(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 581 357 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **93202034.0**

(51) Int. Cl.5: **E02F 5/10**

(22) Date of filing: **09.07.93**

(30) Priority: **10.07.92 NL 9201246**

(43) Date of publication of application:
02.02.94 Bulletin 94/05

(84) Designated Contracting States:
BE DE FR GB IT NL

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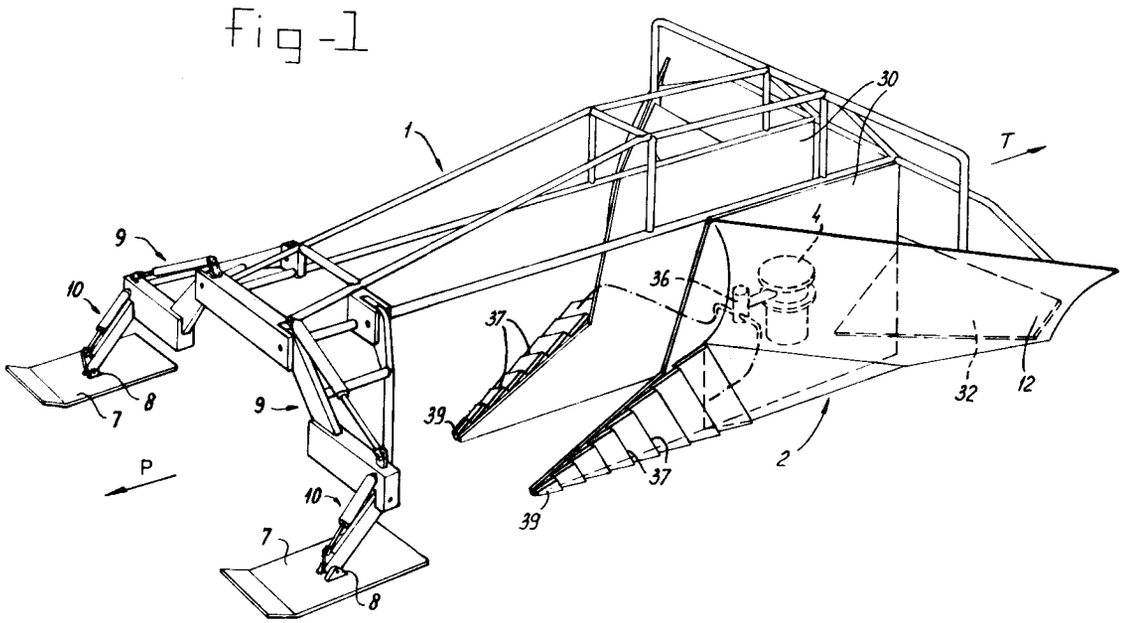
(54) Underwater bed cutting device.

(57) Method for ploughing a trench in the ground under water. In this case a plough is introduced into the ground and propelled. In order to reduce the force needed to propel the plough through the ground, it is proposed according to the invention that rows of openings should be provided in the part of the plough blade which is under the ground during the ploughing. During the ploughing, a fluid such as water from the surrounding environment is sprayed through said openings, thus making it simpler to move the soil particles apart.

Fig-1



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The present invention relates to a method according to the preamble of Claim 1.

Such a method is known from US Patent Specification 2,992,537. In order to facilitate underwater ploughing, this publication proposes that fluid, such as water, should be injected in front of the plough blade by means of nozzles. This loosens up the soil slightly in front of the plough blade, with the result that the cutting is easier.

However, it has been found that, although the cutting force is reduced slightly as a result, a considerable cutting force is still necessary for moving the blade through the ground.

The object of the present invention is to reduce this force further, so that a blade can be moved through the ground with relatively little power. Such a movement of the cutting blade is used during, for example, the burying of pipelines. Burying pipelines, cables and the like in the seabed provides the best protection from mechanical damage from the outside. It also avoids nuisance for the fishing industry. With existing methods for underwater ploughing, it is difficult even in readily pervious material to dig a deeper trench, for example deeper than 1.5 m. Extremely high cutting forces occur in the case of such values. This translates into a higher tractive force being necessary on the cable for propelling the digging equipment over and in the seabed. Such tractive forces can rise to 350 tonnes and are produced by a towing pontoon or tugboats.

This object is achieved in the case of a method of the type described above by the characterizing measures of Claim 1.

The invention is based on the idea that most of the towing force necessary for the propulsion of a cutting blade is used to overcome the pressure exerted by the ground material on the cutting blade and the friction produced by it. During underwater cutting of, for example, sand the cutting forces are determined largely by the partial vacuums occurring in the sand mass in the interstitial water. These partial vacuums are produced by the volume increases occurring in the sand mass during shear (dilatation). At a certain cutting speed and cutting depth, the magnitude of the partial vacuums depends mainly on the permeability of the sand mass. This partial vacuum causes the ground material which has been removed to press against the cutting blade, thus producing the considerable friction. This partial vacuum is now removed and the friction is reduced by according to the invention providing fluid at the position of the cutting blade. A sort of "lubricating" fluid film is produced between the cutting blade and the removed material. It is only necessary here to apply the fluid in such a way that a film is produced on the cutting blade. Unlike the situation in the prior art, this fluid is not used for loosening up the sand in front of or behind the cutting blade. In principle, it is even undesirable for fluid jets to extend far into the adjoining ground material, because a first sharp cut can be largely destroyed again as a result (instability of the slope formed).

As indicated above, the method is preferably used for underwater ploughing. Underwater ploughing is used for laying pipelines. The occurrence of the partial vacuums regularly results in a situation in which, after lowering of the cutting speed, the excavation depth of the plough also has to be reduced, because the necessary tractive forces are too high. When this occurs, a pipeline is, for example, less well buried or not buried at all. As a result of this, great difficulties can occur, particularly if parts of the pipeline form a clear span at places where the seabed is not flat. If fluid is introduced according to the invention, this partial vacuum phenomenon is limited or even removed, and it is found that the cutting forces fall considerably as a result.

This fluid can very simply be water which is present on the spot.

The fluid is preferably introduced from the cutting blade. Indeed, it is at the position of the cutting blade that said fluid film must be formed. It is in principle possible here to introduce the fluid in all directions relative to the direction of movement of the cutting blade. However, it has been found that introducing the fluid in the direction of movement of the cutting blade requires high fluid pressures and is not very practical. Injecting fluid at right angles to the cutting blade gives a result which is simpler to achieve, but it has the disadvantage that such openings become blocked through the pressure of the ground material. The fluid is therefore preferably introduced in the opposite direction to the direction of movement of the cutting blade.

The invention also relates to a device according to the preamble of Claim 5 with the characteristics of Claim 5. The outlet openings in this case are preferably provided in the cutting blade, in such a way that a cascade is formed. The fluid outlet openings are disposed here in the "step" part of the cascade, in the opposite direction to the direction of movement of the cutting blade. If the cutting faces between cutting blade and the ground material are also made to run essentially parallel to each other between the stepped parts, the optimum space is created at the position of the jump for the introduction of fluid. Due to the fact that the cutting faces always remain parallel to each other, the cutting angle with the ground material remains the same, which contributes to a constant cutting force, thereby preventing the ground material from compacting and pressure phenomena on the cutting blade from still occurring. The outlet openings

are preferably provided in adjacent rows in the stepped part. The fluid jets consequently effectively cover as great a part as possible of the blade, and at the place where the volume increase occurs fluid is added directly, so that the tractive force is limited as much as possible. Due to the fact that the effect of the volume increase is more marked as the depth of the trenches increases, according to a preferred embodiment of the invention, it is preferable to provide relatively more openings near the last part of the plough blade than in the part lying nearer the boundary face between ground and water. In order to produce optimum outflow from the outlet openings, the outlet end comprises a cylindrical part to which a tapering part connects upstream. A better jet is obtained in this way.

The ploughing device described above can be used either alone or in combination. In the latter case, two adjacent ploughing devices are present. Such a ploughing assembly is used, for example, for laying a pipeline. In this case the pipeline is already laid, and the trench belonging to it is then dug. This can be carried out in different ways. According to a first method, trenches are dug on either side of the pipeline, and the bed on which the pipeline is lying is then removed. This is described in Dutch Patent Application 9101937. According to another method, the plough blades are introduced into the ground next to the pipeline already lying there, and are then rotated under the pipeline. This is possible due to the fact that the plough blades are fixed rotatably to the frame. The pipeline in this case is lifted up slightly, and the entire unit is then moved along, following which the pipeline is sunk in the trench produced in this way.

The invention will be explained in greater detail below with reference to an example of an embodiment illustrated in the drawing, in which:

Fig. 1 shows a perspective general view of an application of the ploughing device according to the invention;

Fig. 2 shows a detail of the device shown in Fig. 1; and

Figs. 3a, 3b show various variants of outflow openings for fluid according to the invention, in cross-section.

Fig. 1 shows a ploughing device for the laying of pipelines. The frame thereof is indicated by 1. Skids 7 are fixed at the front of the frame by means of hinged connections 8. By means of the hinged fastenings 9, the skids 7 are also tiltable in the direction at right angles to the direction of movement. The skids 7 are adjustable in height by means of the hinged fastenings 10. The device is moved in the direction of the arrow P. Ploughshares 2 are also immovably fixed on the frame 1. Of course, the ploughshares can also be hingedly fixed to the frame, as described above. There is a pump 4 which draws in water and pumps it to manifold 36. Various pipes lead from manifold 36 to rows 37 of openings 38 provided in the ploughshare 2. Plates 30 are also provided, by means of which in the example in question two trenches are dug, with some material remaining between the trenches. For details of such a method reference is made to the abovementioned Dutch Application 9101937. The heel parts of the ploughshares are indicated by 12. Reference number 32 indicates a plate which slants relative to the ground, and which facilitates backward movement of the device in the direction of the arrow T. This is achieved in conjunction with the bevels 31.

Fig. 2 shows a detail of the ploughshare 2. The openings 38 in the rows 37 are shown more clearly in this figure. It can be seen that the distance between the various rows increases constantly from the end 39 of ploughshare 2. These changes in distance preferably occur according to a logarithmic division.

Fig. 3 shows two different embodiments of the outflow openings. It can be seen that they comprise a cylindrical part 38 and a flared part 42 lying upstream. This means that the fluid supplied by the pump 4 encounters little resistance in the supply lines from manifold 36, while a high outflow velocity can be obtained. It is possible here, on the one hand, to use a stepped shape with right angles 40, as shown in Fig. 3a, and it is possible, on the other hand, to use a bevelled construction 41, as shown in Fig. 3.

It has been found that with the above-described construction not only can the towing force for digging trenches be considerably reduced, but it is also ensured that the trenches can be produced with sufficient depth.

Although the invention is described above with reference to a preferred embodiment, it must be understood that the construction shown here can be used in the case of all known ploughshares according to the prior art. All that is essential for the invention is that outflow openings are present on the surface of the ploughshare which comes into contact with the ground. Such modifications are considered to be within the ability of those who are skilled in the art.

Claims

1. Method for moving a cutting object in the ground under water, such as ploughing a trench, comprising lowering said cutting object onto the ground, moving it through the ground and supplying a fluid, such as water, during the movement, characterized in that the fluid is sprayed onto the cutting blade of the cutting

object in such a way that a fluid film is produced between the cutting blade and the ground material.

2. Method according to Claim 1, in which the movement comprises ploughing, and in which provision is made for the discharge of material.

3. Method according to one of the preceding claims, in which the fluid is supplied from openings in the cutting blade.

4. Method according to one of the preceding claims, in which the fluid is supplied in a direction opposite to the direction of movement of the cutting blade.

5. Device for making a cut in the ground under water, such as a ploughing device, comprising a cutting blade to be ground, such as a plough blade (12) disposed in a frame (1), and also fluid supply means, characterized in that the fluid supply means are designed to supply the water to the blade in such a way that a fluid layer is produced between the blade and the material to be removed.

6. Device according to Claim 5, in which fluid outlet openings (38) are provided in the cutting blade.

7. Device according to Claim 6, in which the fluid outlet openings are directed in the opposite direction to the direction of movement of the cutting blade.

8. Device according to Claim 7, in which the cutting blade is essentially horizontally stepped, and the outlet openings (38) are disposed in the transitional part in rows (37), directed in order to make the fluid jet extend over the adjacent blade part lying above.

9. Device according to Claim 8, in which the cutting surfaces between cutting blade and material are designed so that they extend essentially parallel between the stepped parts.

10. Device according to Claim 8 or 9, in which the distance between the rows of outlet openings decreases towards the bottom end of the cutting blade.

11. Device according to one of Claims 8 - 10, in which the outlet openings comprise a cylindrical outlet part (38), which widens (39) upstream.

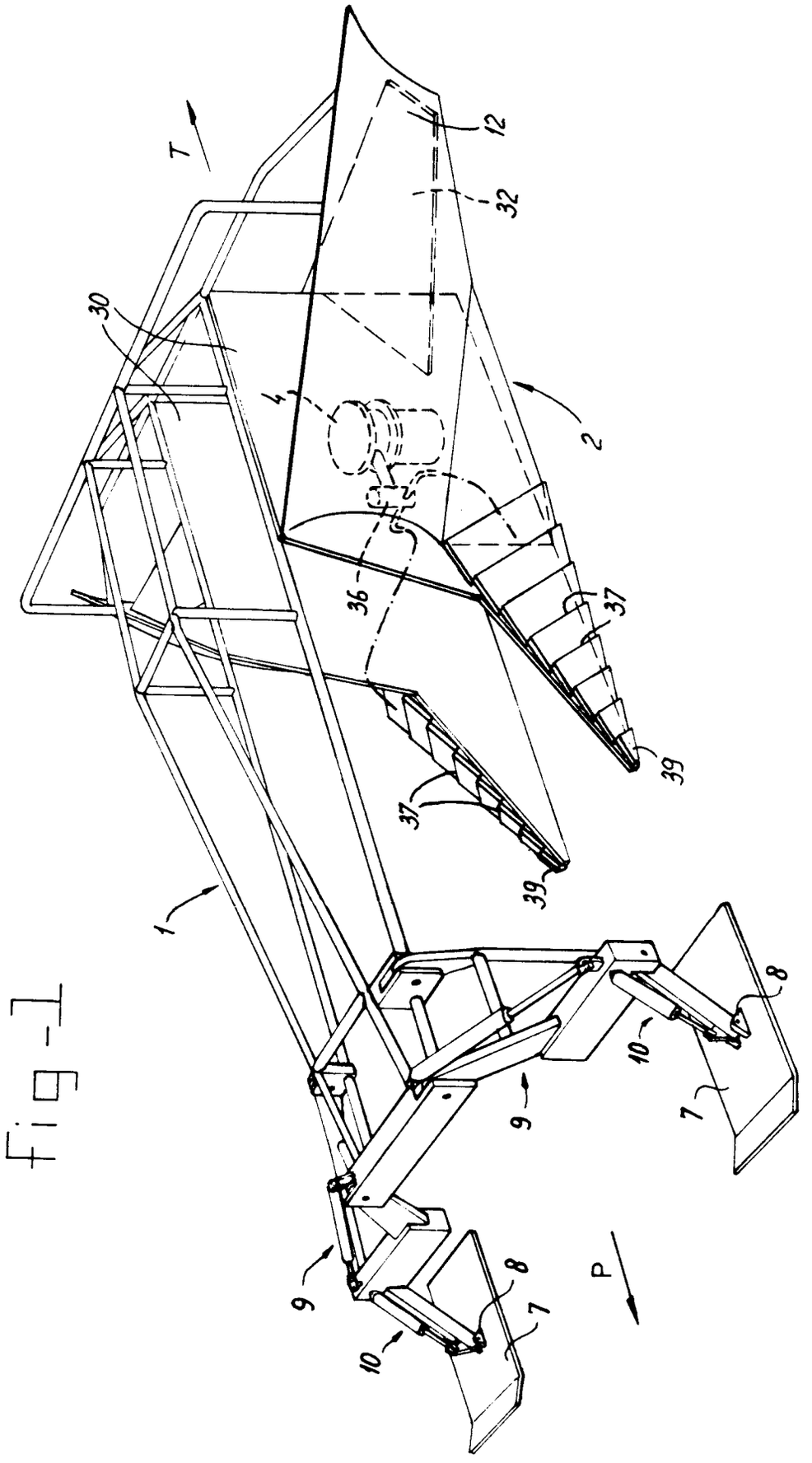


Fig-1

fig-2

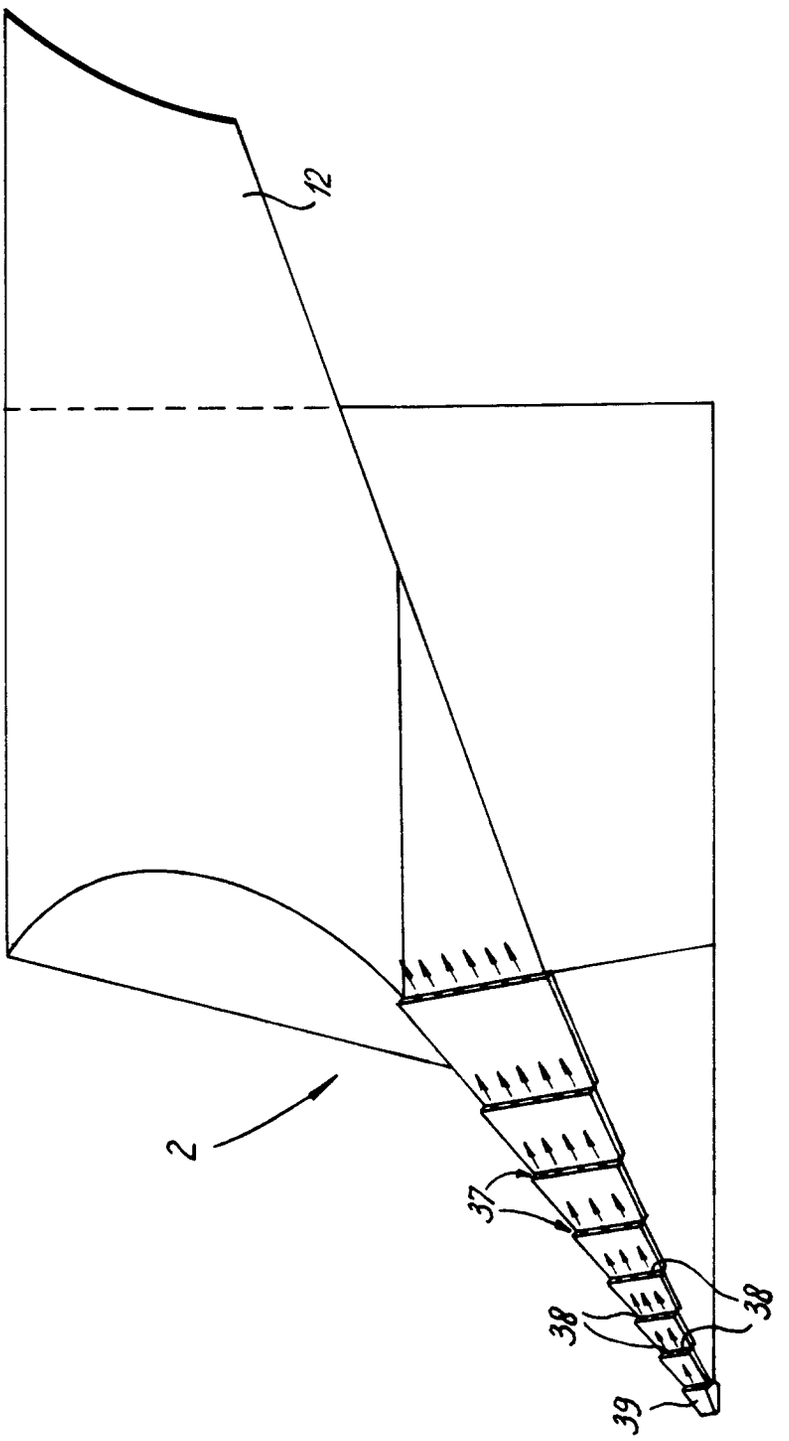


fig - 3a

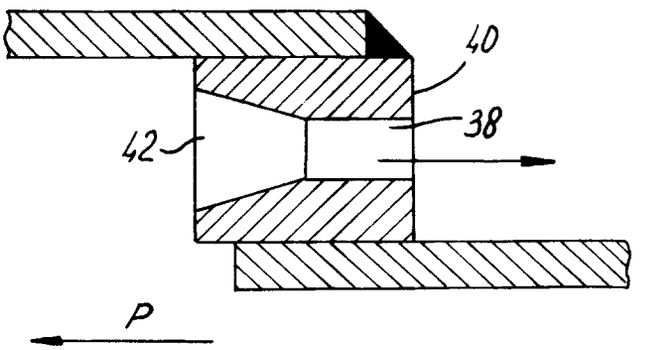
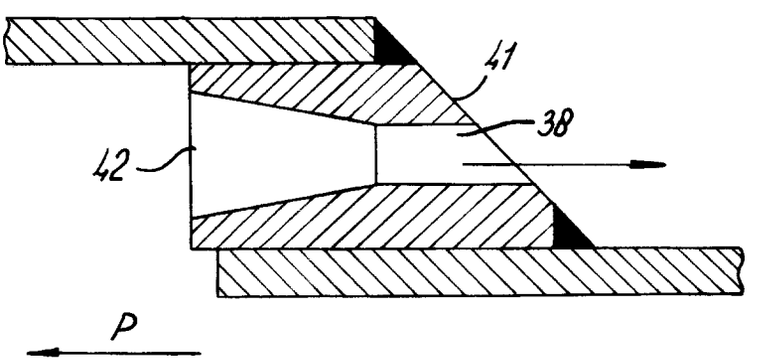


fig - 3b



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EUROPEAN SEARCH REPORT

Application Number
EP 93 20 2034

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.5)
A	US-A-2 992 537 (CALLAHAN) * column 2, line 10 - line 20; figures *	1-7	E02F5/10
A	US-A-3 368 358 (ELLIOT) * claim 1; figures *	1-7	
A	DE-A-22 23 942 (HARMSTORF KG) * figures *	107	
A	US-A-3 638 439 (NIEDERER)		
A	FR-A-2 455 235 (COFLEXIP)		

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

E02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 November 1993	DE SCHEPPER, H

CATEGORY OF CITED DOCUMENTS

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