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(54) Improvements relating to dredgers.

(57) A method and apparatus for dredging in flowing waters comprising a support member (3) carrying thrust means (13) so that the thrust means (13) is directed downwardly towards the area to be cleared, the support member (3) being mounted in the water so that in operation it presents a surface towards the flow of water which causes a resultant downward component of force to balance the upward component of force caused by the thrust means (13).

EP 0 328 198 A1

IMPROVEMENTS RELATING TO DREDGERS

This invention relates to dredgers for removing sand, silt and like material from the river or sea bed, and has application, for example, to clearing wrecks.

A suction dredger is the most widely used apparatus for lifting such material, the suction being created by a motor and pump unit, somewhat like a vacuum cleaner. However, if used for clearing wrecks, such apparatus has the disadvantage that small and/or lightweight articles from the wreck can also be lifted and, even if a screen is provided in the suction path, the articles may be small enough to pass through the screen, or they may become damaged by hitting the screen, or be difficult to extract from the other debris lifted.

A modified form of the suction method, which is used in tidal waters, is to provide a vertical length of pipe above the area to be cleared near the lower end of which air is let under pressure to pass upwardly through said pipe. This creates a vacuum, which will act to lift the sand, silt and like material and set it in suspension with the water, whereafter it may be carried away from the area by the tide. This method is reliable in reducing the possibility of small/lightweight articles being lost, but is time consuming due to the relatively small diameter of the pipe, normally around 0.5 metres, and hence restricted area covered.

Another method, which can be used in relatively shallow tidal waters, eg up to about 10 metres in depth, is by mooring a tug, ship or other vessel in a fixed position above the area to be cleared and deflecting the propeller wash downwardly using a suitable guide plate. The wash disturbs the material around the wreck, which material is thereby lifted, set in suspension and carried away from the area by the tide. Apart from the shallow depth, another disadvantage of this method is that, for a large wreck, the position of the vessel must be changed progressively to cover the complete area of the wreck, which is difficult and time consuming.

According to one aspect, the present invention provides a method of dredging in flowing water characterised by lowering a support member carrying thrust means so that the thrust means is directed downwardly towards the area to be cleared, adjusting the orientation of the support member in the water so that it presents a surface relative to the flow which causes a resultant downward vertical component of force, and operating said thrust means to direct a wash of water towards said area, whereby the turbulence created sets the sand, silt and like material covering the area in suspension in the water so as to be carried away from said area by the flow of the water, the weight of the support member and said resultant downward force component in use being designed to provide a downward force in excess of the upward force caused by said thrust means (3).

Preferably, the support member is lowered from a vessel. Although it can be dynamically held in position by thrusters, or mounted on a trestle sitting on the sea or river bed it will normally be set in its correct orientation by the adjustment of, for example, cables, chains or telescopic arms. The vessel may initially be stationed immediately downstream of the area to be cleared, whereafter the vessel is moved forward to cover the complete area at a controlled speed, this movement acting to increase the resultant downward force component on the support member.

The support member can be designed to work in opposite directions, so that the vessel can then be turned and retraced over the area, after resetting the orientation of the support member by adjustment of the cables.

According to another aspect of the invention there is provided dredging apparatus for carrying the above method comprising, a support member having thrust means mounted thereon, means to orientate the support member to maintain the thrust means in a downward attitude, said support member providing a face against which the water flow can act to provide a resultant downward component of force, the arrangement being such that in use, the weight of the support member together with the resultant force component produced provide a downward force which exceeds the upward force provided by the thrust means.

The means to orientate the support member preferably comprises cables or the like connected to the support member at at least three spaced points. Said means may be mounted to an associated vessel.

Preferably, the support member is generally in the form of a wing comprising a casing having ballast tanks to adjust its weight, depending upon the working depth and the type of material to be cleared, said casing also having at least one closed bore passing between its upper and lower faces, in which said thrust means is located.

Conveniently, the casing is provided with an angled face at least along one (leading) edge thereof which, at least in part, causes the resultant downward force component in use; this component can be varied by appropriately tilting the casing so that its upper surface is angled to the horizontal.

In a modification, the thrust means and the drive therefore can be made reversible, so that, for

more general applications, the apparatus can be used as a suction dredger.

The thrust means may comprise one or more propellers, each mounted within a closed bore, to rotate substantially parallel to the plane of the casing, in which case drive means for the propeller(s) are mounted on the casing and may be driven from an energy source on board the vessel by a cable, hose or the like.

The energy source may be an electric generator and the drive means electric motors. Alternatively, the source of energy may be a hydraulic pump on board the vessel and pressure fluid may be circulated through the drive unit via flexible hoses, the drive unit comprising an hydraulic motor including gearing which meshes suitably with gearing on the or each propeller shaft.

The support member may be provided with transducers, and/or sonar, or like devices, directed downwardly so that, in use, electrical signals indicative of the working distance, and work progress can be transmitted to a suitable display on board the vessel.

Preferred embodiments of the invention will now be described, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic view showing the dredging method

Figures 2 (a), (b) and (c) are diagrammatic end, side and plan views respectively of a first example of dredging apparatus according to the invention.

Figure 3 is a sectional side view of said dredging apparatus

Figure 4 is a view similar to Figure 2(a) partly cut away,

Figure 5 is a vertical section through a second example of dredging apparatus according to the invention.

Figures 6 and 7 are plan and front views of the dredging apparatus of Figure 5,

Figure 8 is a part section part elevation of part of the dredging apparatus of Figure 5 and

Figure 9 shows a general arrangement of a cable mounting means for mounting the dredging apparatus of Figure 5.

Referring to Figure 1, a carrying vessel 1 is shown, moving forward against the tidal flow over a wreck 2. To facilitate this operation, the area to be covered can be buoyed along each side, or perhaps in channels if a wide area is involved, to provide guide tracks for the vessel. Alternatively, particularly for a small area to be covered, the carrying vessel can be stationed over the area by a four point mooring, or it can be dynamically positioned. A weighted support member 3 is suspended at an appropriate distance from the wreck via two pairs of cables 4, 5 arranged fore and aft, one cable of each pair extending from each side of the vessel. The cables of each of the pairs can be driven in unison so as to ensure that the support member maintains a horizontal attitude laterally. However, the two cable pairs are preferably driven independently so that the attitude of the support member 3 can be adjusted with respect to the horizontal in its longitudinal (fore and aft) direction.

Referring to Figures 2 and 3, the support member 3 is generally in the form of a wing and is rectangular in plan. It is constructed as a casing comprising vertical end walls 6, connected by laterally extending walls 7, which provide angled faces 8 to provide a downward vertical component of force when acted on by tidal flow. The upper wall 9 is generally flat, so that it can be raised and conveniently stowed just beneath the bottom of the carrying vessel 1 (as shown chain dotted in Figure 1) when being transported to or from the area of operations and the lower wall 10 has a convex curve to provide the wing with a hydrofoil section, and thus produce an additional downward force component.

It will be seen from Figure 2(a) that the support member is symmetrical about its lateral axis so that it can be used in either direction with the respective lateral wall 7 leading. It will also be seen that two spaced fixing points 11 are provided on each end wall 6 for the cables 4, 5.

In this embodiment, the casing 3 is provided with two closed vertical bores 12 (see Figure 2(c) and 3) which are laterally spaced from each other, each housing a propeller 13 which is mounted via its shaft 14 and support member bearings 15 on spider support member arms 16 (see Figures 2(c). The propellers 13 are thus mounted to rotate substantially in the plane of the casing 3 and are driven in opposition to reduce the effect of centrifugal/centripetal forces. They are driven via appropriate gearing 17 from respective drive shafts 18, which in turn are driven by a central hydraulic unit 19, through which pressure fluid is circulated via feed and return hoses 20,21 from a source on board the vessel 1.

The support member casing 3 is provided with a number of ballast tanks 22 so that the weight of said casing can be adjusted by the injection/ejection of a suitable ballast medium such as water and/or sand, silt, etc from the area being cleared. To recover the smallest articles from a wreck, preferably the lowest thrust required to lift the material to be cleared should be used. Thus, it will be appreciated that weight adjustment of the support member casing is necessary, depending upon the depth at which working is to be effected and the amount of thrust required to be generated by the propellers, which in turn will depend upon

the nature of the material being cleared, eg light or heavy sand, silt, gravel etc.

As mentioned hereinbefore, a downward vertical component of force is provided by the leading angled face 8 when acted on by the tide, and/or forward speed of the vessel, which component can be increased by adjustment of the fore cables 4 with respect to the aft cables 5 to tilt the casing, and hence the upper wall 9 thereof, appropriate to the horizontal.

It is possible that, in use, particularly in a tilted attitude, vortices will be created at the trailing edge 7 of the casing, in which case turbulence will occur which could cause the casing to shear. To prevent this, a spoiler 23 (see Figure 1) may be fixed along the rear edge 7. Also, it may prove difficult in use to hold the casing steady on course into the tidal flow, in which case suitable steering vanes, 24 may be provided on the upper wall 9, or even small, rearwardly facing, propulsion units may be used along the trailing edge 7.

To ensure that the casing is correctly positioned a required distance above the area to be cleared, and also to provide a TV display of working progress, on board the vessel, a transducer/sonar arrangement, may be provided, comprising a pair of transducers 25 (see Figure 3) to detect distance, which are set one on the lower wall 16 adjacent each leading/trailing edge 7 of the support member casing 3 and, for TV monitoring, a centrally mounted sonar transmitter/receiver 26 which can rotate, and thereby scan, through 360° around the vertical axis of the casing 3.

In a practical construction in accordance with the invention, capable of operating down to a depth of approximately 45 metres of water, the support member casing would have dimensions of the order of 9000 x 6000 mm with a weight of up to about 20 tonnes. This would require a thrust (bolland pull) by the support member casing of up to 4 tonnes. In addition, it has been calculated that, with a casing of such size tilted 20° from the horizontal, a resultant downward vertical component of force of up to 0.77 tonnes would be generated, depending upon the combined speeds of the tide flow and vessel. To counter the weight and force components the propellers would be designed to produce a thrust of up to about 4.5 tonnes.

It will be appreciated that, for wider applications, the thrust means (propellers) and the drive therefore can be made reversible, so that the apparatus may be used as a suction dredger for general clearing operations. In this case, the thrust means would act directly on the wing casing 3 to provide a substantial downward component of force and, hence, tilting of the casing in use would not be so important in this mode of operation.

Figures 5-9 show an alternative embodiment of the invention. Similar parts carrying similar numbers to the embodiments of Figures 2-4.

As before, the support member 3 is generally in the form of a wing and is rectangular in plan. Referring to Figure 5, it will be seen that the support member 3 is constructed of three units, a fore unit 3A, a mid unit 3B and an aft unit 3C connected together, so that the support member can be split into three sections for ease of transportation.

Upwardly extending from the upper wall 9 are a pair of fins 51,52, each extending from adjacent the front edge to adjacent the rear edge. Each closed vertical bore 12 extends up through a respective fin 51,52.

In this case, the propellers 13 are driven by respective electric motors 53 via a gear box 54 as is shown in more detail in Figure 8. Each electric motor 53, gear box 54 and propellers 13 are mounted by six stays 66 extending to the wall of the respective bore 12, one of the stays 66 carrying an electric cable 57.

The dredger of Figures 5-8 may be operated and suspended in the same way as the first embodiment of the invention.

Alternatively, the wing dredger may be suspended in the manner shown in Figure 9 (the support member (3) being shown in diagrammatic form only). Two cables 58 may pass down from the support membering vessel to a respective ring 59, each ring carrying a loop 61 of cable. Each loop 61 passes over a respective pair of drums 62,63, one drum 62 being adjacent the front edge of the dredger and the other drum 63 being adjacent the rear edge of the dredger. Each loop 61 of cable is also looped over a respective drive drum 64 mounted towards the middle of the dredger. It will be understood that by rotation of each drum 64, the horizontal disposition of the dredger may be changed as the effective length of the part of the cable between each drum 64 and its respective ring 59 via its respective drum 62 is changed with respect to the effective length of the part of the cable between each drum 64 and its respective ring 59 via its respective drum 63. Each drum 64 may be driven by, for example, an electric motor (not shown).

This arrangement simplifies the mounting of the dredger to the vessel 1.

The dredgers described above have many uses, for example they can be simply used for a normal dredging purpose, that is clearing a channel in a river or the sea. A dredger of lateral dimensions approximately 9m x 6m may be used to clear from a river or sea bed of heavy clay a channel approximately 10m wide, 5m deep and 100m long in approximately 6 hours. Thus in that 6 hour

period it would move something of the order of 300 tonnes of heavy clay.

Clearly if the river or sea bed is of sand or silt, then a much larger volume of material would be removed in that six hour period.

In addition to dredging, the dredger may be used in salvaging, that is for clearing mud and silt from wrecks.

A particularly interesting use is to dredge a trench in which oil pipelines may be inserted and then by a similar operation of the dredger, the trench may be backfilled.

The dredger may be used to clear silt away from what is called in the oil industry, "Christmas trees".

The dredger may also be used to level a site on which an oil platform is to be mounted and can be conveniently used to remove the silt which accumulates around the legs of an oil rig, so that the oil rig may be removed.

In another use, the dredger may be used to remove the top layer of silt from the river or sea bottom so that an offshore mining operation can get to the required lower layers.

Although the dredger has been shown suspended from a vessel, in practice it can also be suspended from a jib of a crane cited on a quay or from a flat topped barge.

Other uses of the dredger include disturbing the bottom of a river to maintain in the stream toxic substances which would otherwise settle on the bottom of the river so that the river and river bed life is improved.

Claims

1. A method of dredging in flowing water characterised by lowering a support member (3) carrying thrust means (13) so that the thrust means (13) is directed downwardly towards the area to be cleared, adjusting the orientation of the support member (3) in the water so that it presents a surface relative to the flow which causes a resultant downward vertical component of force, and operating said thrust means (13) to direct a wash of water towards said area, whereby the turbulence created sets the sand, silt and like material covering the area in suspension in the water so as to be carried away from said area by the flow of the water, the weight of the support member (3) and said resultant downward force component in use being designed to provide a downward force in excess of the upward force caused by said thrust means (3).

2. A method as claimed in claim 1 characterised in that the support member (3) is supported from a vessel (1) by flexible support means (4,5) and set in its correct orientation by adjustment of the flexible support means (4,5), with the vessel (1) initially stationed immediately downstream of the area to be cleared, whereafter the vessel (1) is moved forward to cover the complete area at a controlled speed, this movement acting to increase the resultant downward force component on the support member (3).

3. Dredging apparatus for carrying the method of claims 1 or 2 characterised by a support member (3) having thrust means (13) mounted thereon, means (4,5) to orientate the support member (3) to maintain the thrust means in a downward attitude, said support member (3) providing a face against which the water flow can act to provide a resultant downward component of force, the arrangement being such that in use the weight of the support member (3) together with the resultant downward component of force produced provide a downward force which exceeds the upward force provided by the thrust means (13).

4. Apparatus as claimed in claim 3 characterised in that the support member (3) is in the form of a wing comprising a casing (3) having ballast tanks (22) to adjust its weight, said casing (3) also having at least one closed bore (12) passing between its upper and lower faces, in which said thrust means (13) is located.

5. The apparatus as claimed in claim 3 or 4 characterised in that the casing (3) is provided with an angled face at at least a one leading edge thereof which, at least in part, causes the resultant downward force component in use.

6. The apparatus as claimed in any of claims 3 to 5 characterised in that the thrust means (13) is reversible.

7. The apparatus as claimed in any of claims 3 to 6 characterised in that the thrust means (13) comprises at least one propeller (13), mounted within a closed bore (16), to rotate substantially parallel to the plane of the support member (3).

8. The apparatus as claimed in claim 7 characterised in that a drive means (19) for the propeller(s) is mounted on the casing (3) and driven from an external energy source.

9. The apparatus as claimed in claim 8 characterised in that the external source of energy is a hydraulic pump on board a vessel (1) and pressure fluid is circulated through the drive means (19) via flexible hoses, the drive means (19) including gearing (17) which meshes with gearing on the shaft (14) the or each propeller (13).

10. The apparatus as claimed in claim 7 characterised in that a drive means (19) for the propeller(s) (13) comprises an electric motor (53) mounted coaxially with the axis of the propeller(s) (13).

11. Apparatus as claimed in any of claims 3 to 10 characterised in that said means (4,5) to orientate the support member (13) comprises a plurality of flexible support means (4,5).

12. Apparatus as claimed in claim 11 characterised in that the flexible support means (4,5) comprise cables (4,5).

13. Apparatus as claimed in claim 12 characterised in that the cables (4,5) depend downwardly from a vessel (1) on the surface of the water.

14. Apparatus as claimed in claim 13 characterised in that there are provided four flexible supports (4,5), one mounted adjacent each corner of the support member (3).

15. Apparatus as claimed in claim 13 characterised in that there are provided two flexible supports (58) depending downwardly from the vessel (1), two flexible supports (61) extending from the lower end of each of said first mentioned flexible supports (58) to a front and rear corner of the support member (3), and means (64) being provided to adjust the relative length of each said two second mentioned flexible support members (61).

16. Apparatus as claimed in claim 15 characterised in that said means (64) for adjusting the relative lengths of said two second mentioned flexible support members comprises a driven drum (64) mounted on said support member (3) which may be driven.

17. The apparatus as claimed in any of claims 3 to 15 characterised in that the support member (3) is provided with transducers (25), and/or sonar, or the like devices, directed downwardly so that, in use, electrical signals indicative of the and work progress is provided.

Fig.1.

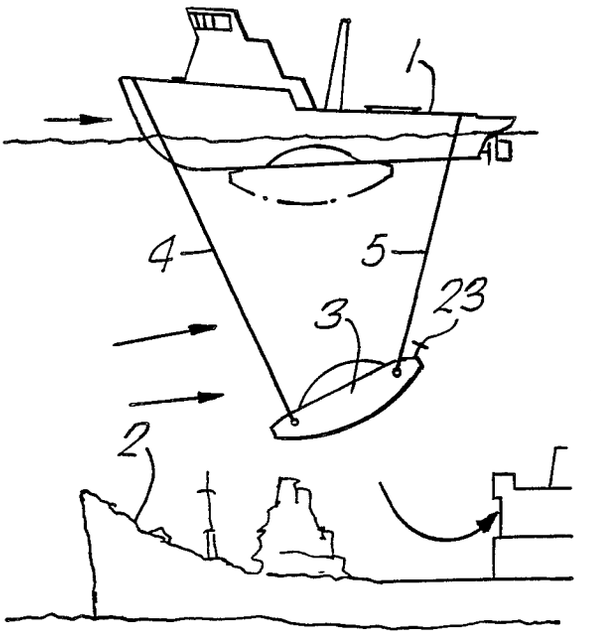


Fig.2.

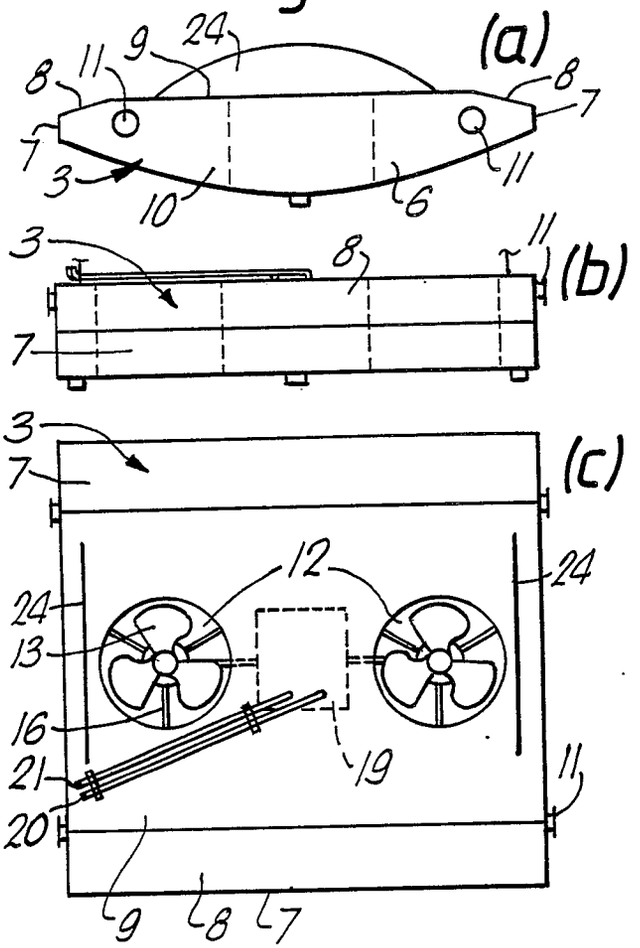


Fig.4.

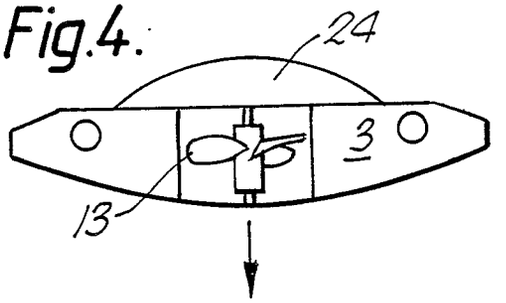
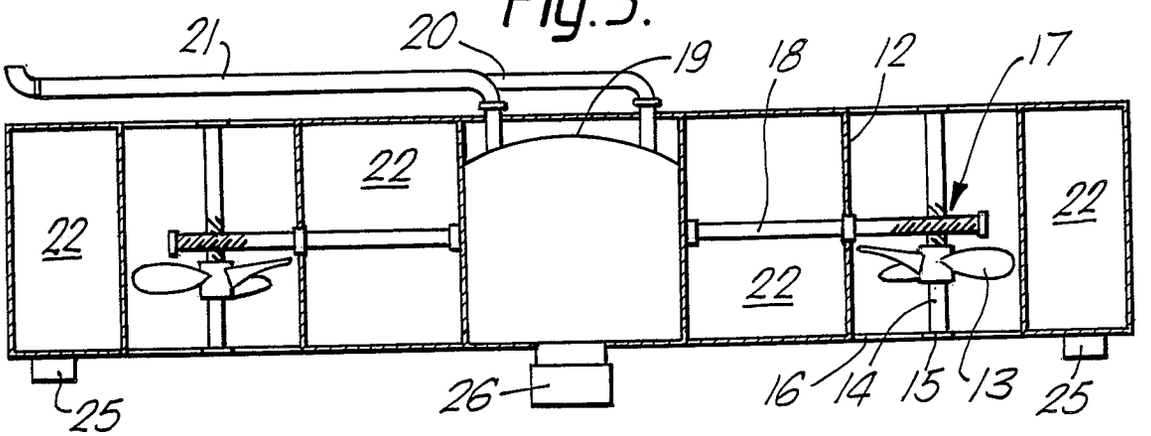


Fig.3.



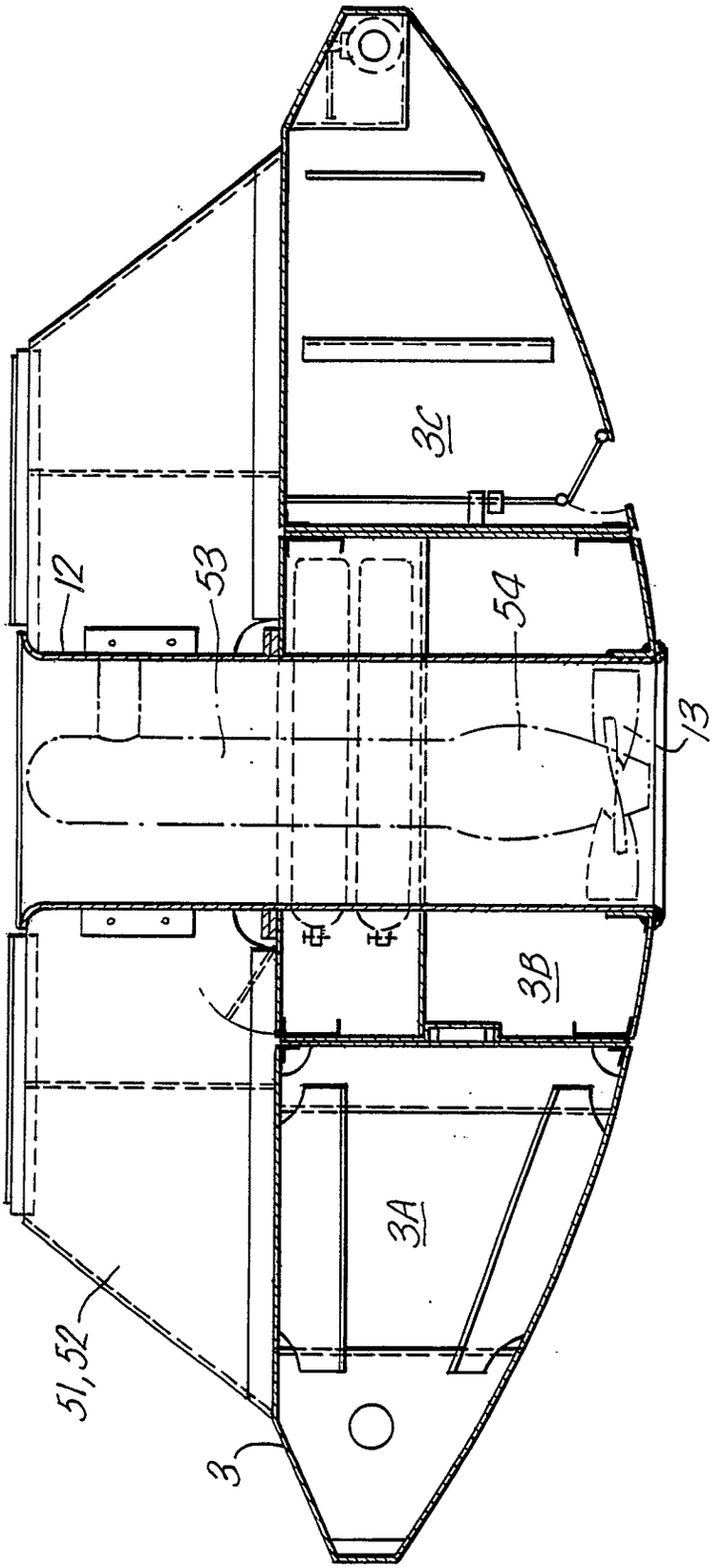


Fig.5.

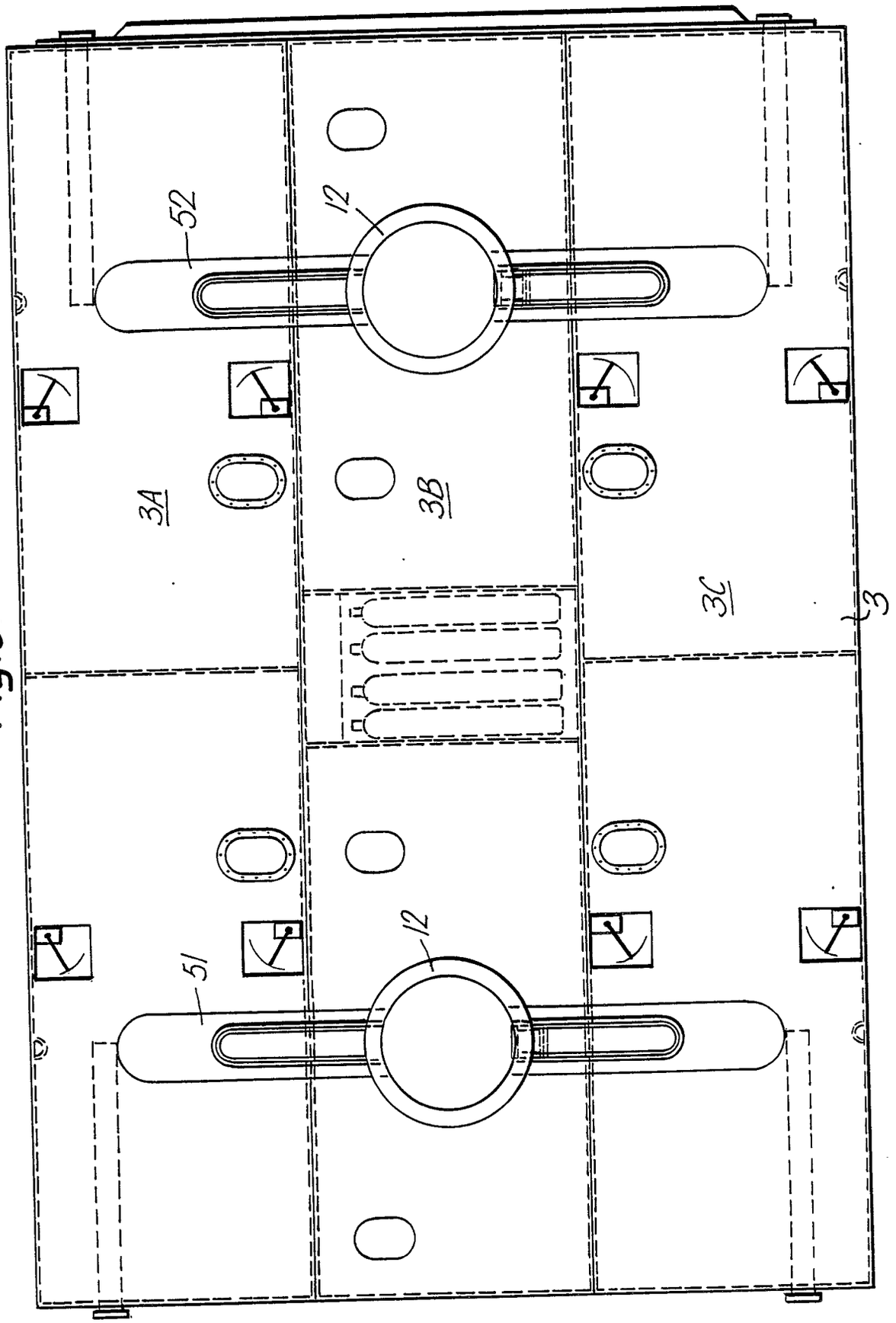


Fig.6.

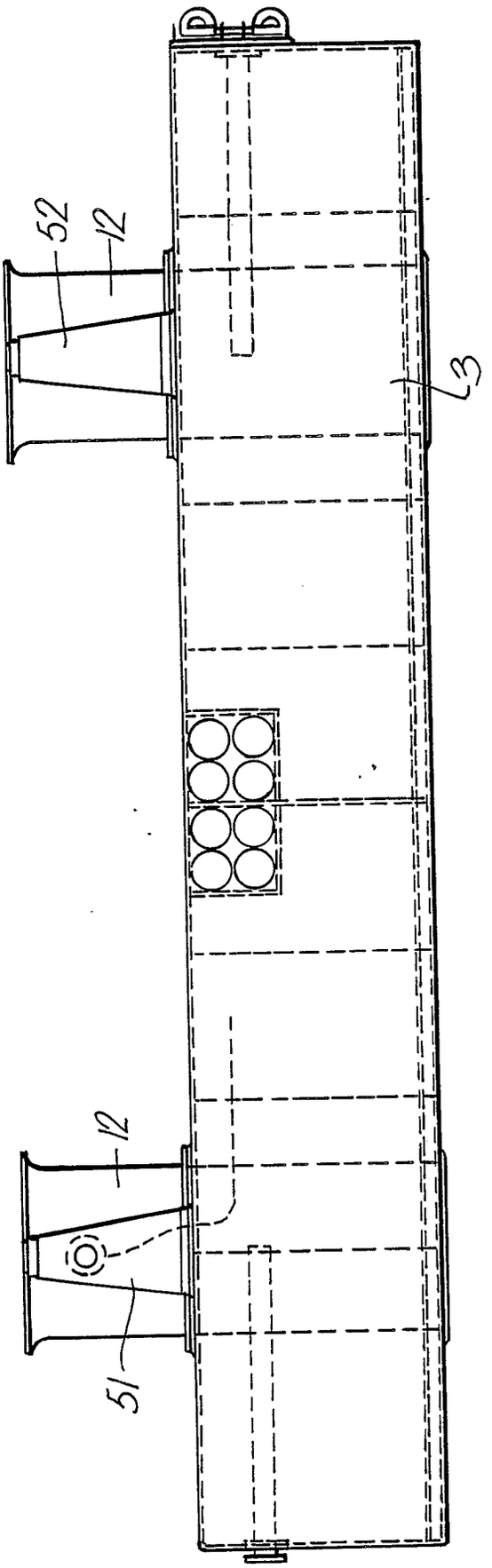


Fig.7.

Fig.8.

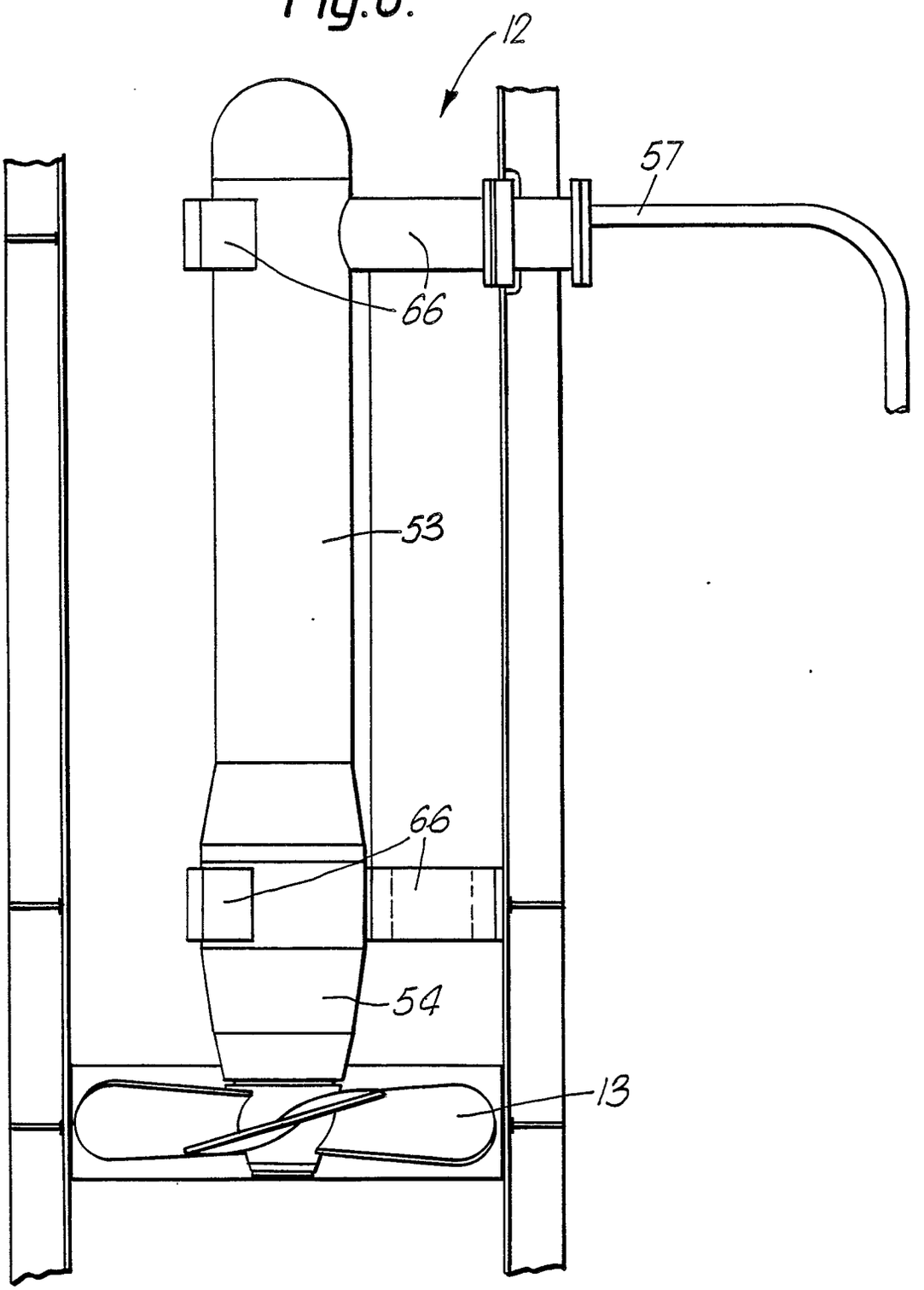
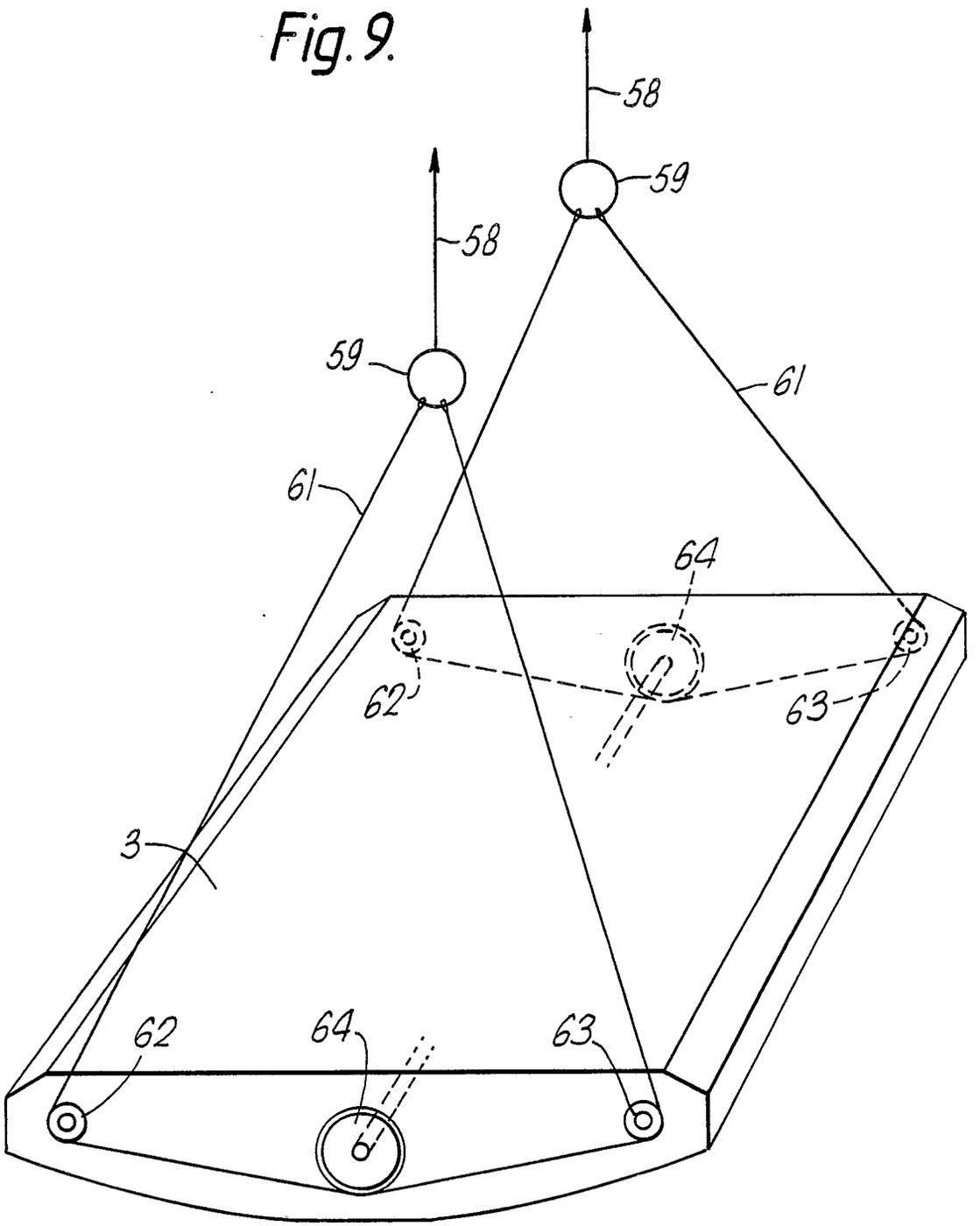


Fig. 9.



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EUROPEAN SEARCH REPORT

Application Number

EP 89 20 0239

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	FR-A-2 389 533 (HERVIEU) * Whole document *	1-4,7,8,10,17	E 02 F 3/88 E 02 F 3/90 E 02 F 3/92
A	US-A-3 706 142 (BRUNNER) * Column 2, lines 1-19; figures 1-3 *	1,4,6,8,13	
A	FR-A- 997 304 (DOLGOFF) * Page 2, lines 16-71; figures 1-3 *	1,3,6,8,17	
A	EP-A-0 012 458 (N.G. KONIJN) * Abstract; figures 1,2 *	1,6-8	
A	FR-A- 920 546 (L. SMITH & ZOON'S SCHEEP'S- EN WERKTUIGBOUW N.V.) * Abstract; figures *	1,6-8	
A	US-A-4 123 858 (BATCHELDER) * Abstract; column 1, lines 60-66; figure 3 *	1,4	
A	US-A-4 253 255 (DURELL) * Abstract; figures 1-4 *	1,17	TECHNICAL FIELDS SEARCHED (Int. Cl.4) E 02 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03-04-1989	ANGIUS P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

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