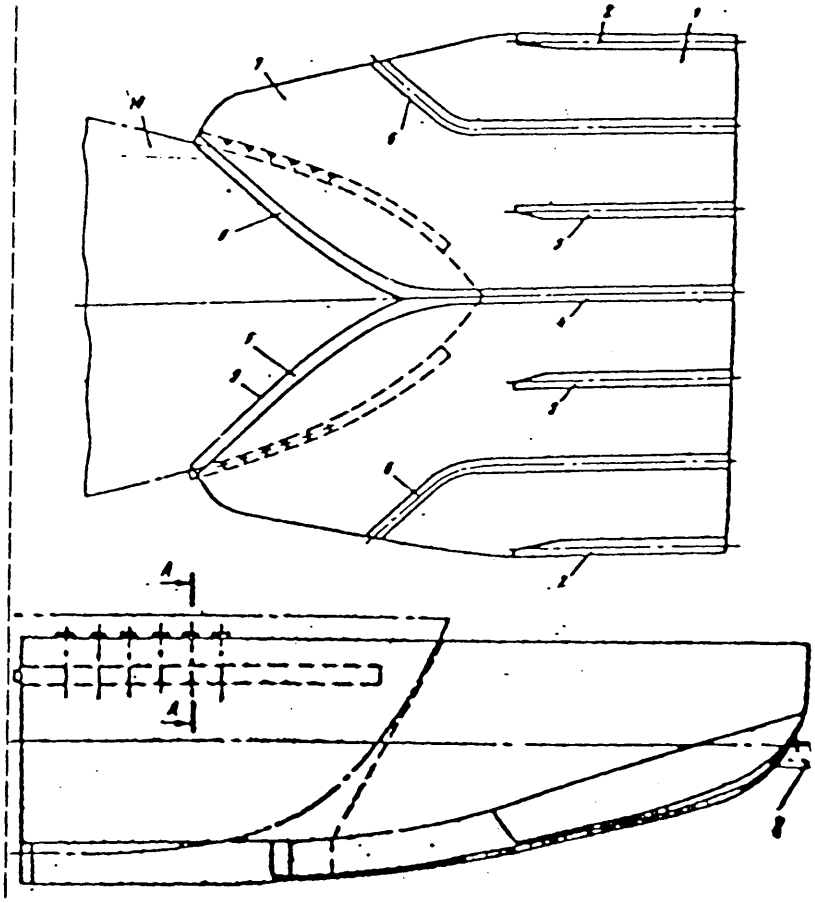
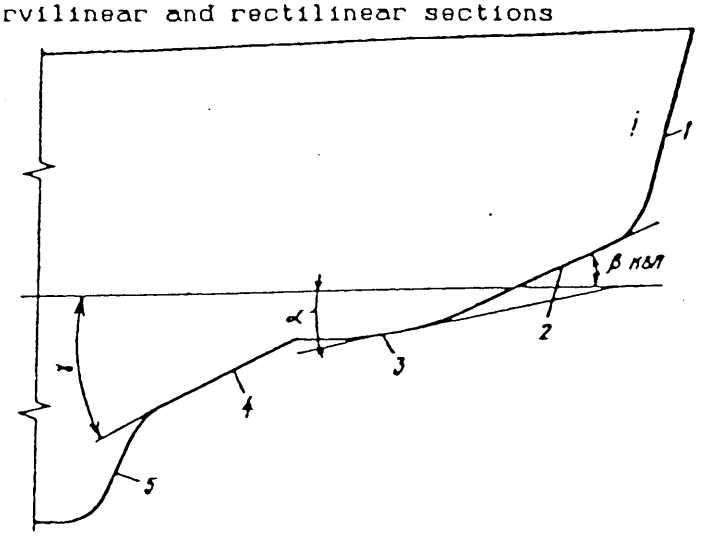
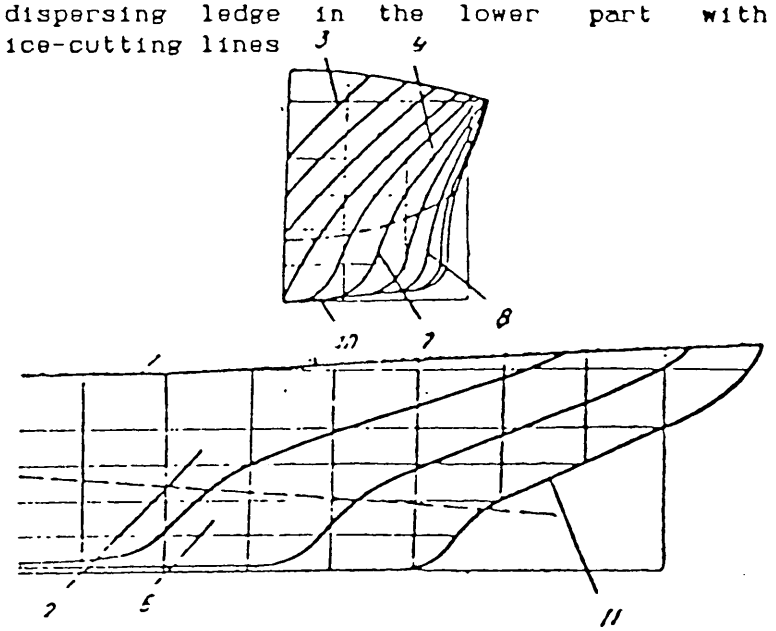
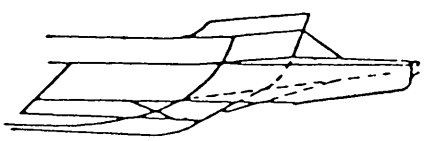
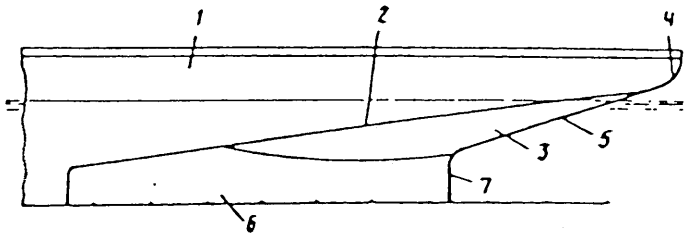
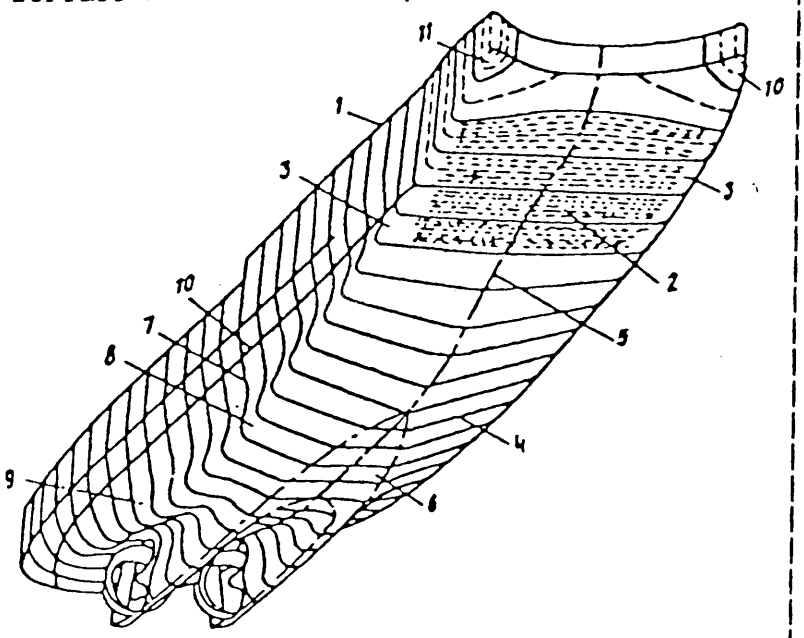
APPENDIX I

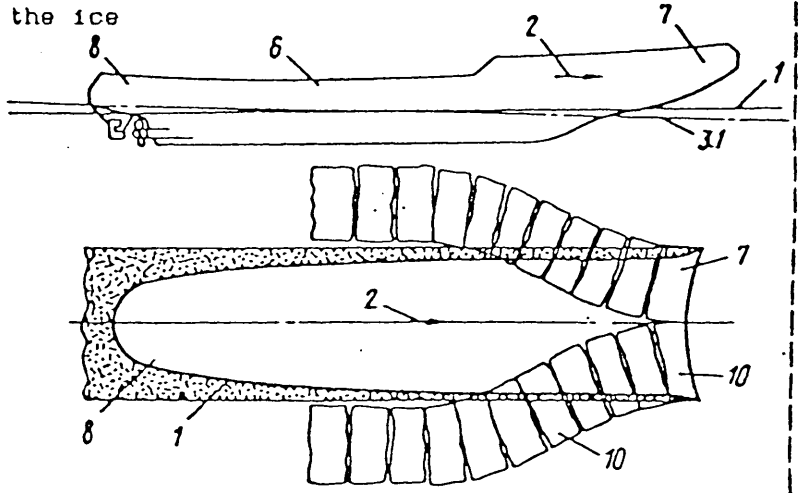
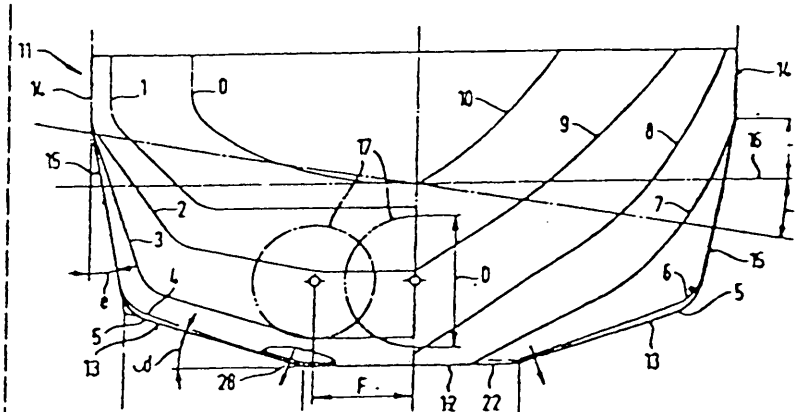
RESULT OF PATENT AND INFORMATION SEARCH

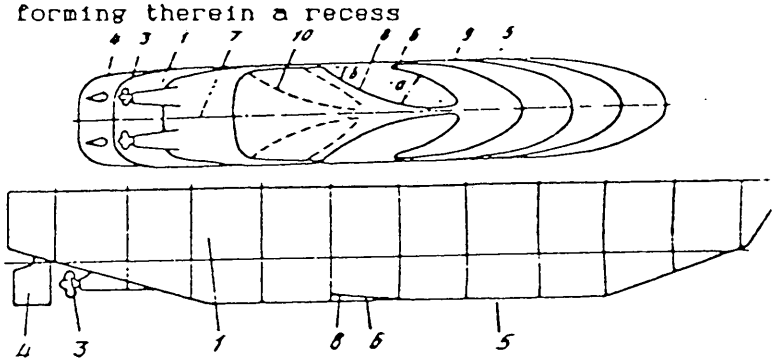
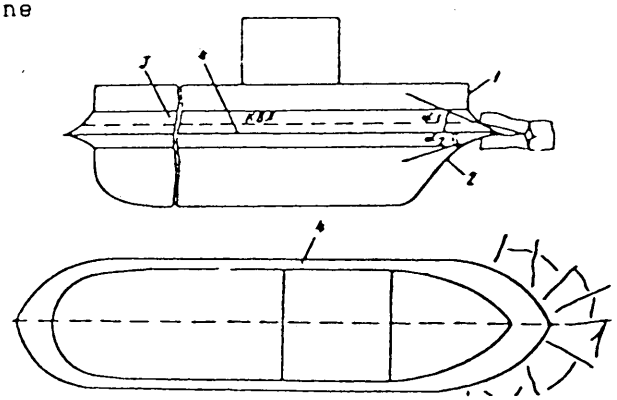
N	AUTHOR'S CERTIFICATE	DESCRIPTION
	BREAKING OF ICE BY THE SHIP'S HULL (NON - TRADITIONAL FORM OF LINES)	
1	Author's certificate (11) 310837 (21) 1340722/27-11 (22) 23.04.69 (51) B63 B 35/08 (53) 629.124.791.2 (71) Moscow river shipping company (72) G.J.Serbul	Pushed icebreaking attachment as a pontoon with sleigh lines, runners alongside and a cutting tool in centre-line plane 
2	Author's certificate (11) 125735 (21) 618564/29 (22) 05.02.59 (51) B63 B 35/08 (72) G.M.Tekuchev	River icebreaker with a wedge-like hull and icebreaking wedges alongside and at the stem 

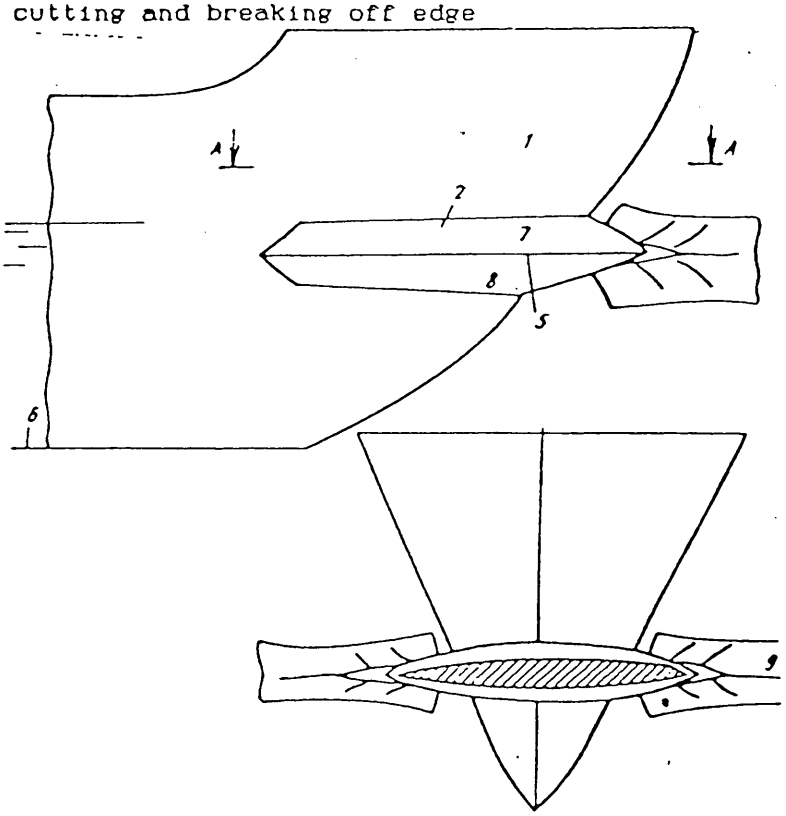
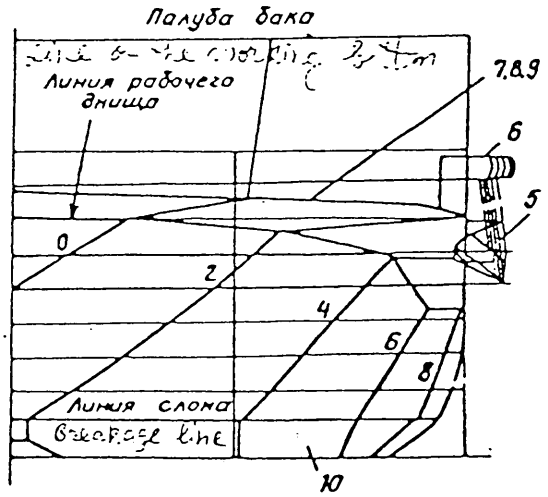
N	AUTHOR'S CERTIFICATE	DESCRIPTION
3	Author's certificate (11) 72364 (21) 3702906/27-11 (22) 14.11.47 (51) B63 B 35/08 (72) V.L.Pozdyunin	Stem for "Ermak" type icebreakers with a fixed toothed knife for cutting the ice 
4	Author's certificate (11) 903243 (22) 22.05.80 (51) B63 B 35/12 (53) 629.124.791 (71) Leningrad institute of water transport (72) Z.B.Segal, G.P.Popov, P.A.Maly	Icebreaking complex of ships contains icebreaking attachment connected with the forebody of pushing ship; water-tight hull of the icebreaking attachment has sleigh lines with fixed lateral projection -knives 

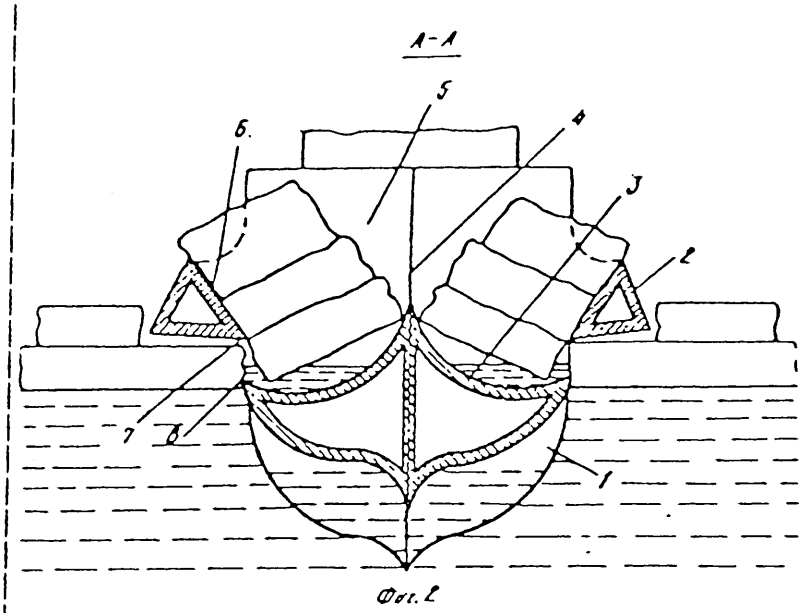
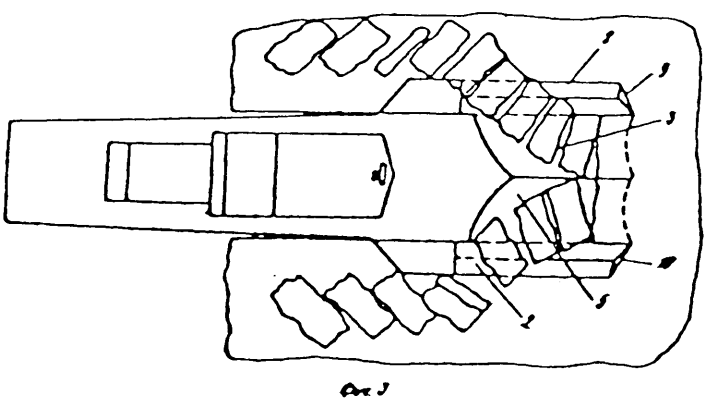
N	AUTHOR'S CERTIFICATE	DESCRIPTION
5	Author's certificate (11) 918173 (21) 2916549/27-11 (22) 23.04.80 (51) B63 B 35/08 (53) 629.124.791 (72) G.A.Palikhov	Forebody of the icebreaker the working stem edge of which is made of conjugate rectilinear, curvilinear and rectilinear sections 
6	Author's certificate (11) 391001 (21) 1386114/27-11 (22) 08.12.69 (51) B63 B 35/58 (53) 629.124.291.2 (72) A.S.Zefirov, M.S.Jakovlev	Hull forebody of the sea icebreaker has an ice dispersing ledge in the lower part with ice-cutting lines 
7	Author's certificate (11) 1062116 (21) 3486350 (22) 19.08.82 (51) B63 B 35/12 (53) 629.12.011.2 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov	Icebreaking and ice removing ship's attachment contains a hull joined to the ship by the afterbody and having the working bottom with central and lateral ice-cutting knives as well as guide surfaces for the breaking of ice and made with wedge-like projection 

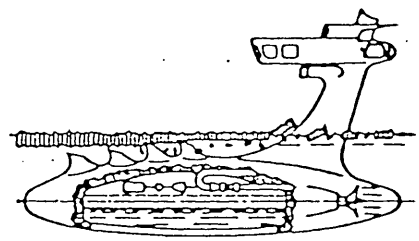
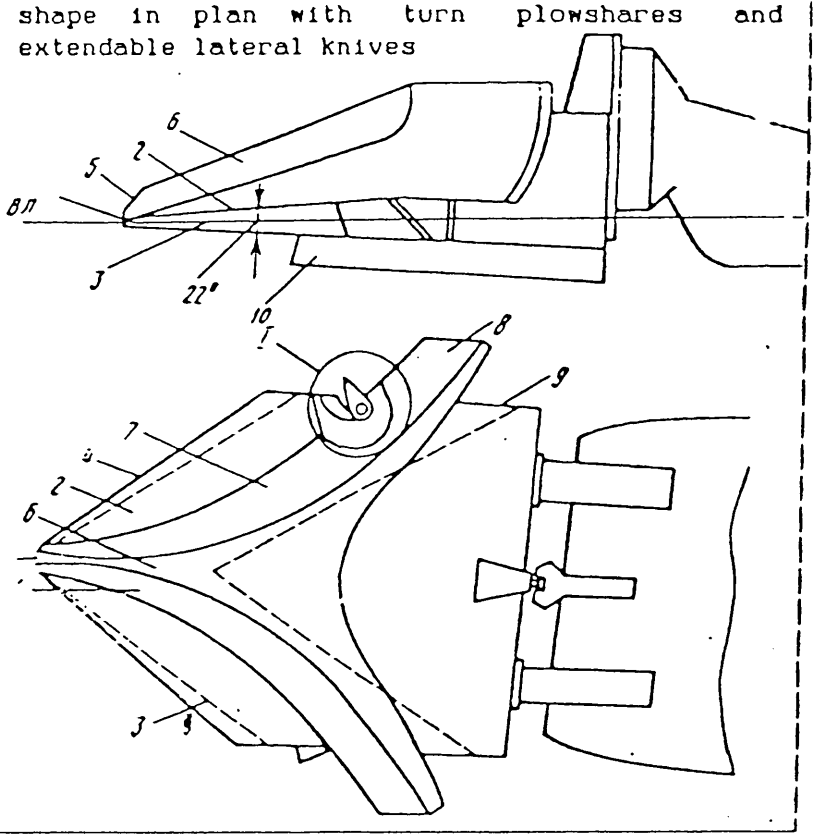
N	AUTHOR'S CERTIFICATE	DESCRIPTION
8	Author's certificate (11) 1204476 (21) 3767845/27-11 (22) 13.07.84 (51) B63 B 35/08 (53) 629.124.791 (088.8) (71) Leningrad institute of water transport (72) Z.B.Segal	Icebreaker containing hull with curvilinear lines and ice dispersing wedge fixed on the bottom 
9	Patent (11) 1308188 (21) 3510549/27-11 (22) 04.11.82 (51) B63 B 35/12 (53) 629.124.791 (088.8) (71) Thyssen Nordseewerke GmbH (DE) (72) Heinrich Waas, Ires Freitas	Ship for navigation in open sea and in basin covered with ice has ice-cutting elements made in the form of runners with sharp cutting edges the central of which is located in the middle-line plane and two other lateral runners are located on side ribs of sections of the transfer of side walls into the bottom front surface 

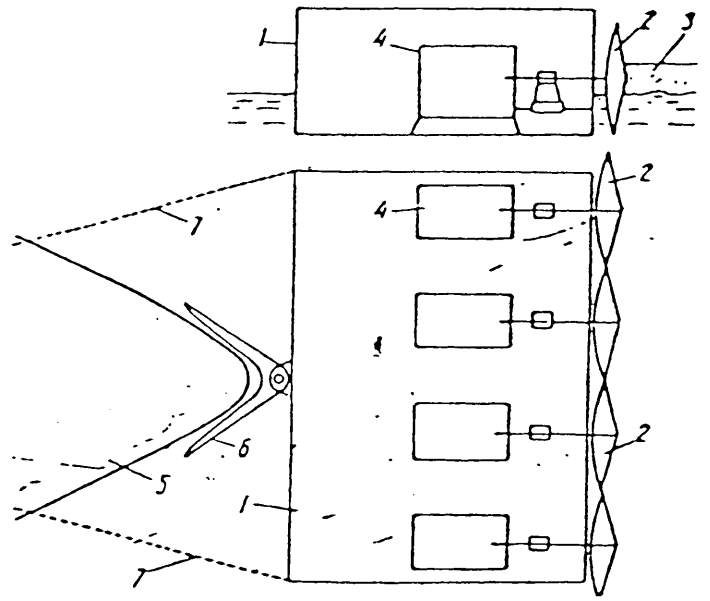
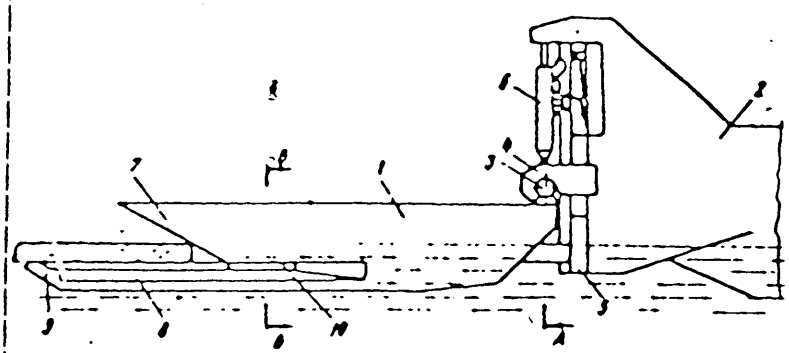
N	AUTHOR'S CERTIFICATE	DESCRIPTION
10	Patent (11) 1812994 (21) 4202445/27-11 (22) 29.04.87 (31) 87103459.1 (32) 10.03.87 (33) EP (51) B63 B 35/12 (53) 629.124.791 (71) Thyssen Nordseewerke GmbH (DE) (72) Gunter Varges (DE)	Icebreaking ship the afterbody of which is fitted with lateral projections for breaking the ice 
11	Patent (11) 1816272 (21) 3870307/11 (22) 11.03.85 (51) B63 B 35/08.3/00 (53) 629.124.791.2 (71) Wartsila Meriteollisuus (72) Gustav Lindkvist (Fi)	Hull of the ice ship including forebody of Y-shape form in the waterline plane , side sections each of which is vertical or has inclination out-/upwards and bottom section horizontal in cross section. The hull is made with bottom sections inclined in cross section and arranged symmetrically between horizontal bottom section and side sections 

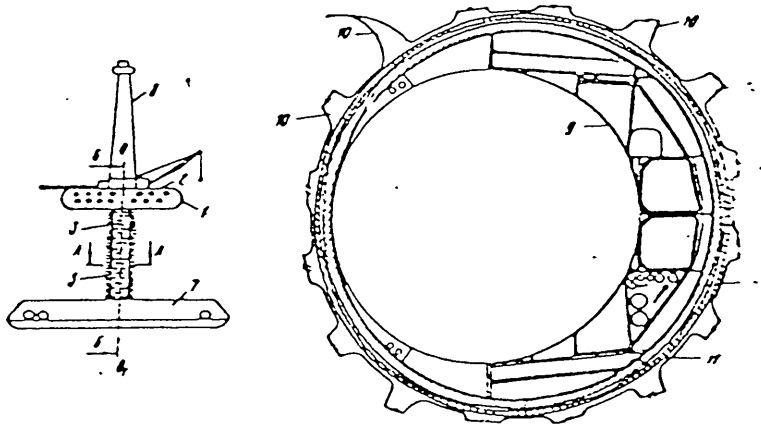
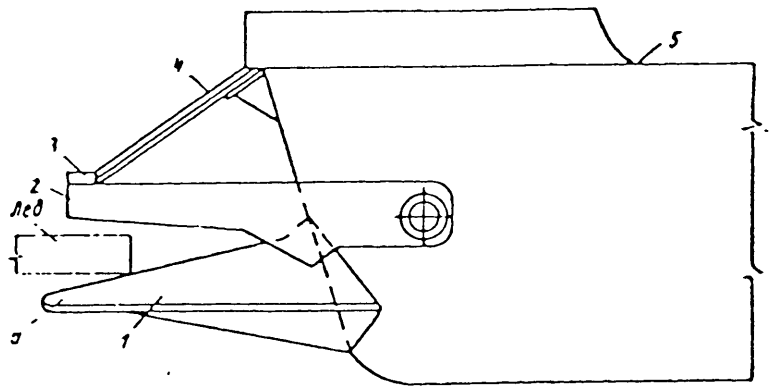
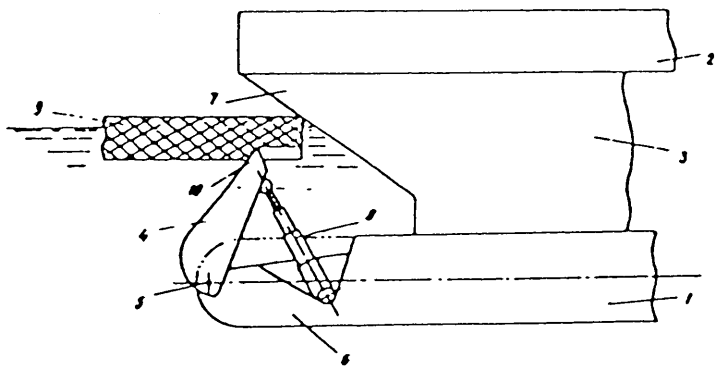
N	AUTHOR'S CERTIFICATE	DESCRIPTION
12	Patent (11) 1828443 (21) 4831142/11 (22) 12.09.90 (51) B63 B 35/08 (71) Masa-Yards Oy (Fi) (72) Gustav Lindkvist (Fi)	Ice ship containing hull with a raked ahead stem and horizontal in longitudinal direction bottom in which hollows are formed diverging from the central plane towards the stern and boards, the rear wall of each hollow being vertical. Front portion of each of the said hollows is located in the area of the central plane and the rear portion - in the board area forming therein a recess 
13	Author's certificate (11) 1143645 (21) 3625129/27-11 (22) 27.05.83 (51) B63 B 35/08 (53) 629.124.791.2 (088.8) (71) Arctic and Antarctic Research Institute (72) V.A.Nikitin, B.A.Fiodorov, V.P.Tripolnikov	Icebreaker containing hull with a wedge-like shape and cutting attachment having an edge and fixed over the hull perimeter at the level of waterline 

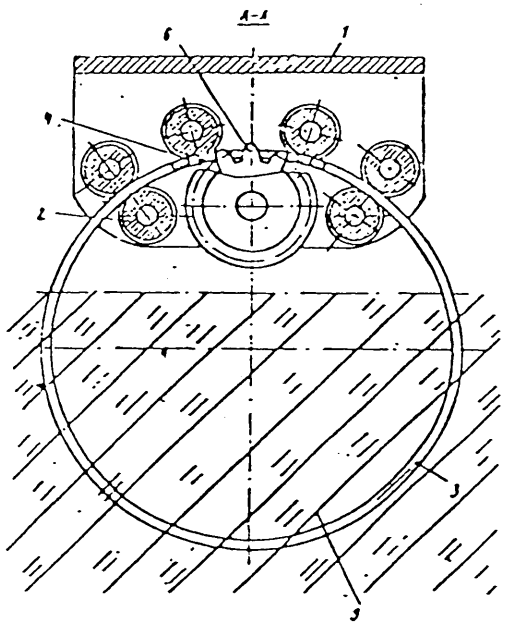
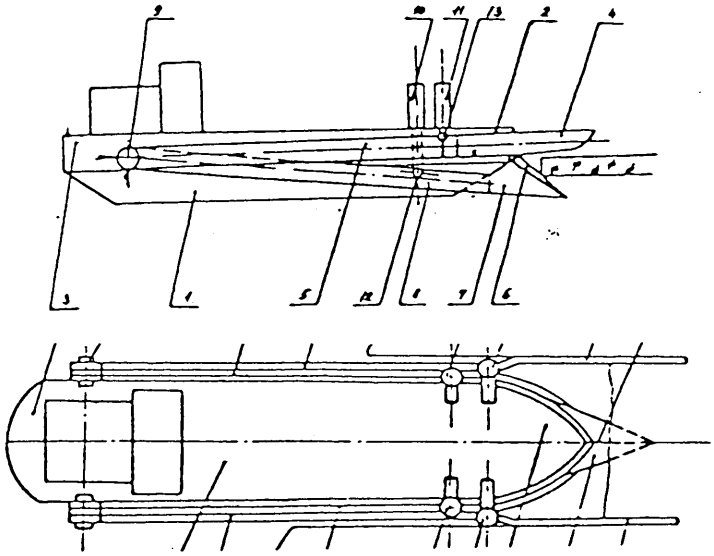
N	AUTHOR'S CERTIFICATE	DESCRIPTION
14	Author's certificate (11) 1122549 (21) 3592677/27-11 (22) 28.03.83 (51) B63 B 35/08 (53) 629.124.791 (088.8) (71) Far-East V.V.Kuibyshev polytechnical institute decorated with the Order of the Red Banner of Labour (72) N.G.Khrapatyi, V.A.Babtsev	Iceship forebody containing icebreaking attachment located in the underwater portion of ship and made in the form of the wedge having a cutting and breaking off edge 
15	Author's certificate (11) 1291491 (21) 3862388/27-11 (22) 06.03.85 (51) B63 B 35/08 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov	Icebreaker - ice remover contains ice dispersing wedge and lateral knives in the widest part 

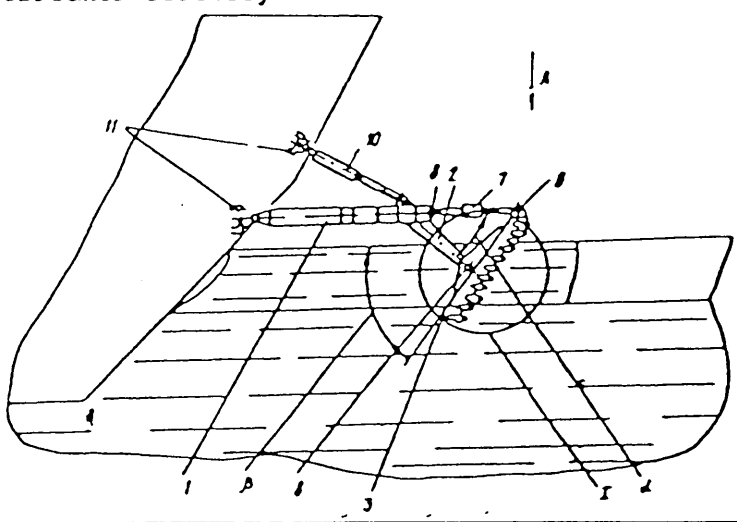
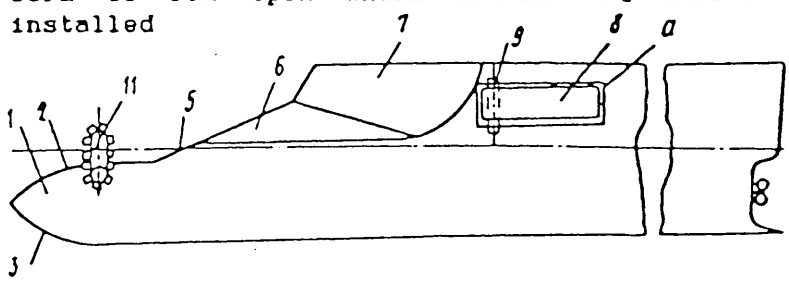
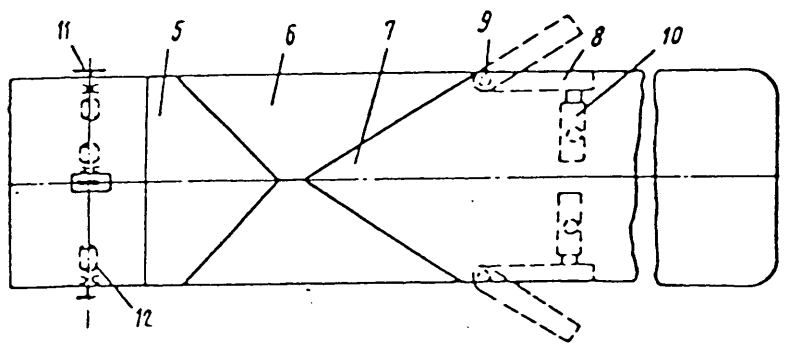
N	AUTHOR'S CERTIFICATE	DESCRIPTION
16	Author's certificate (11) 956348 (21) 2859047/27-11 (22) 26.12.79 (51) B63 B 35/08 (53) 629.791.2 (088.8) (72) V.A.Gusev, V.T.Sklyar	Icebreaker containing hull with boards and stem made with lateral sharp edges. The hull is made with bow supporting brackets profiled in the form of trihedral prisms their edges being located at the waterline level  Фиг.2  Фиг.3

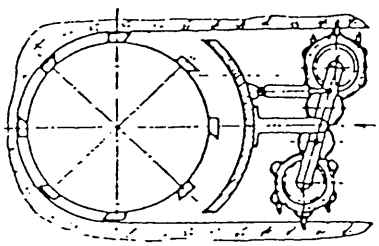
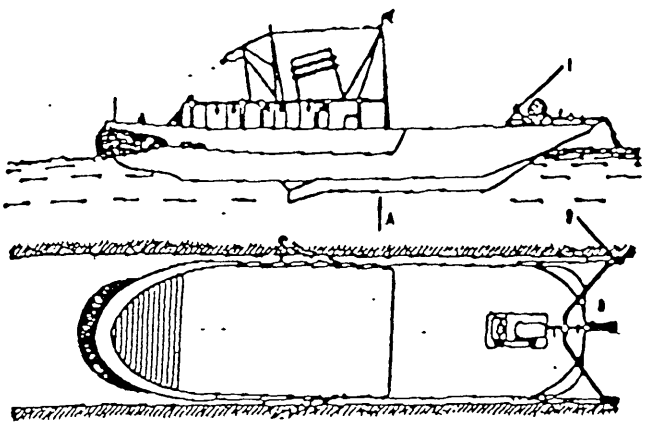
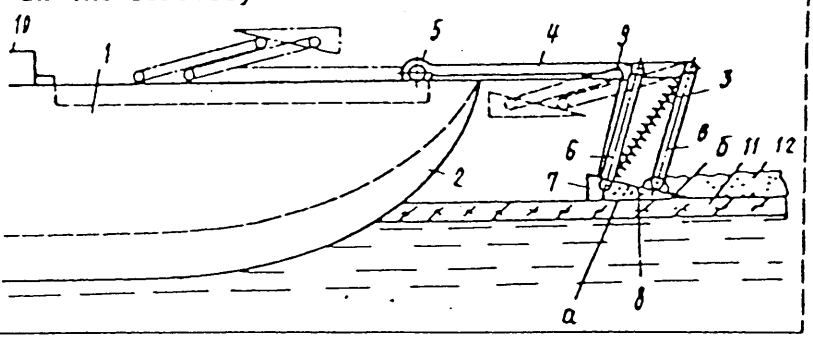
N	AUTHOR'S CERTIFICATE	DESCRIPTION
17	Author's certificate (11) 1031844 (21) 3403804/27-11 (22) 02.03.82 (51) B63 B 35/12 (53) 629.123.5 (72) V.N.Pikul	Spring - loaded icebreaker having ice-destructive teeth and ice-passage pillon as well as a ballast system of special construction 
18	Author's certificate (11) 895799 (21) 2863385/27-11 (22) 04.01.80 (51) B63 B 35/08 (53) 629.124.791 (71) Central design office under the Ministry of river fleet of the RSFSR in the city of Gorky (72) L.K.Preis, P.I.Antonov	Ship's icebreaking attachment of wedge-like shape in plan with turn plowshares and extendable lateral knives 

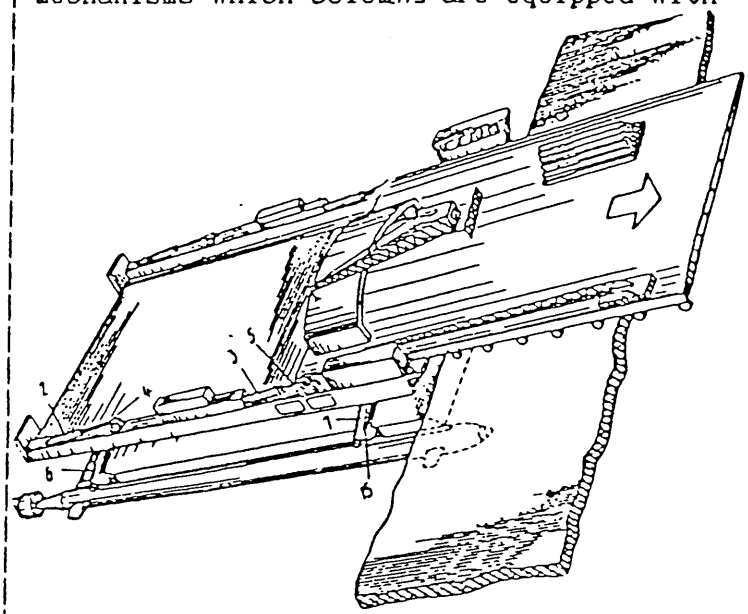
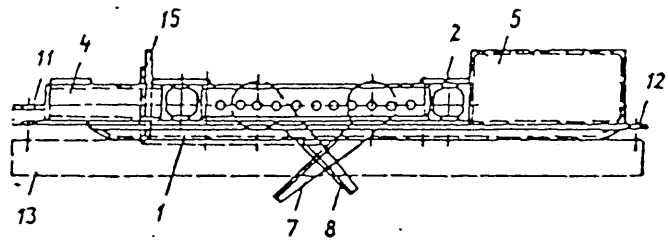
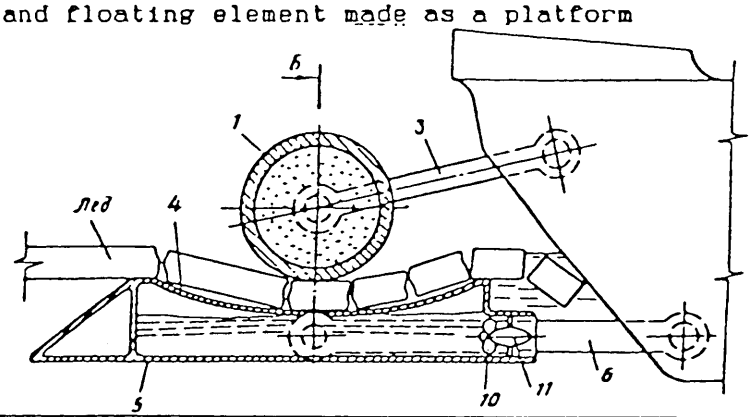
N	AUTHOR'S CERTIFICATE	DESCRIPTION
	BREAKING OF ICE BY DEVICES FIXED AT THE SHIP'S HULL	
19	Author's certificate (11) 58750 (21) 337 (22) 27.10.40 (51) B63 B 35/08 (72) F.N.Sergeev	Icebreaking device as a pontoon with cutters and guiding curvilinear surfaces to remove ice 
20	Author's certificate (11) 738938 (21) 2575565/27-11 (22) 27.01.78 (51) B63 B 35/10 (53) 629.124.791.2 (71) Novosibirsk institute of water transport engineers (72) B.Ja.Stazhevsky, L.Ja.Churakov	Icebreaking attachment the hull of which is fitted with cantilever and heel at the end and horizontal guiding seams 

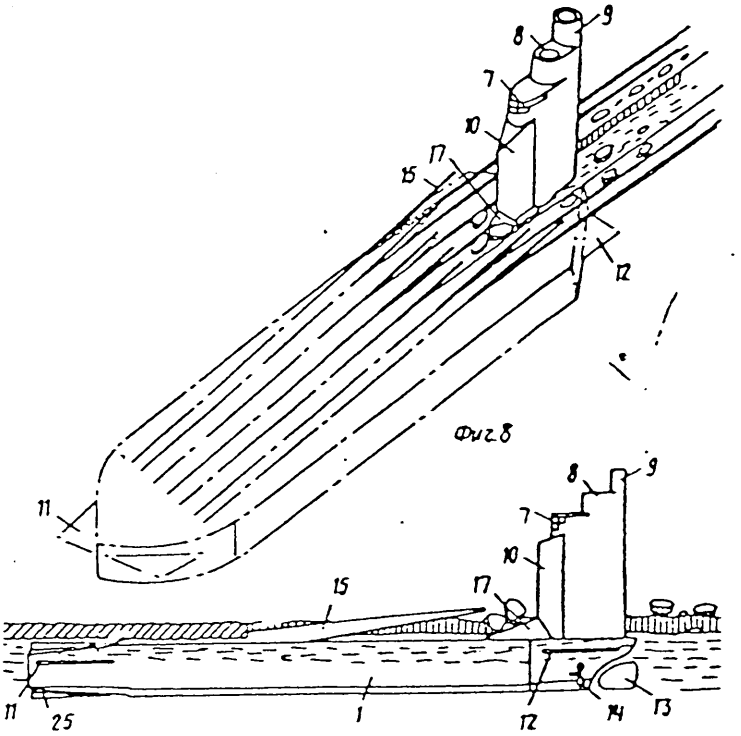
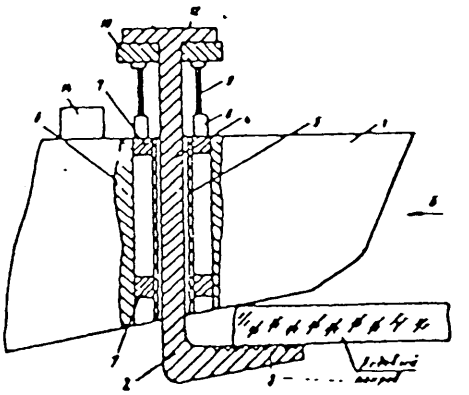
N	AUTHOR'S CERTIFICATE	DESCRIPTION
21	Patent (11) 9425582 (22) 07.04.75 (51) B63 B 35/12 (53) 629.124.791 (71) "Sea-Log Corporation" (USA) (72) Shirtsinger (USA)	Device for the destruction of ice for ships operating in ice contains a shaft vertically arranged on supporting cylinder and co-axial with the latter a number of levers radially situated and tied with the shaft the levers being provided with sickle-shaped plates 
22	Author's certificate (11) 743912 (21) 2331005 (22) 05.03.76 (51) B63 B 35/08 (53) 629.791.2 (72) N.V.Batanogov, Ju.M.Bazhenevskikh	Icebreaker contains upper deck, forebody, in the stem zone of which there is, a wedge-like working organ and also wedge-like supports with triangular girder and cross-beam 
23	Author's certificate (11) 796062 (21) 2726410/27-11 (22) 19.02.78 (51) B63 B 35/12 (53) 629.124 (72) R.N.Belavin, E.K.Piskareva	Ice ship breaking ice by means of a lever in the underwater portion of ship 

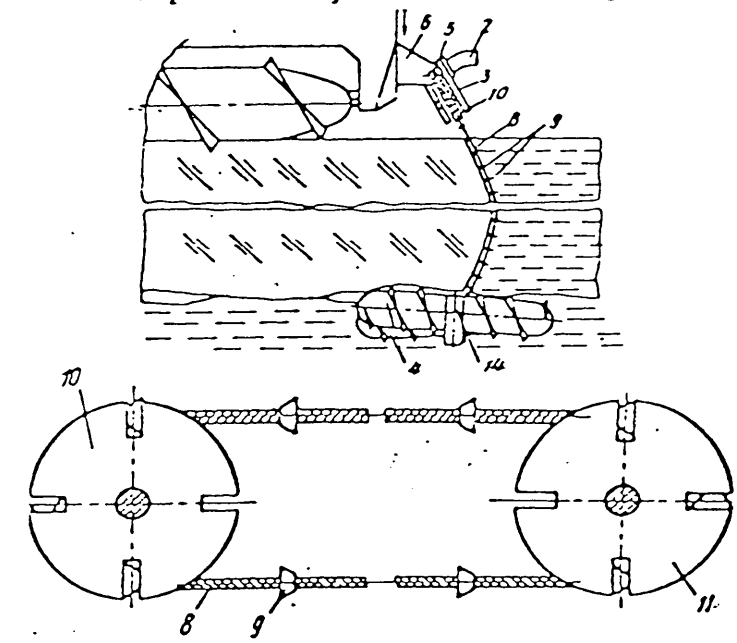
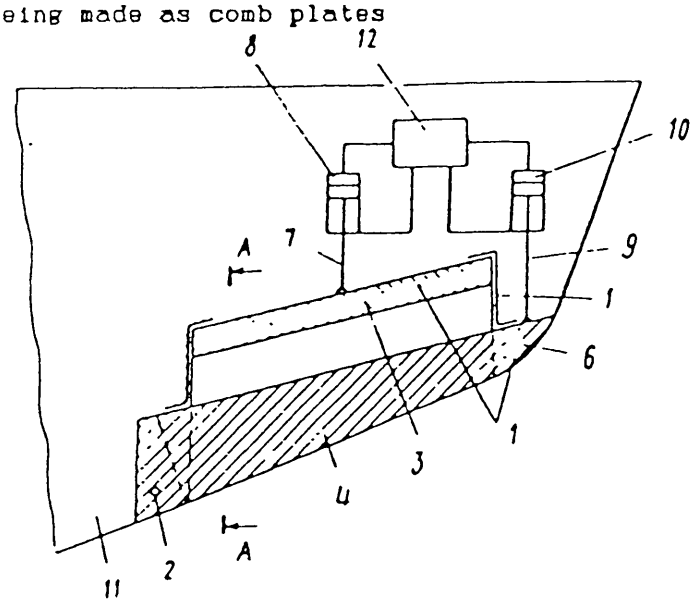
N	AUTHOR'S CERTIFICATE	DESCRIPTION
24	Author's certificate (11) 877263 (21) 2785084/28-13 (22) 28.06.79 (51) F25 C5/02 (53) 621.581 (71) Novosibirsk Institute of water economy (72) A.I.Glebov, N.N.Monzyrev	Ice-cutting device containing a frame with fixing rollers; working head as a rigid ring, motor and element for the transfer of movement to the working head made as a gear 
25	Author's certificate (11) 880872 (21) 2877088/27 (22) 29.10.80 (51) B63 B 35/12 (53) 629.124.791.2 (72) V.B.Kazakov	Icebreaker contains hull with extension upper and lower ice-cutting knives installed in the forebody, the knives being equipped with outer and inner extension frames 

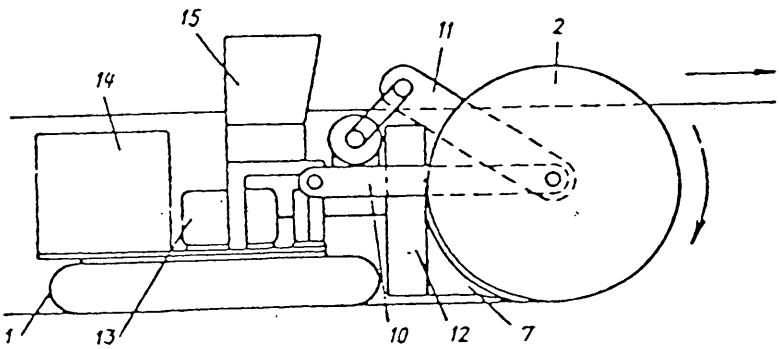
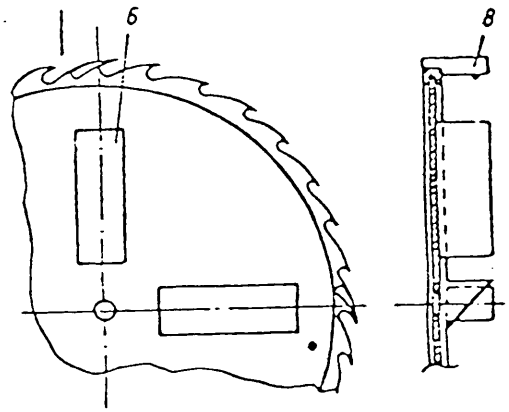
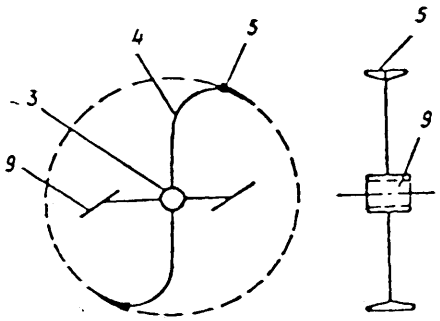
N	AUTHOR'S CERTIFICATE	DESCRIPTION
26	Author's certificate (11) 950587 (21) 2781452/27-11 (22) 18.06.79 (51) B63 B 35/12 (53) 629.124.791.2(088.8) (72) B.V.Lysyakov	Ship's ice-cutting device including carrier construction on which cutting tools are installed containing cutters connected with icebreaker forebody 
27	Author's certificate (11) 919920 (21) 2539962/27-11 (22) 01.11.77 (51) B63 B 35/08 (53) 629.124.791 (71) Estonian Sea shipping company (72) A.K.Vasilkov	Icebreaker hull with bow underwater part in a form of ram upon which the cutting tool is installed  

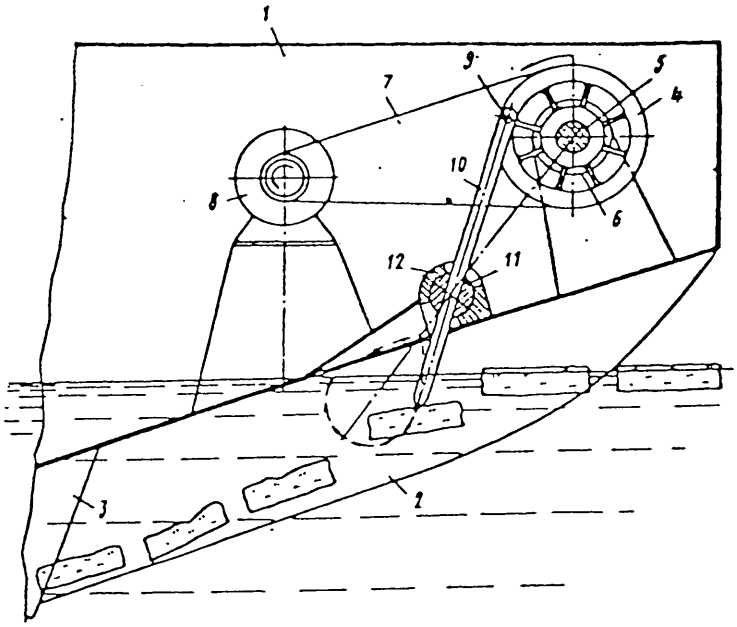
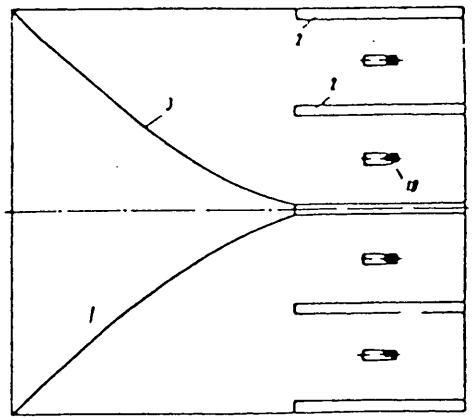
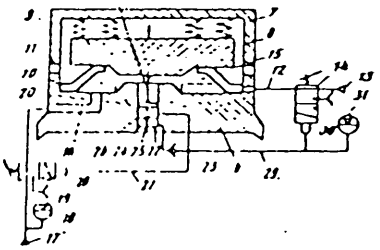
N	AUTHOR'S CERTIFICATE	DESCRIPTION
28	Author's certificate (11) 1402780 (21) 4163554/31-13 (22) 19.12.86 (51) F25 C 5/02 (53) 621.565 (71) Gorky polytechnical institute named after A. A. Zhdanov (72) V. V. Romanov, V. N. Khudyakov, A. P. Kuljashov	Device for cutting slits in ice of reservoirs; mechanism of movement is made in the form of two kinematically connected blocks of planetary gears 
29	Author's certificate (11) 147469 (21) 7280726/27 (22) 26.04.61 (51) B63 B 35/08 (72) I. S. Peschansky, Z. I. Shvaistein, F. D. Sokolov	Icebreaker with bow disk saws and guiding ribs on the bottom 
30	Author's certificate (11) 943087 (21) 2993960/27-11 (22) 11.12.80 (51) B63 B 35/12 (53) 629.124.791 (72) L. V. Ivanov, N. D. Andreev	Ship's icebreaking attachment contains a floating hull with sleigh lines on the bottom of which are cutters made of vertical plates as well as a group of snow-removal units in the forebody 

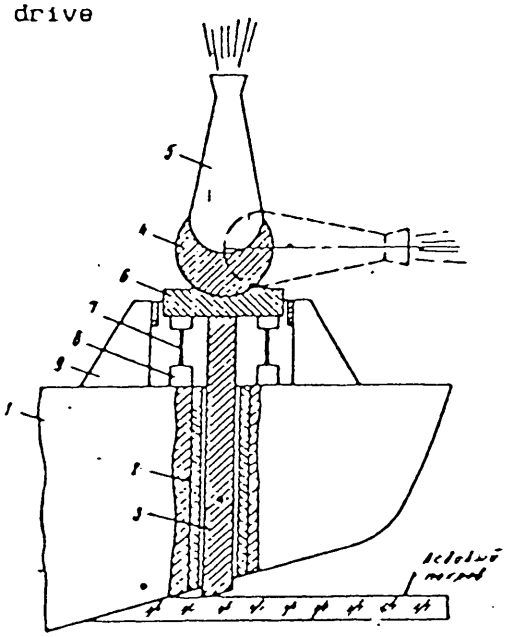
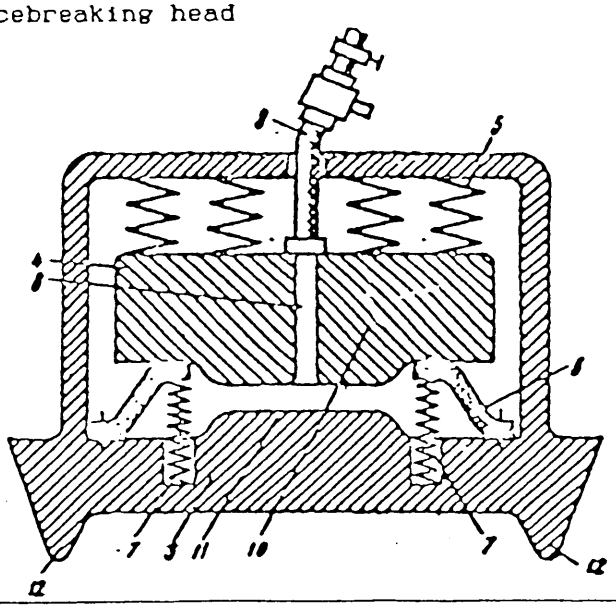
N	AUTHOR'S CERTIFICATE	DESCRIPTION
31	Patent (11) 917690 (21) 1894803/27-11 (22) 01.03.73 (31) 231154 (32) 02.03.72 (33) USA (51) B63 B 35/12 (71) "Air Logistics Corporation" (72) Josef Franklin Shirtsinger	Icebreaking semi-underwater ship for the transportation of cargo over the ice surface ice-cutting is made by rotating ice-splitting mechanisms which columns are equipped with 
32	Author's certificate (11) 1518193 (21) 4309195/27-11 (22) 25.09.87 (51) B63 B 35/12 (53) 627.2 (72) I.V.Zagryadsky, I.I.Tunik	Icebreaking device contains a frame with central and lateral longitudinal girders and icebreaking-icecutting elements which are fitted with cutters 
33	Author's certificate (11) 1230921 (22) 26.11.84 (51) B63 B 35/08 (53) 629.124.791.2 (72) N.V.Batanogov, Ju.M.Bazhenevskikh	Icebreaker contains hull with forebody and ice-breaking device consisting of working head and floating element made as a platform 

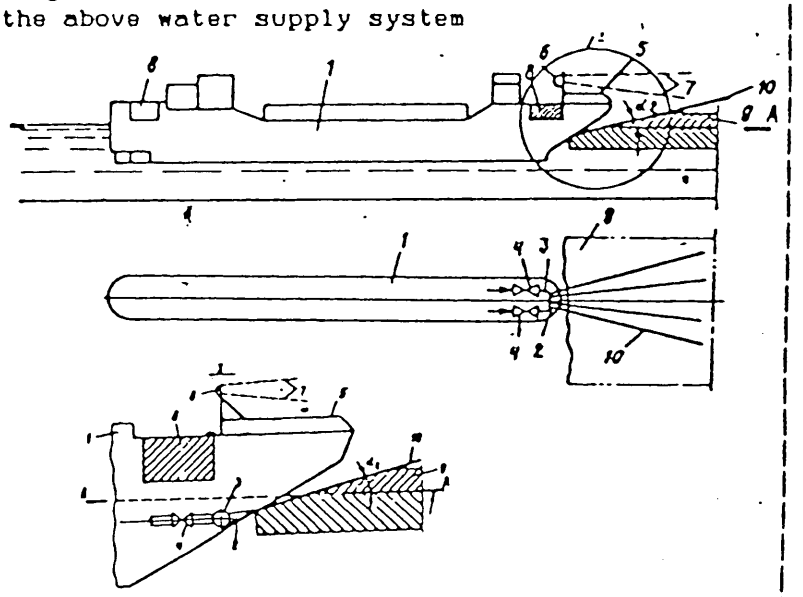
N	AUTHOR'S CERTIFICATE	DESCRIPTION
34	Author's certificate (11) 1181937 (21) 3729842 (22) 24.04.84 (51) B63 B 35/12 (53) 629.124.791(088.8) (72) Ju.B.Kashevarov	Semi-submersible ice-cutting ship has parallel flat saws arranged parallel to the central plane of the hull and an icebreaking device set behind them  Фиг.8
35	Author's certificate (11) 1106730 (21) 3419886 (22) 07.04.82 (51) B63 B 35/08 (53) 629.124.791.2 (72) V.V.Kovryzhkin, V.A.Nikitenko	Icebreaker contains hull with deck, levers installed on the hull symmetrically about the central plane and equipped with hull-linked drives in the form of hydraulic jacks connected with the common source of working fluid the running end of each lever being provided with a working head 

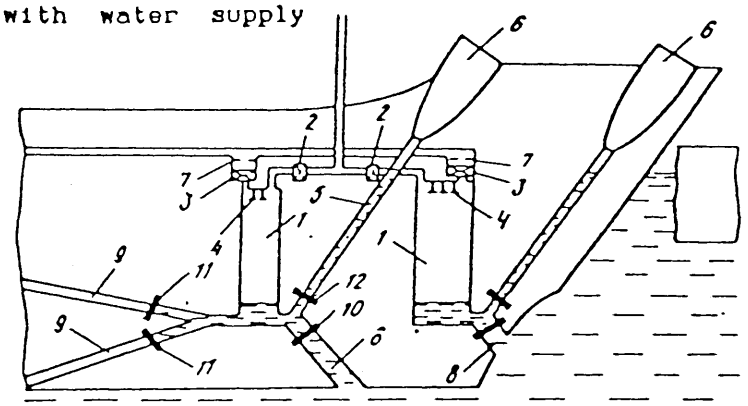
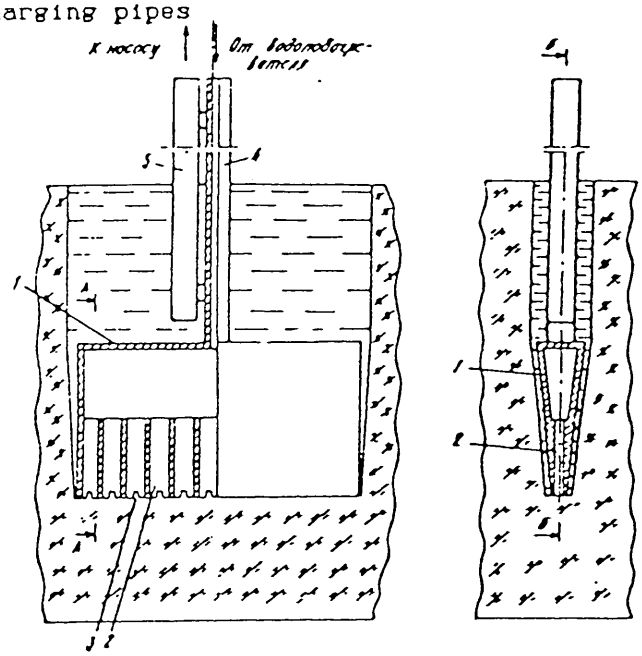
N	AUTHOR'S CERTIFICATE	DESCRIPTION
36	Author's certificate (11) 1698596 (21) 4675833/13 (22) 11.04.89 (51) 5 F25 C5/02 (53) 621.565 (71) Gorky polytechnical institute (72) A.P.Kuleshov, N.N.Tarbaev, E.A.Baldaev, A.V.Yankovich	Device for cutting slits in ice of reservoirs has a working head made in the form of an endless rope-block system with cutting elements 
37	Author's certificate (11) 893701 (22) 12.10.79 (51) B63 B 35/08 (53) 629.124.791.2 (71) Mining institute of the Academy of sciences of the Kazakh SSR (72) V.E.Khvan, L.A.Faleev	Icebreaking ship's attachment contains power elements built into the forebody these elements being made as comb plates 

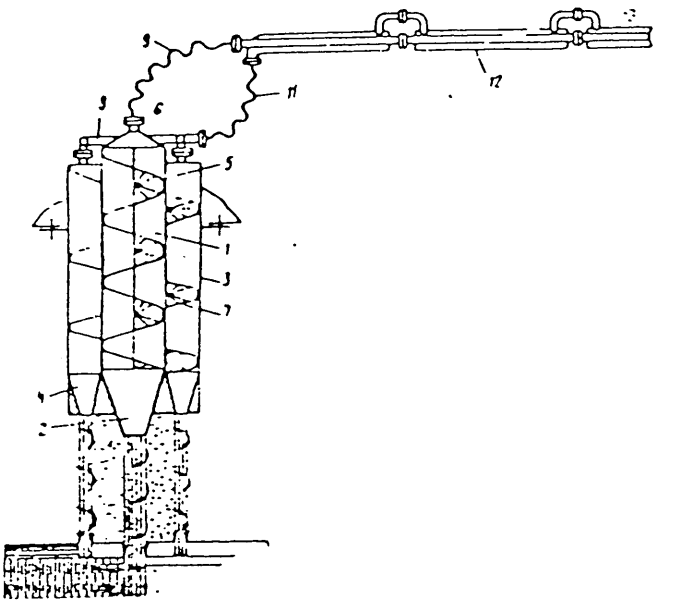
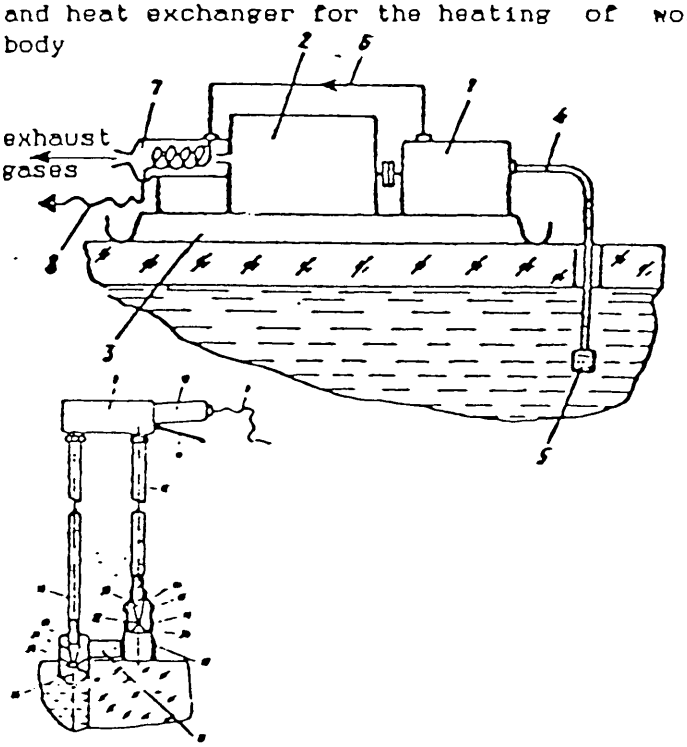
N	AUTHOR'S CERTIFICATE	DESCRIPTION
38	Author's certificate (11) 1703926 (21) 4497789/13 (22) 24.10.88 (51) 5 F25 C5/02 (53) 621.36 (72) I.I.Nekhoroshev	Device to work out the ice containing a self-propelled mechanism, working head including two disk-cutters   

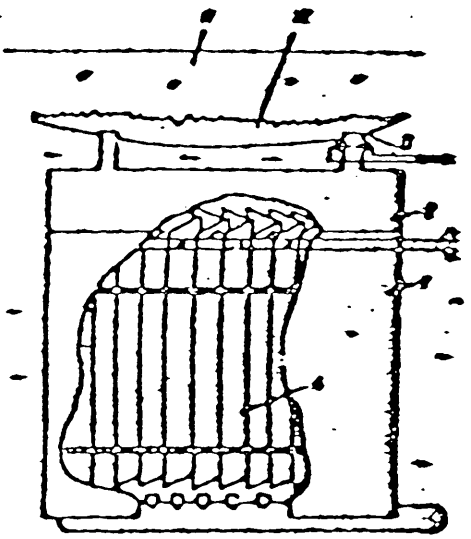
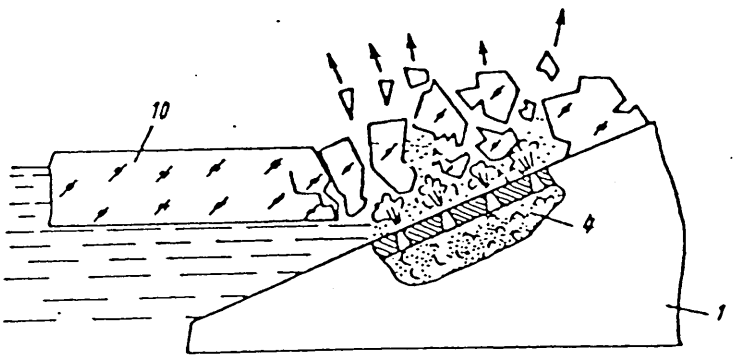
N	AUTHOR'S CERTIFICATE	DESCRIPTION
39	Author's certificate (11) 1004192 (21) 3351587/27-11 (22) 02.11.81 (51) B63 B 35/02 (53) 629.124.791.2 (71) Leningrad water transport institute (72) Z.B.Segal	Ice-cleaning ship contains knives installed on the outer side of the bottom and wedge moving ice apart as well as ice-dispersing devices  
40	Author's certificate (11) 1578252 (21) 4437914/31-15 (22) 08.06.88 (51) B63 B 35/02 (53) 629.24 (71) Pskov branch of the Leningrad polytechnical institute named after M.I.Kalinin (72) V.D.Glebov, A.M.Vetlitsyn, V.V.Mironchuk, V.M.Ivanova	Icebreaking device including hull with plate, pump, hydraulic tank, hydraulic line, spring-loaded cargo located inside the hull elastic sealing cup, working chamber, pneumatic and hydraulic distributors, hydraulic accumulators, source of compressed gas and hydraulic cylinder embedded into the plate 

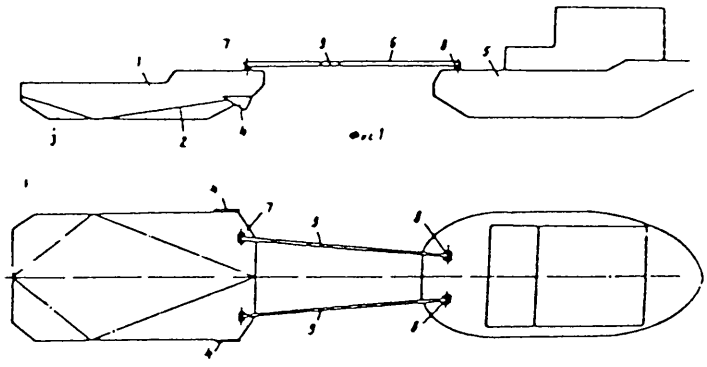
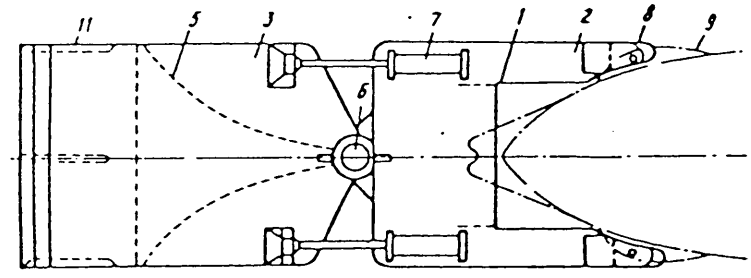
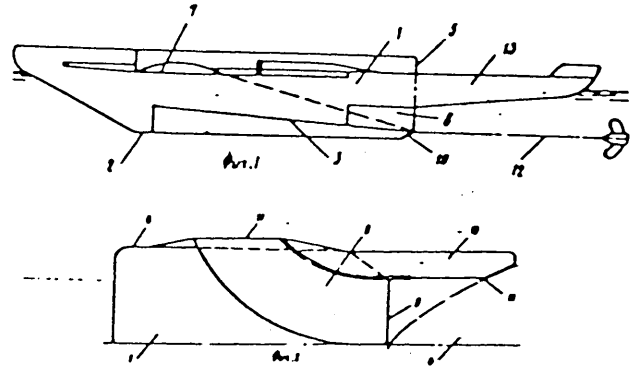
N	AUTHOR'S CERTIFICATE	DESCRIPTION
41	Author's certificate (11) 925752 (21) 2915043/27-11 (22) 21.04.80 (51) B63 B 35/12 (53) 629.124.791.2 (72) V.V.Kovryzhkin, V.A.Nikitenko, V.S.Eremeev, N.I.Gerasimov	Icebreaking device of ship as a vertical knife installed in the zone of stem and equipped with a jet drive 
42	Author's certificate (11) 761356 (21) 2676010/27-11 (22) 20.10.78 (51) B63 B 35/10 (53) 629.124.791.2.002.54 (72) Zh.G.Mukhin, V.N.Vlasov, A.E.Umnov	Icebreaker including forebody upon which mechanical vibrator with cargo is mounted this vibrator being connected with the working icebreaking head 

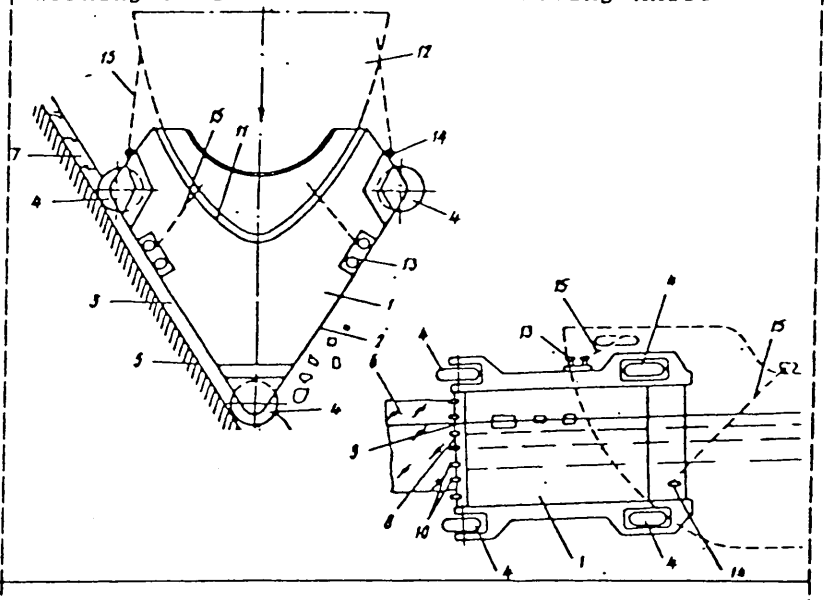
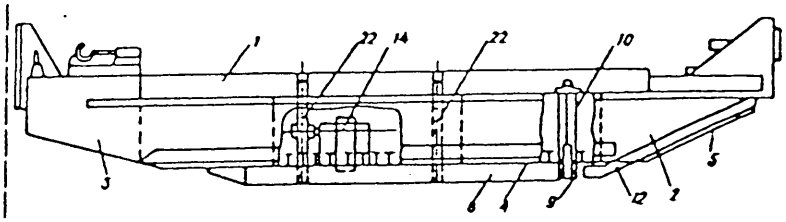
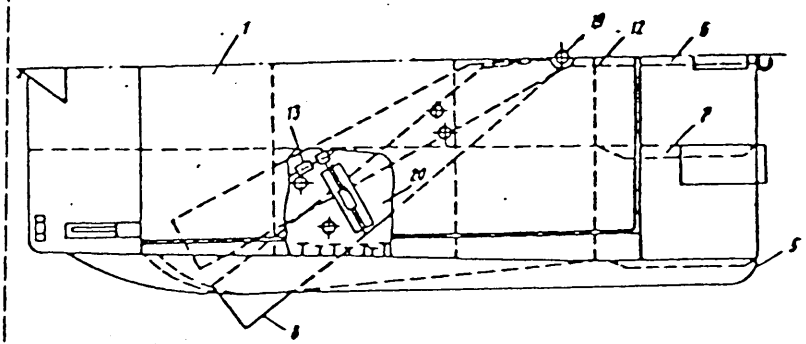
N	AUTHOR'S CERTIFICATE	DESCRIPTION
43	Author's certificate (11) 203494 (21) 1015849/27-11 (22) 21.06.65 (51) B63 B 35/08 (71) Arctic and Antarctic Research Institute, Leningrad institute of railway transport engineers, Institute of hydrodynamics of the Siberian Branch of the Academy of Science of the USSR (72) I.S.Peschanskiy, Z.I.Shvaistein, V.P.Nikolaev, G.Ja.Shoikhet	Method of breaking ice by pulse hydraulic jet
44	Author's certificate (11) 1206172 (21) 3744446/27-11 (22) 13.04.84 (51) B63 B 35/08 (53) 629.124.791 (72) S.V.Belyaev	Ship's device for breaking the ice cover contains in the forebody of ship a hydraulic nozzle, system of the water supply under pressure as well as nozzles arranged in the ship's hull below waterline and connected with the above water supply system 

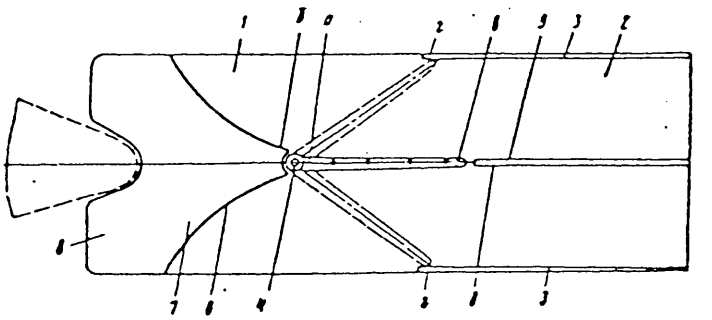
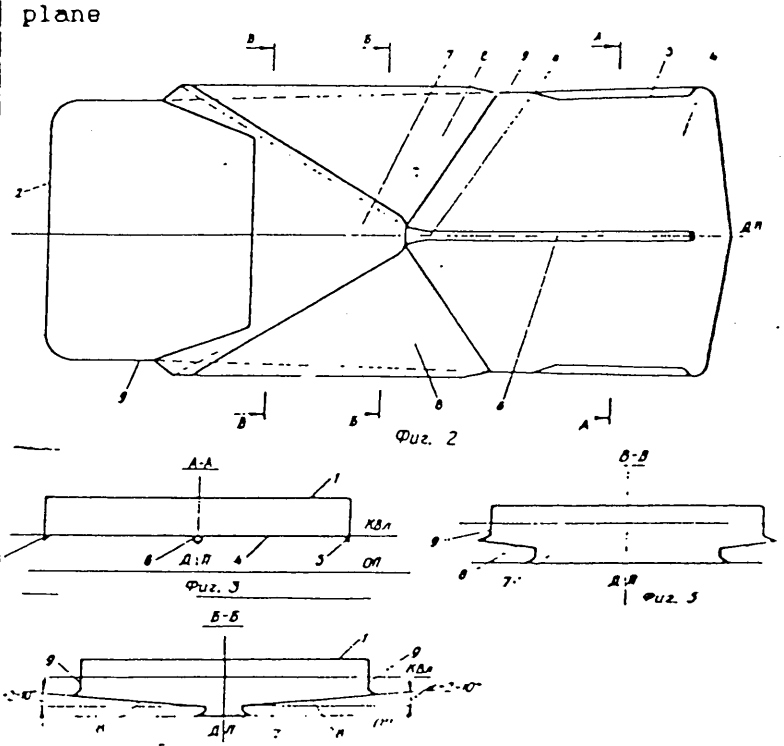
N	AUTHOR'S CERTIFICATE	DESCRIPTION
45	Author's certificate (11) 1054198 (21) 3420945/27-11 (22) 12.04.82 (51) B63 B 35/08 (53) 629.124.791.2 (72) V.V.Chernukha	Icebreaker contains hull, hydraulic ice-destructive device having a pipe connected with water supply 
46	Author's certificate (11) 844465 (21) 2816064 (22) 20.08.79 (51) B63 B 35/12 (53) 629.124.791 (71) Arctic and antarctic research institute (72) V.A.Morev	Ship's device for ice destruction contains a full hull of wedge-like section, suction and discharging pipes 

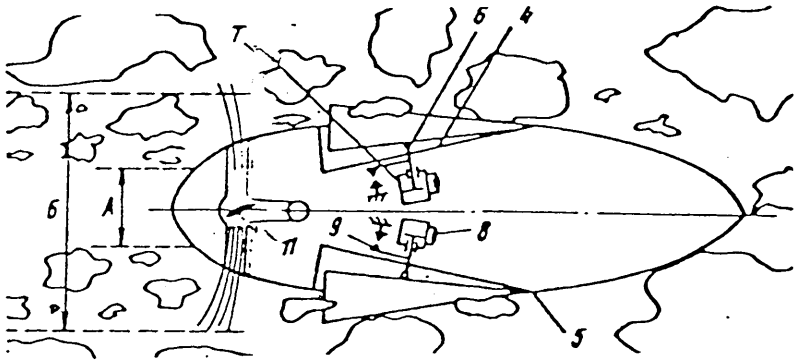
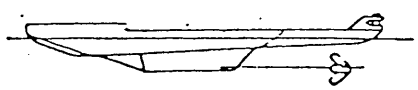
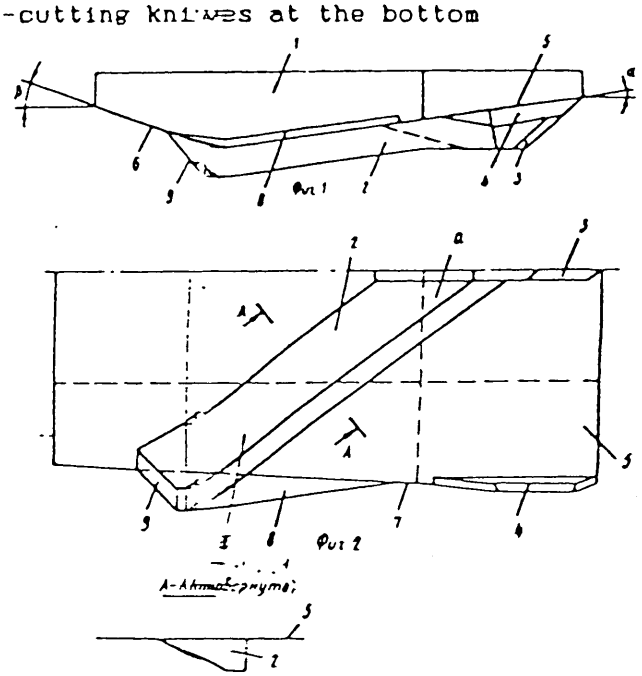
N	AUTHOR'S CERTIFICATE	DESCRIPTION
47	Author's certificate (11) 1174323 (21) 3576947/28-13 (22) 28.02.83 (51) B63 B 35/12 F25 C 5/10 (53) 621.588 (088.8) (72) A.F.Grinbaum, Ju.M.Filatov	Method of destroying ice involving the supply onto the ice surface of simultaneously heated and twisted high pressure jet of liquid and of heated circular twisted air jet 
48	Author's certificate (11) 1506020 (21) 4279448/29-15 (22) 08.07.87 (51) B63 B 35/12 E02 B 15/02 (53) 627.2 (72) A.F.Malevannyi, A.P.Subbotin	Ice-cutting device including a hydraulic system and heat exchanger for the heating of working body 

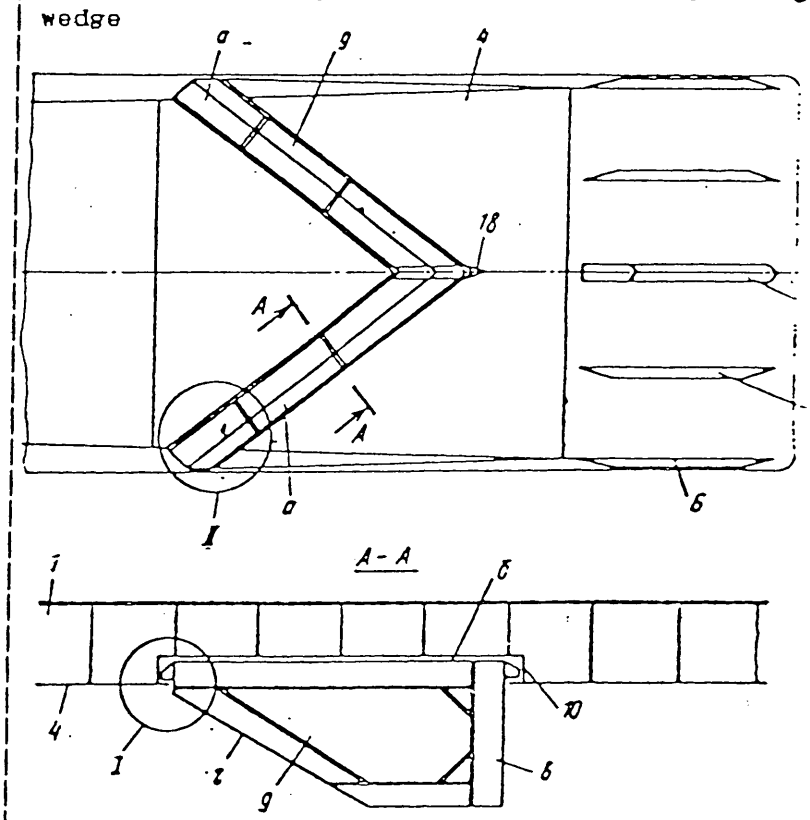
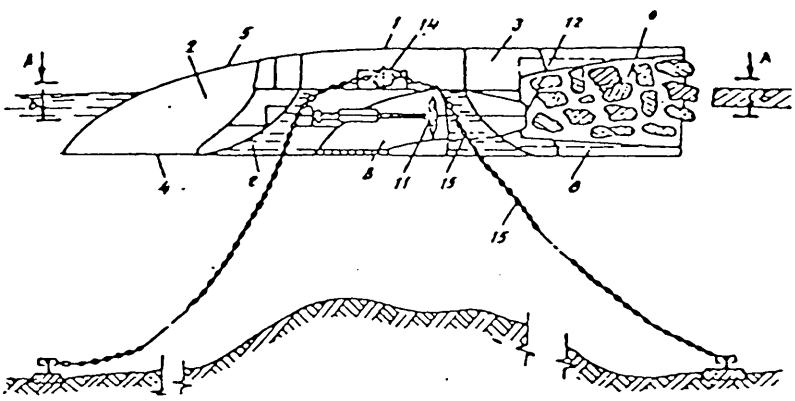
N	AUTHOR'S CERTIFICATE	DESCRIPTION
49	Author's certificate (11) 1242582 (21) 3819117/29-15 (22) 04.12.84 (51) E02 B 15/02 (71) Leningrad institute of water transport engineers (72) V.I.Moiseev, N.K.Vasilyev	Device for the destruction of ice contains chambers and a main for the supply of air as well as a batter for water electrolysis set up of metallic electrodes connected with the direct current power source 
50	Author's certificate (11) 1131757 (21) 3646039/27-11 (22) 27.09.83 (51) B63 B 35/08 (53) 629.124.791 (72) Ju.V.Kushke, V.N.Timofeev	Ship's icebreaking attachment contains working head in the form of inclined up-directed wedge forming the stem and chamber with nozzles; in the chamber there is a source of high-voltage pulse tension and blocks of electrodes connected with this source 

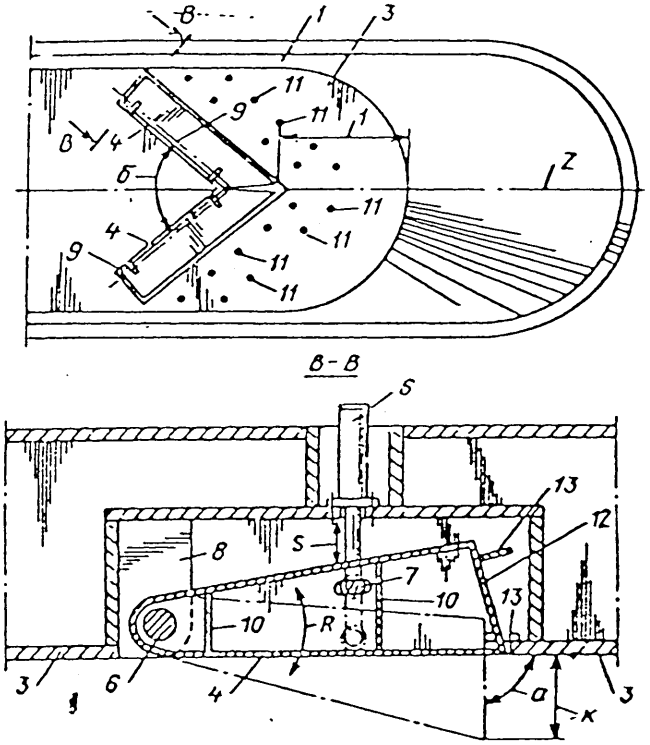
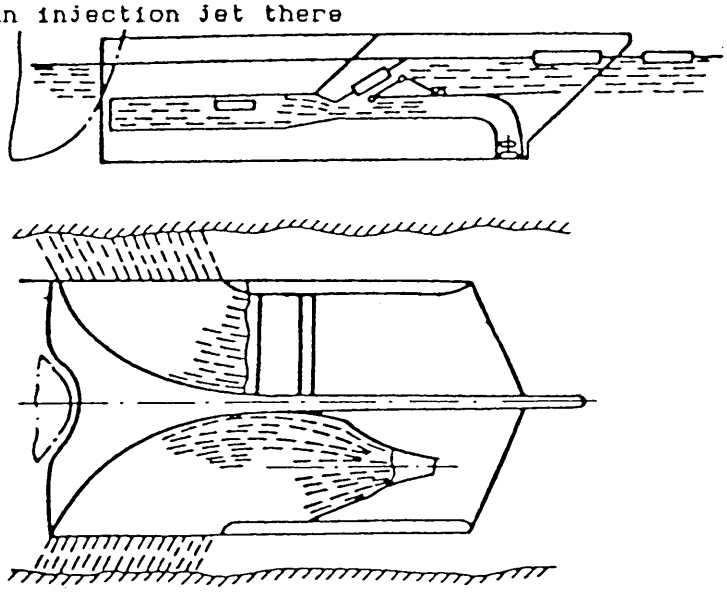
N	AUTHOR'S CERTIFICATE	DESCRIPTION
	CLEANING OF THE CHANNEL MADE	
51	Author's certificate (11) 874480 (22) 20.08.79 (51) B63 B 35/12 (53) 629.124.791.2 (71) CTKB of the Ministry of river fleet of the RSFSR (72) B.D.Vyatkin, G.S.Nikitin	Ice removing attachment contains hull with ice dispersing wedge located in the forebody bottom part and lateral ice-cutting knives 
52	Author's certificate (11) 1093613 (21) 3555156/27-11 (22) 23.12.82 (51) B63 B 35/12 (53) 629.124.791.2 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov Ju.B.Bogdanov	Ice-removing attachment of the icebreaker contains principal section on the bottom of which is an ice-dispersing wedge as well as an additional section located between icebreaker and principal section 
53	Author's certificate (11) 927637 (22) 20.06.80 (51) B63 B 35/08 (53) 629.124.791 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov Ju.B.Bogdanov	Towed ice-cleaning ship's attachment contains a floating hull with sleigh-like lines on the bottom of which is an ice-dispersing wedge arranged symmetrically in relation to the central plane 

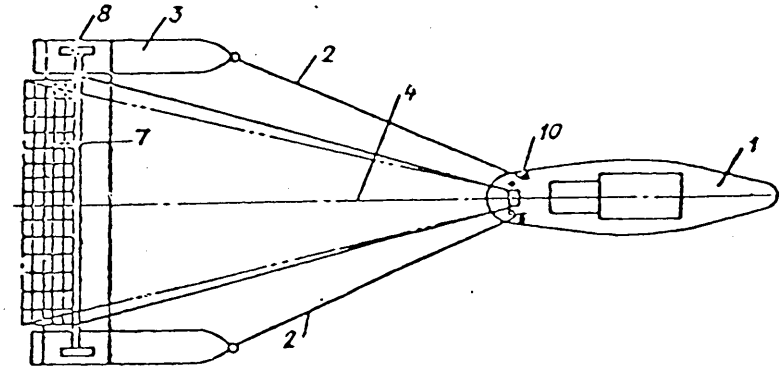
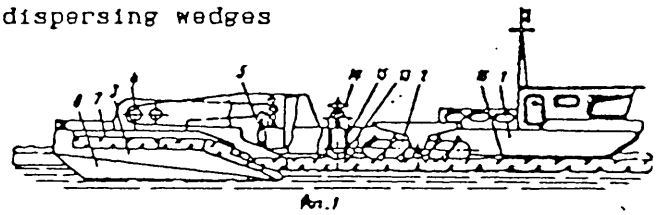
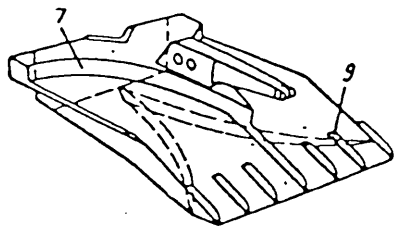
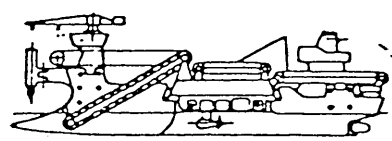
N	AUTHOR'S CERTIFICATE	DESCRIPTION
54	Author's certificate (11) 715383 (21) 2549968 (22) 01.12.77 (51) B63 B 35/02; (53) 629.124.791.2 (71) V.V.Klyuev (72) Board of the Volga-Baltic waterway	Icebreaking and ice removing attachment contains hull made as a trihedral isosceles prism and fited with supporting rollers and breaking cutting tools; it also contains working device made as an icecutting knife 
55	Author's certificate (11) 814807 (21) 2786826/27-11 (22) 28.06.79 (51) B63 B 35/12 (53) 629.124.791.2 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov B.I.Lyubimov	Icebreaking and ice removing attachment with sleigh-like lines, ice-cutting knives below the bow portion and ice dispersing wedge with changing angles  

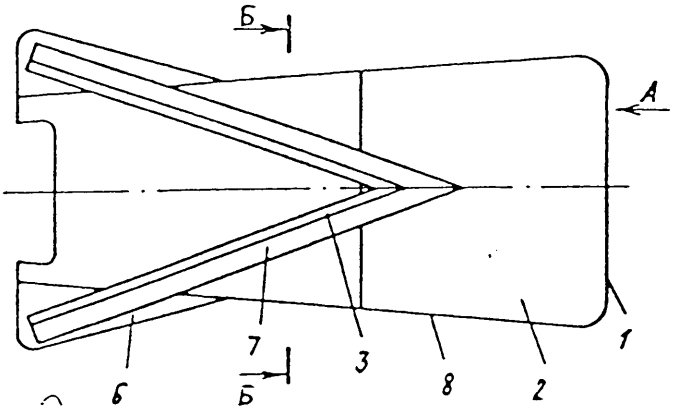
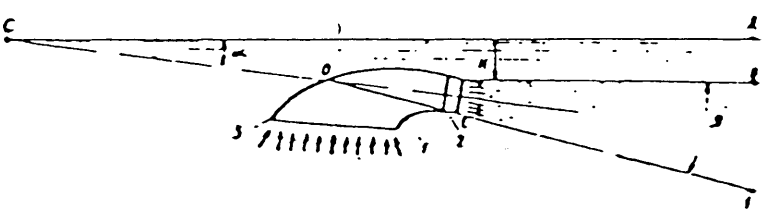
N	AUTHOR'S CERTIFICATE	DESCRIPTION
56	Author's certificate (11) 969585 (21) 2997607/27-11 (22) 29.10.80 (51) B63 B 35/08 (53) 629.124.791 (72) L.V.Ivanov, N.D.Andreev	Icebreaking and icecleaning ship's attachment contains a hull-pontoon with side vertical cutting plates mounted on its bottom and with a guiding plate capable of turning around vertical axis and also an ice-dispersing wedge expanding towards the afterbody 
57	Author's certificate (11) 1000344 (21) 3344265/27-11 (22) 06.10.81 (51) B63 B 35/12 (53) 629.124.791.2 (71) CTKB of the Ministry of the river fleet of the RSFSR (72) A.I.Platanov	Icebreaking and icecleaning ship contains a hull with sleigh-like lines tapering towards the afterbody, unit of mechanical cutting with central and lateral knives mounted under the plates of working bottom as well as an ice-dispersing wedge located in the center plane 

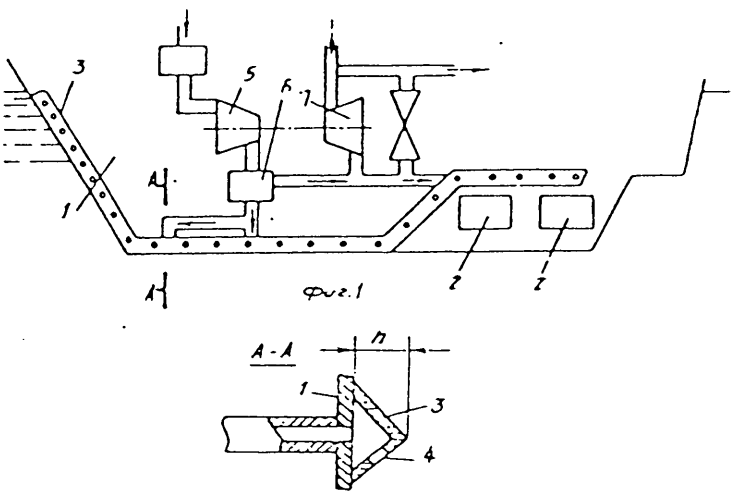
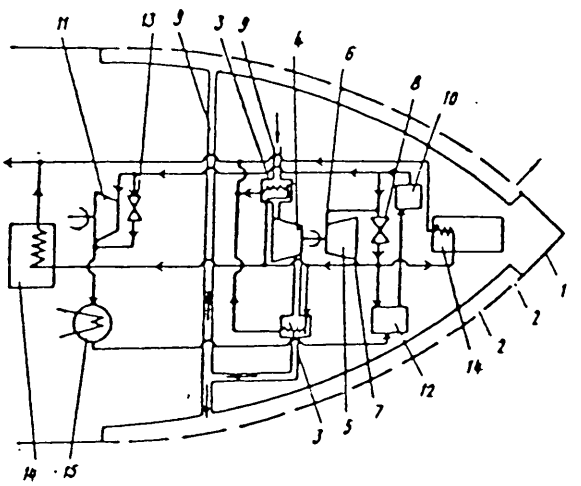
N	AUTHOR'S CERTIFICATE	DESCRIPTION
58	Author's certificate (11) 1096165 (21) 3439717/27-11 (22) 07.05.82 (51) B63 B 35/08 (53) 629.124.791(088.8) (72) N.P.Plastinin, N.D.Smolyaninov	Icebreaker has ice-dispersing elements made in the recesses of hull near middle frames 
59	Author's certificate (11) 1025582 (21) 3415430/27-11 (22) 29.03.82 (51) B63 B 35/12 (53) 629.124.791.2 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov Yu.B.Bogdanov	Towed ice-removing attachment contains a hull on the bottom of which there is an ice-dispersing wedge and ice-cutting knives arranged in the afterbody 
60	Author's certificate (11) 912587 (21) 2954721/27-11 (22) 09.07.80 (51) B63 B 35/12 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov Y.B.Bogdanov, V.G.Smirnov	Pushed icebreaking and ice removing attachment as a pontoon with ice dispersing wedge and ice-cutting knives at the bottom 

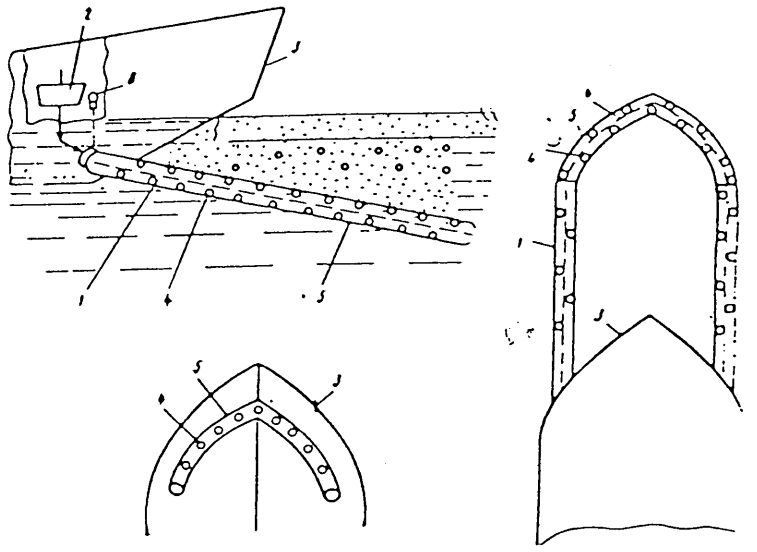
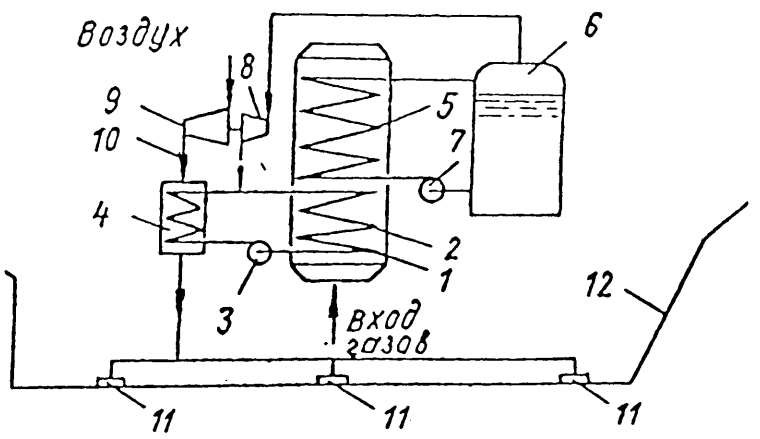
N	AUTHOR'S CERTIFICATE	DESCRIPTION
61	Author's certificate (11) 1421605 (21) 2560257 (22) 26.07.78 (51) B63 B 35/08 (53) 629.124.791.2 (71) Gorky institute of water transport engineers (72) B.V.Bogdanov	Icebreaking and ice removing ship contains hull with sleigh-like lines and transom endines as well as unit of mechanical ice cutting with lateral and intermediate knives under the bottom in forebody and a central ice dispersing wedge 
62	Author's certificate (11) 719914 (21) 2322764/27-11 (22) 02.02.76 (51) B63 B 35/02; E02 B 15/02 (53) 627.7.73 (72) L.V.Ivanov, N.G.Gedevanishvili, E.S.Kaja	Device for cleaning water areas from broken ice including pontoon with ends one of these ends being made with a flat of the upper part and the other being supplied with a chest 

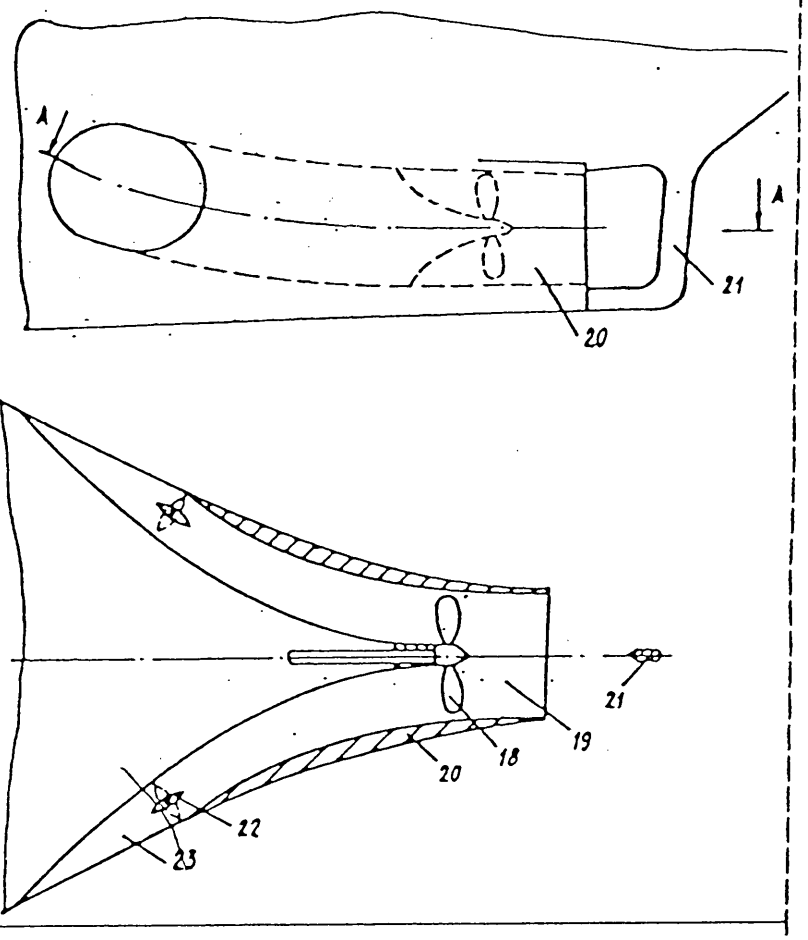
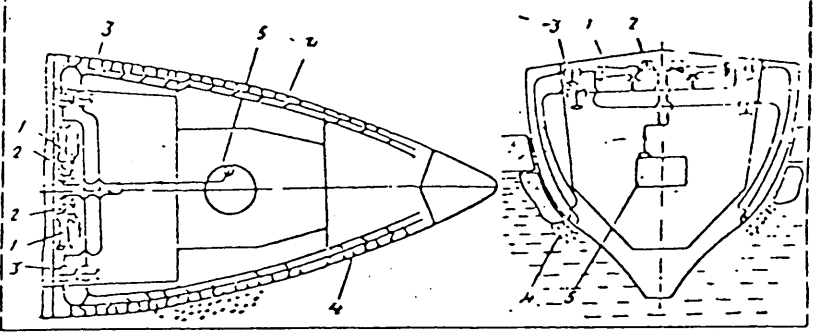
N	AUTHOR'S CERTIFICATE	DESCRIPTION
63	Patent (11) 1554760 (21) 4027283 (22) 01.04.86 (51) B63 B 35/08 (71) Wartsila Meriteollisuus (72) Torsten Heideman, Kaj Levander	Ship for operation in water filled with ice contains hull, forebody and afterbody which break up the ice, and an ice dispersing device made as two elongated plates 
64	Author's certificate (11) 220070 (21) 1122206 (22) 28.12.66 (51) B63 B (53) 629.124.791.2 (71) Leningrad institute of water transport (72) B.M.Levit and others	Ice-removing ship has tunnels in the forebody for the reception and removal of broken ice in the channels made by the icebreaker. Tunnels are located below waterline and connected with delivery pipe of the water jet unit to produce an injection jet there 

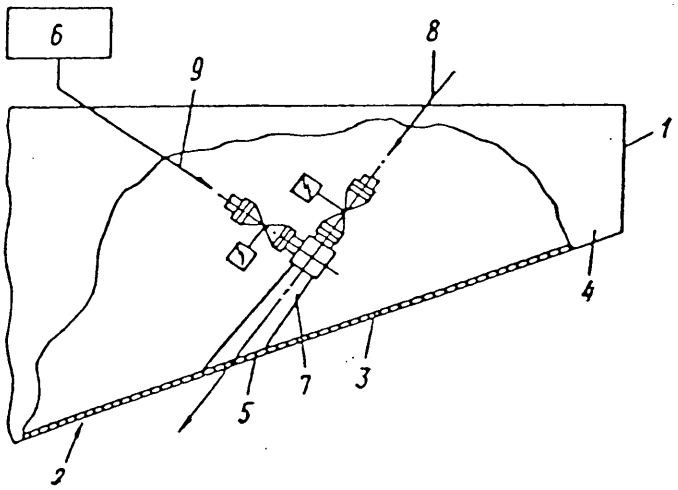
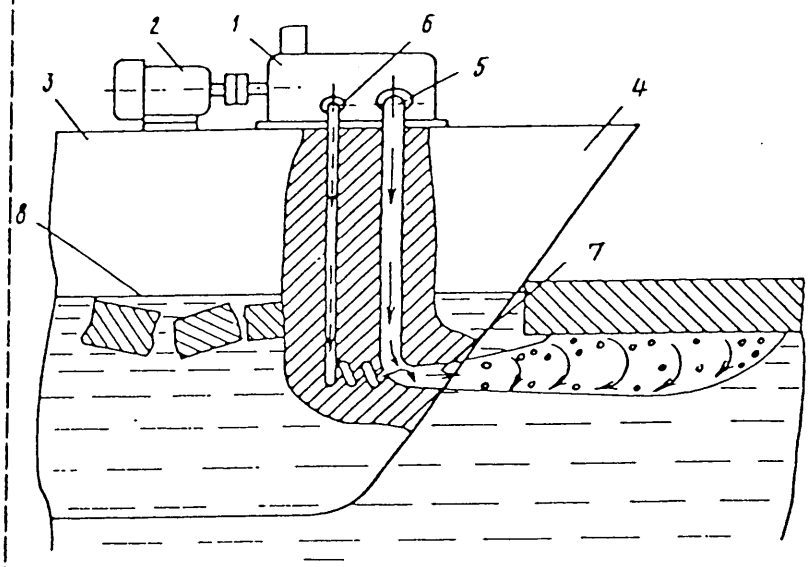
N	AUTHOR'S CERTIFICATE	DESCRIPTION
65	Author's certificate (11) 1618833 (21) 4471605/15 1 (22) 08.08.88 (51) 5 E02 B15/02 (53) 627.2 (71) Leningrad branch of the state design, exploration and research institute of sea transport "Soyuzmorniiproekt" (72) L.V. Ivanov, A.E. Yankevich, E.K. Blinov, O.N. Braginets, I.A. Kalinchuk	Ice-collecting unit consisting of the self-propolled ship and ice-collecting device containing two pontoons, ice entrapment element placed between pontoons 
66	Author's certificate (11) 1131758 (21) 3646777/27-11 (22) 27.09.83 (51) B63 B 35/08 (53) 629.124.791.2 (088.8) (71) Gorky institute of water transport engineers (72) B.V. Bogdanov, B.V. Biryukov, V.A. Sevastyanov	Icebreaking and ice-removing device containing ice-removing attachment with vertical ice-cutting knives and two oppositely directed ice dispersing wedges  Фиг.1 
67	Author's certificate (11) 1008079 (21) 3348304/27-11 (22) 21.08.81 (51) B63 B 35/08 (53) 629.124.791 (72) V.N. Pikulj	Self-propelled icebreaking and ice-removing ship VADPI-4 contains a hull with an ice destruction unit in the forebody made of two semi-hulls arranged symmetrically along both sides of the central plane and a unit of the removal of broken ice with additional conveyers mounted on the bridge and stern parts of semi-hulls 

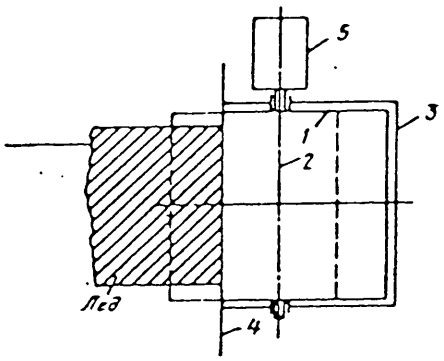
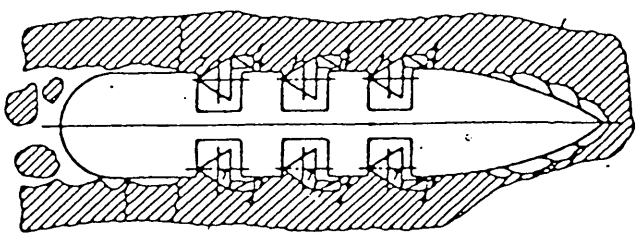
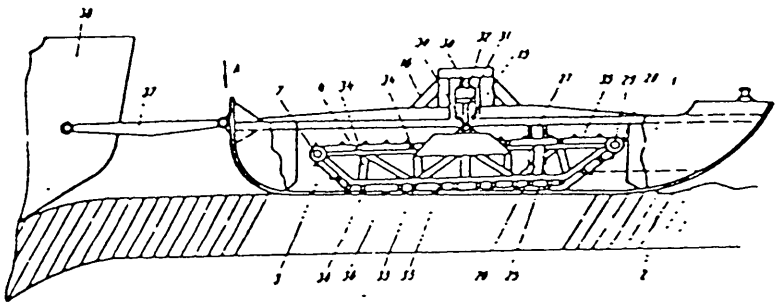
N	AUTHOR'S CERTIFICATE	DESCRIPTION
68	Author's certificate (11) 901153 (22) 13.05.80 (51) B63 B 35/12 (53) 629.124.791 (71) CTKB of the Ministry of river fleet of the RSFSR (72) M.I.Andrievskiy, A.I.Platov	Ice removing attachment of ship contains hull on the bottom of which there is an iceguiding wedge installed symmetrically about the central plane and wedge-like supports running alongside below waterline above the iceguiding wedge 
69	Author's certificate (11) 1435698 (21) 4147934/29-15 (22) 17.11.86 (51) E02 15/02 (53) 627.54 (71) Novosibirsk branch of the All-Union reseach institute of transport building (72) D.V.Roshchupkin, V.D.Semjonov	Method of Reeping the water area in unfrozen state consisting in the use of hydraulic jet at a depth of the water area 

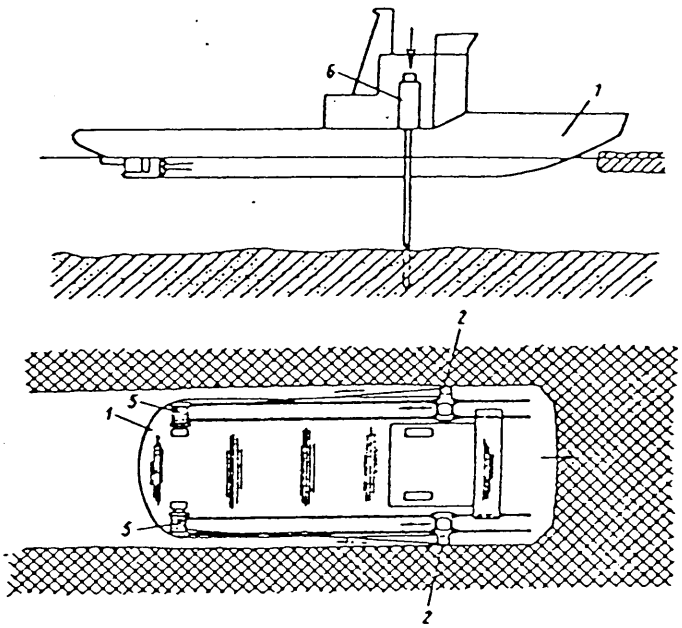
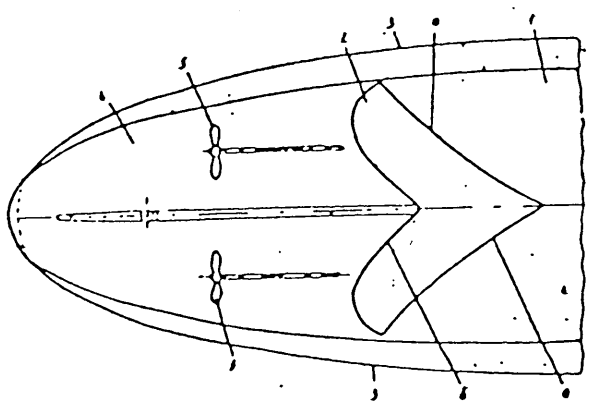
N	AUTHOR'S CERTIFICATE	DESCRIPTION
	AUXILIARY MEANS TO IMPROVE THE EFFECCIENCY OF ICE BREAKING	
70	Author's certificate (11) 1125151 (21) 2990151/27-11 (22) 15.08.80 (51) B63 B 35/08 (53) 629.124.791(088.8) (72) Ju.V.Bykov, A.V.Vorontsov and others	Ice ship containing a hull with ice boxes and collectors connected with the source of air supply and arranged symmetrically to the central plane  Фиг.1
71	Author's certificate (11) 1092093 (21) 3277388/27-11 (22) 16.03.81 (51) B63 B 35/08 (53) 629.124.791 (72) Yu.V.Bykov, A.V.Vorontsov, A.I.Gitelman and others	Ice ship with heated air-bubbling system 

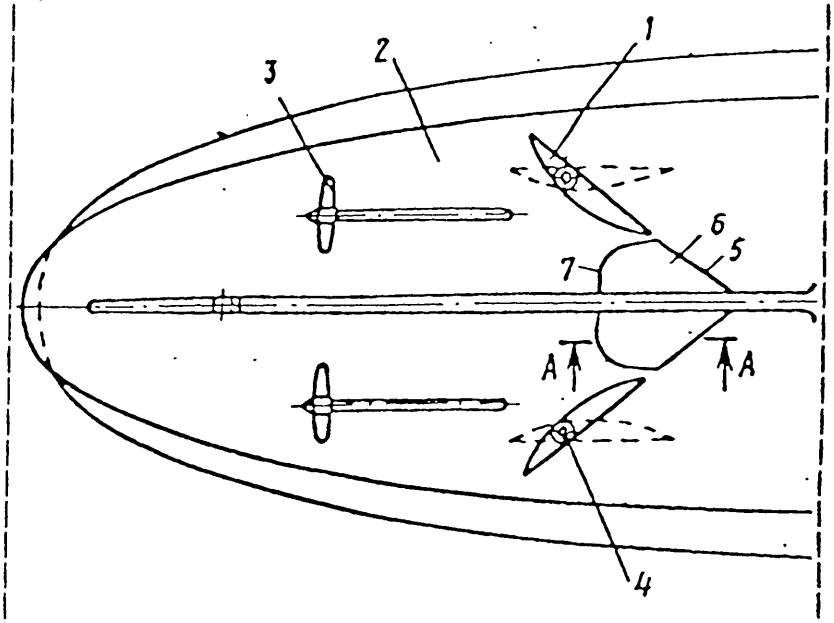
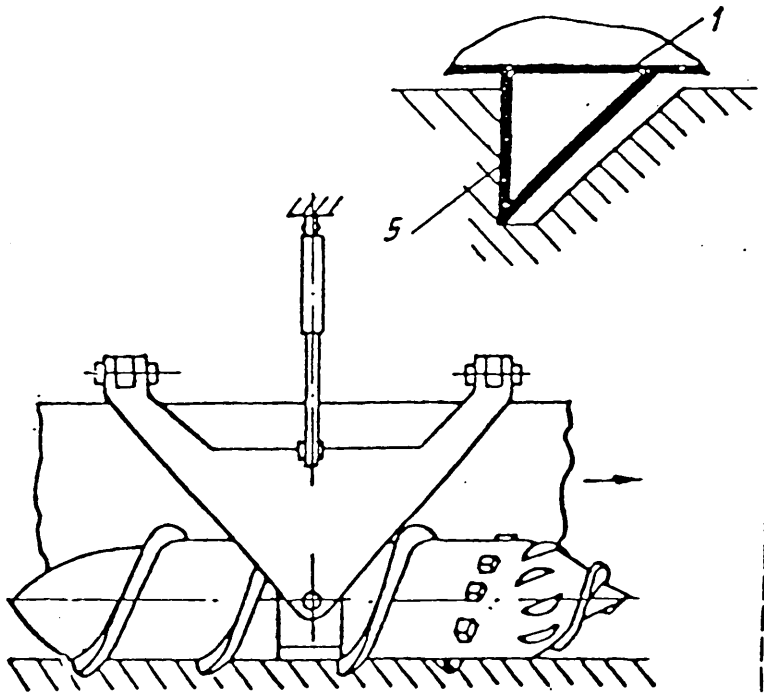
N	AUTHOR'S CERTIFICATE	DESCRIPTION
72	Author's certificate (11) 1121174 (21) 3570689/27-11 (22) 01.04.83 (51) B63 B 35/08 (53) 629.124.791.2(088.0) (72) A.A.Kochan, Ju.V.Kutin	Device for the improvement of ship's icebreaking capability containing perforated air ducts located below the waterline 
73	Author's certificate (11) 1142361 (21) 3663957/27-11 (22) 23.21.83 (51) B63 B 35/08 (53) 629.124.79 (71) Murmansk branch of the Central Marine Research Institute (72) V.A.Chernenjkij, I.G.Selyugin	Ice ship with the use of heated air-bubbling system 

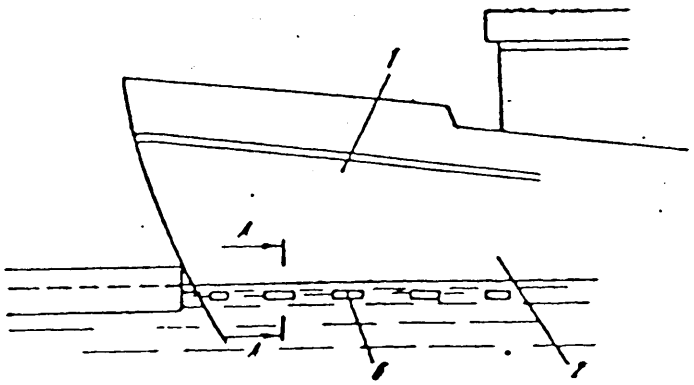
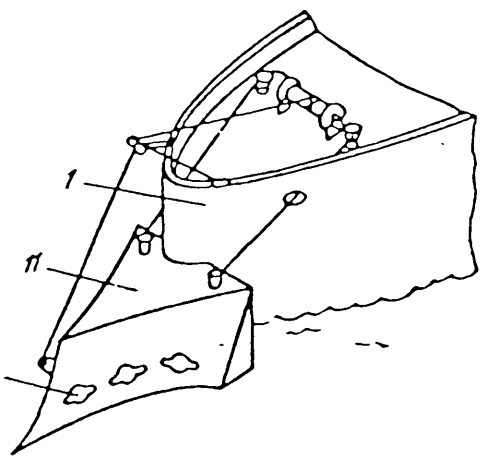
N	AUTHOR'S CERTIFICATE	DESCRIPTION
74	Author's certificate (11) 1309473 (21) 3964759/27-11 (22) 17.09.85 (51) B63 B 35/08 (53) 629.124.791 (72) A.V.Pilipenko, E.M.Novoseltsev	Ice ship with propulsion and steering unit of jet propeller type the side water ducts of which are deflected upwards from horizontal position to provide for the washing of ice belt 
75	Author's certificate (11) 382544 (21) 1731201/27-11 (22) 02.12.71 (51) B63 B 35/08 (53) 629.124.791.2 (72) S.I.Evdokimov, V.I.Kashtelian V.K.Kovalenko, V.K.Tarasov, Yu.S.Yurchenko	Device to ensure the ice passability of ships with the use of hot gas air-bubbling system 

N	AUTHOR'S CERTIFICATE	DESCRIPTION
76	Patent (11) 1612995 (21) 4203250/27-11 (22) 03.09.87 (51) B63 B 35/12 (53) 629.124.791 (71) Thyssen Nordseewerke GmbH(DE) (72) Hermann Herkens and Oskar Schuler	Icebreaking ship contains hull with pontoon-like forebody as well as a device for the formation of liquid lubricating film on the bottom forebody plating this device being connected with the power plant by means of the pipeline which supplies heat-transport medium to the plating 
77	Author's certificate (11) 893902 (22) 07.04.80 (51) B63 B 35/08 (53) 629.124.791.2 (71) Mining Institute of the Academy of sciencies of the Kaz.SSR (72) V.E.Khvan, L.A.Faleev	Device for the improvement of ship's icebreaking capability contains the source of compressed air installed onto the hull and exhaust nozzle as well as pneumatic pipeline with spiral section at one of the ends 

N	AUTHOR'S CERTIFICATE	DESCRIPTION
78	Author's certificate (11) 1071898 (21) 3531150 (22) 24.12.82 (51) E02 B 15/02 (53) 627.73.002.5 (72) V.A.Grigoryev, Y.D.Kravchuk	Device for the protection of floating bodies against ice impact contains perforated, filled with heat-transport medium and hinge suspended channel arranged alongside below waterline
79	Author's certificate (11) 1131758 (21) 3631070/27-11 (22) 03.08.83 (51) B63 B 35/08 (53) 629.124.791.2 (72) A.V.Ierusalimsky	Ice ship contains ice propulsors made in the form of trihedral equilateral prisms and arranged in hull recesses at the level of waterline  
80	Author's certificate (11) 1065289 (21) 328857 (22) 20.05.81 (51) B63 B 35/08 (53) 629.124.791 (72) N.N.Efimov	Ancillary traction mechanism for the movement of icebreaking ship's hull through the ice cover contains driving-propulsion system for the interaction with ice mounted on the supporting unit connected with the ship's hull by the connecting unit 

N	AUTHOR'S CERTIFICATE	DESCRIPTION
81	Patent (11) 1616510 (21) 4028263/27-11 (51) B63 B 35/08 (53) 629.124.791.2 (71) Thyssen Nordseewerke GmbH(DE) (72) Jens-Holger Helmann	Icebreaking ship is fitted with the device to provide for horizontal movement of ship independent of the propeller this device containing piles installed with the possibility of interaction with ground and drives of horizontal and vertical displacement of piles in relation to the hull; the drive of vertical displacements of each pile is made in the form of hydraulic cylinder or a crane 
82	Author's certificate (11) 757385 (21) 2665368/27-11 (22) 11.09.78 (51) B63 B 35/08 (53) 629.124.791.2 (71) Leningrad institute of water transport (72) P.A.Maly, Z.B.Segal, I.M.Chechot	Icebreaker for clearing the channel of broken ice contains a wedge-like projection on bottom in the afterbody 

N	AUTHOR'S CERTIFICATE	DESCRIPTION
83	Author's certificate (11) 1127805 (21) 3578242/27 (22) 12.04.83 (51) B63 B 35/08 (53) 629.124.791 (71) Leningrad institute of water transport (72) Z.B.Segal	Device for the protection of ship's propulsion against impact with broken ice contains a wedge-like projection on bottom in the afterbody of hull and two vertical wings with vertical axes of turn located in the area of projection 
84	Author's certificate (11) 872378 (21) 2847949/27-11 (22) 06.12.79 (51) B63 B 35/08 (53) 629.124.791 (71) Gorky polytechnical institute named after A.A.Zhdanov (72) A.F.Nikolaeva B.V.Biryukov	Auxiliary propulsion plant of icebreaking ship contains rotor-screw propulsors with cutting tools and borer 

N	AUTHOR'S CERTIFICATE	DESCRIPTION
85	Author's certificate (11) 889527 (21) 2501727/27-11 (22) 29.08.77 (51) B63 B 35/08 (71) State union factory on the mechanical and chemical cleaning of boiler units "Kotloochistka" (72) I.A.Levin	Icebreaking ship which forms a clearance between board and ice edge by means of elastic deformation in hull plating by electro-magnetic inductors of eddy currents  

APPENDIX 2

Review of a paper entitled New Concepts of Removing Ice by A. V. Ierusalimsky, Y. V. Glebko, A. A. Golubeva, and N. V. Ulatova.

This paper is a survey of all patents issued in Russia from 1940 to 1993 on devices and ideas to facilitate breaking and clearing of ice. Included in this survey is a literature search of inventions published since 1890, which is considered to be the beginning of icebreaking technology in Russia.

In the main body of the paper, the authors have presented the information according to the scheme used in proposed devices to break or clear ice, as shown in Figure 2.1. The appendix of this paper contains a tabulated presentation of all ideas. The authors expect the readers to understand the ideas from the sketches and brief descriptions given in the paper. However, there are a few ideas that may need further explanation to be understood by an average reader.

Most of the icebreaking ideas presented in this paper are not practical from the operational point of view. Most of the good ideas patented or proposed in the past have already been implemented by now, e.g., Thyssen-Waas bow, bubbler system to reduce ice-hull friction, etc. The only use of this type of survey is to avoid duplication of efforts in the future by preventing "reinvention of the wheel." If that is the intent of this survey, it should be clearly stated in the introduction of this paper.

On page 38, it is merely stated that a swinging device was tested in full scale on icebreakers Smerch and Portovy-1. The results of those tests should be included, and would be a valuable addition to this paper, so that a reader may know the effectiveness of the proposed swinging device.

In the conclusion, the authors have recommended future studies on different topics. Comments on some of those studies are given below:

With respect to the authors' suggestion that a similar patent and literature search should be conducted on the concepts patented or published in USA, Canada, Finland, Sweden, Germany, Norway, Japan, and other countries, the objectives of the proposed work should be clearly stated. It will be a major task to conduct a search of this type in those countries.

It is a good idea to investigate the efficiency and advisability of using unconventional hull lines for Arctic class vessels, and to examine the prospects of improving conventional hull lines of polar ships on the basis of operational experience and experimental investigations. The cost of using air cushion vehicles should be included in any future studies.

A few editorial corrections have been pointed out on the manuscript. All references are in the Russian language, and these should be translated in the English language.

Reviewer: Devinder S. Sodhi, US Army Cold Regions Research and Engineering Laboratory,
72 Lyme Road, Hanover, NH 03755-1290, USA. Date : 3 November, 1994.