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(54) A slant plate type compressor with a variable displacement mechanism.

(57) A slant plate type compressor (1) with a variable displacement mechanism is disclosed which comprises a compressor housing enclosing a crank chamber (32). The housing includes a cylinder block (31). A plurality of cylinders (33) are formed for defining compression space in the cylinder block. A piston (20) is slidably fitted with each of the cylinders (33). The stroke of the piston changes in response to the change of the slant angle and defines compression volume in the compression space to change the capacity of the compressor. The position of the top dead center of the piston (20) changes within a certain range in response to the change of the stroke of the piston. A suction chamber (52) and a discharge chamber (53) are enclosed within the compressor housing. A communication path links the crank chamber with the suction chamber. A control valve varies the capacity of the compressor by controlling the link between the crank (32) and the suction chambers (52) through the path. The detecting device (70) is disposed adjacent the cylinder (33) for detecting the position of the top dead center of the piston (20) in the compression space. Therefore, the detecting device can directly detect its displacement correctly. In addition, an inexpensive and simple detecting device can be used.

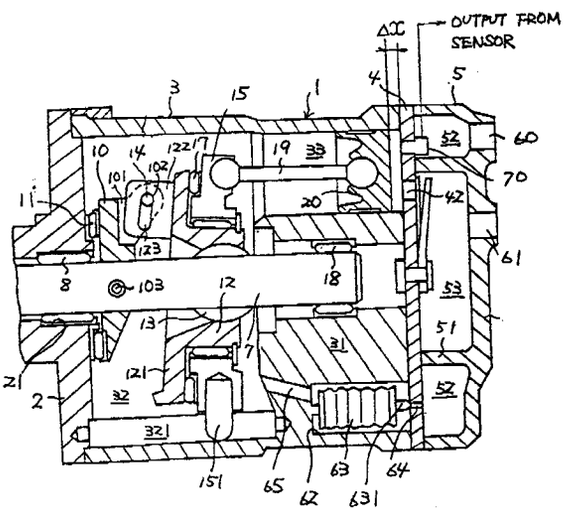

FIG. 2

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The present invention relates to a compressor with a variable displacement mechanism, and more particularly, to a slant plate type compressor with a variable displacement mechanism, of which the top dead center position of the piston can be changed in response to the change of the piston stroke.

A conventional slant plate type compressor with a variable displacement mechanism as used in an automotive air conditioning system controls the displacement of the compressor in response to the condition of the air conditioning load and the other requirements. However, since the mechanism for detecting the displacement of the compressor is complicated on the construction thereby to be in high cost, such a mechanism is not generally used.

Alternatively, if the displacement of the compressor can be easily detected, the information can be usefully utilized for the control of an engine control system or a monitor of an air conditioning system.

A conventional detecting device for detecting the displacement of the compressor is disclosed in, e.g., Japanese Patent Laid-Open Gazette No. 62-21867. The detecting device includes a non-contact type position detecting device, which has a detected object, for utilizing the change of the electrostatic volme or the change of the magnetic flux density. This non-contact type position detecting device can detect only the range of about 1 mm. Accordingly, it is difficult for the detecting device to directly detect the change of the position of the slant plate which largely varies on angle. Likewise, it is difficult for the detecting device to directly detect the change of the position of the piston, i.e., the change of the piston stroke since the piston stroke changes within the range of 1-30 mm. Then, in case of this type of the detecting device, it is necessary to use an electrical calculation circuit for changing the variety of the proportion of the width of the pulse from the detecting device during the rotation of the drive shaft of the compressor into the displacement of the compressor, thereby to be in high cost.

In the accompanying drawings:-

FIG. 1 is a cross-sectional view of a slant plate type compressor with a variable displacement mechainism, of which the inclined angle of the slant plate is at the largest, in accordance with the first embodiment of this invention.

FIG. 2 is a cross-sectional view of a slant plate type compressor with a variable displacement mechainism, of which the inclined angle of the slant plate is at the least, in accordance with the first embodiment of this invention.

FIG. 3 is a cross-sectional view of a part of a slant plate type compressor with a variable displacement mechanism in accordance with the second embodiment of this invention.

FIG. 4 is a cross-sectional view of a part of a slant pate type compressor with a variable displacement mechanism in accordance with the third embodiment of this invention.

FIG. 5 is a graph of showing the relationship between a piston stroke and a position of a top dead center of a piston.

It is an object of this invention to provide a slant plate type compressor with a variable displacement mechanism which includes a detecting device can directly detect its displacement correctly.

It is another object of this invention to provide a slant plate type compressor with a variable displacement mechanism which includes an inexpensive and simple detecting device.

A slant plate type compressor with a variable displacement mechanism according to the present invention comprises a compressor housing which encloses a crank chamber. The housing includes a cylinder block. A plurality of cylinders are formed for defining compression space in the cylinder block. A piston is slidably fitted with each of the cylinders. A drive mechanism is coupled to the pistons to reciprocate the pistons within the cylinders. The drive mechanism includes a drive shaft rotatably supported in the housing. Coupling means drivingly couples the the pistons with the drive shaft and converts rotary motion of the drive shaft into reciprocating motion of the pistons. The coupling means includes a slant plate having a surface disposed at a slant angle relative to a plane perpendicular to the drive shaft. The slant angle changes in response to a change in pressure in the crank chamber. The stroke of the piston changes in response to the change of the slant angle and defines compression volume in the compression space to change the capacity of the compressor. The position of the top dead center of the piston changes within a certain range in response to the change of the stroke of the piston. A suction chamber a discharge chamber are enclosed within the compressor housing. A communication path links the crank chamber with the suction chamber. A control valve varies the capacity of the compressor by controlling the link between the crank and the suction chambers through the path. The sensor means is disposed adjacent the cylinder for detecting the position of the top dead center of the piston in the compression space.

Further objects, features and other aspects of the invention will be understood from the following description of the preferred embodiments of the invention referring to the attached drawings.

Referring to FIG. 1, wobble plate type compressor 1 includes front end plate 2, cylinder casing 3 having cylinder block 31, valve plate 4, and cylinder head 5. Front end plate 2 is fixed on one end of cylinder casing 3 by securing bolts (not shown). Axial hole 21 which is formed through the center of front end plate 2 receives drive shaft 7. Radial bearing 8 is disposed in axial hole 21 to rotatably support drive shaft 7. Annular sleeve portion 22 projects from front end plate 2 and and surrounds drive shaft 7, defining seal cavity

23. Cylinder casing 3 is provided with cylinder block 31 and crank chamber 32. Cylinder block 31 has a plurality of equiangularly spaced cylinders 33 formed therein.

Cam rotor 10 is fixed on drive shaft 7 by pin 103. Thrust needle bearing 11 is disposed between the inner surface of front end plate 2 and the adjacent axial end surface of cam rotor 10. Arm portion 101 of cam rotor 10 extends in the direction of cylinder block 31. Hole 102 is formed on arm portion 101. Cylindrical member 12, provided with flange portion 121 is disposed around drive shaft 7 and is rotatably supported on drive shaft 7 through spherical element 13 slidably fitted on drive shaft 7. Second arm portion 122 is formed on the outer surface of flange portion 121 of cylindrical member 12 and faces arm portion 101 of cam rotor 10. Elongated hole 123, formed in arm portion 122, is aligned with hole 102. Pin 14, inserted through hole 102, is slidably movable within elongated hole 123. Ring-shaped wobble plate 15 is mounted on the outer surface of cylindrical member 12 through radial needle bearing 16. Thrust needle bearing 17 is disposed in a gap between flange portion 121 and wobble plate 15. The other end of drive shaft 7 is rotatably supported through radial bearing 18 in the central bore of cylinder block 31. Sliding shaft 151 is attached on the outer peripheral portion of wobble plate 15 and projects toward the bottom surface of cylinder casing 3. The end of sliding shaft 151 is slidably disposed in groove 321 to prevent the rotation of wobble plate 15.

One end of piston rod 19 is rotatably connected to receiving surface 152 of wobble plate 15. The other end of piston rod 19 is rotatably connected to piston 20 which is slidably disposed in cylinder 33.

A suction port (not shown) and discharge port 42 are formed in valve plate 4. A suction reed valve (not shown) is disposed on valve plate 4. Discharge reed valve (not shown) is disposed on valve plate 4 opposite the suction reed valve. Cylinder head 5 is connected to cylinder casing 3 through a gasket (not shown) and valve plate 4. Partition wall 51 extends axially from the inner surface of cylinder head 5 and divides the interior of cylinder head 5 into suction chamber 52 and discharge chamber 53. Suction chamber 52 is connected to the external fluid circuit through fluid inlet port 60 formed in cylinder head 5. Discharge chamber 53 is connected to the external fluid circuit through fluid outlet port 61 formed in cylinder head 5.

Bellows 63 is disposed in cylindrical bore 62 formed in cylinder block 31. Bore 62 is communicated with suction chamber 52 through aperture 64 formed through valve plate 4 and is communicated with crank chamber 32 through passageway 65 formed through cylinder block 31. Aperture 64 is normally closed by needle element 631 disposed on one end of bellows 63. The communication between crank chamber 32 and suction chamber 52 is controlled in accordance with the movement of bellows 63.

Proximity position sensor 70 is a non-contact type position detecting device and has a cpacity for detecting the range of about 1 mm. Proximity position sensor 70 is disposed on valve plate 4 at the cylinder side to face to the top surface of piston 20.

In operation, rotational motion is applied to drive shaft 7 through an external driving source (not shown) and is communicated to cam rotor 10. The rotational motion of cam rotor 10 is converted to nutational motion at wobble plate 15 through cylindrical member 12. Sliding shaft 151, connected to wobble plate 15 and disposed in groove 321, prevents wobble plate 15 from rotating. The nutational motion of wobble plate 15 is converted to the reciprocating motion of pistons 20 in cylinders 33 through piston rods 19. Accordingly, refrigeration fluid is sucked through inlet port 60 to suction chamber 52 and flows into cylinder 33 through suction port 41. Refrigeration fluid is compressed in cylinder 33 and is discharged into discharge chamber 53 through discharge port 42. The compressed refrigeration fluid then flows into the external fluid circuit through outlet port 61.

Distance Δx between the inner surface of valve plate 4 and the top surface of piston 20 is 0.3 mm when the inclined angle of flange portion 121 as shown in FIG. 1 is at the largest and is 1.3 mm when the inclined angle of flange portion 121 as shown in FIG. 2 is at the least.

The change of the displacement of the compressor, i.e., the relationship between the change of the inclined angle of slant plate 121 and the position of the top dead center of piston 20 is defined in accordance with the shape of elongated hole 123 formed in arm portion 122. Therefore, even though the detected output from position sensor 70 is non-linear to the value of distance Δx, the detected output proportional to the piston stroke can be outputted by suitably selecting the shape of elongated hole 123.

With reference to FIG. 3, a part of the construction of a compressor in accordance with the second embodiment of this invention is shown. Detected object 80 which is a permanent magnet is disposed in the top end surface of piston 20. Hall generator 81 is on valve plate 4 at the cylinder side to face to detected object 80. Hall generator 81 can output the output corresponding to distance Δx between itself and detected object 80.

With reference to FIG. 4, a part of the construction of a compressor in accordance with the third embodiment of this invention is shown. Detected object 90 which is a permanent magnet is disposed on the side surface of piston 20. Hall generator 81 is disposed on the side of cylinder casing 3. Hall generator 81 can output the output corresponding to distance Δx between itself and detected object 80.

As shown in FIG. 5, the displacement of the com-

pressor can be directly detected by changing the position of the top dead center of a piston within the range between 0.3 - 1.3 mm and by a non-contact type position sensor which has a capacity for detecting range of about 1 mm.

Although illustrative embodiments of the invention have been described in detail with respect to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope of the invention.

Claims

1. A slant plate type compressor with a variable displacement mechanism comprising a compressor housing enclosing a crank chamber, said housing including a cylinder block;

   a plurality of cylinders formed for defining compression space in said cylinder block;

   a piston slidably fitted with each of said cylinders;

   a drive mechanism coupled to said pistons to reciprocate said pistons within said cylinders, said drive mechanism including a drive shaft rotatably supported in said housing, and coupling means for drivingly coupling said pistons with said drive shaft and for converting rotary motion of said drive shaft into reciprocating motion of said pistons, said coupling means including a slant plate having a surface disposed at a slant angle relative to a plane perpendicular to said drive shaft, said slant angle changing in response to a change in pressure in said crank chamber, the stroke of said piston changing in response to the change of said slant angle and defining compression volume in said compression space to change the capacity of said compressor, the position of the top dead center of said piston changing within a certain range in response to the change of said stroke of said piston;

   a suction chamber and a discharge chamber enclosed within said compressor housing;

   a communication path linking said crank chamber with said suction chamber;

   control valve means for varying the capacity of said compressor by controlling the link between said crank and said suction chambers through said path; and

   sensor means disposed adjacent said cylinder for detecting the position of said top dead center of said piston in said compression space.

2. The compressor recited in claim 1 wherein said sensor means disposed on the surface of said valve plate opposing to said piston in the direction of reciprocating motion of said piston.

3. The compressor recited in claim 2 further comprising a detected object made of permanent magnet disposed on the surface of a piston to oppose to sensor means.

4. The compressor recited in claim 1 wherein said sensor means disposed on the surface for defining said cylinders.

5. The compressor recited in claim 4 further comprising a detected object made of permanent magnet disposed on the outer circumferential surface of said piston.

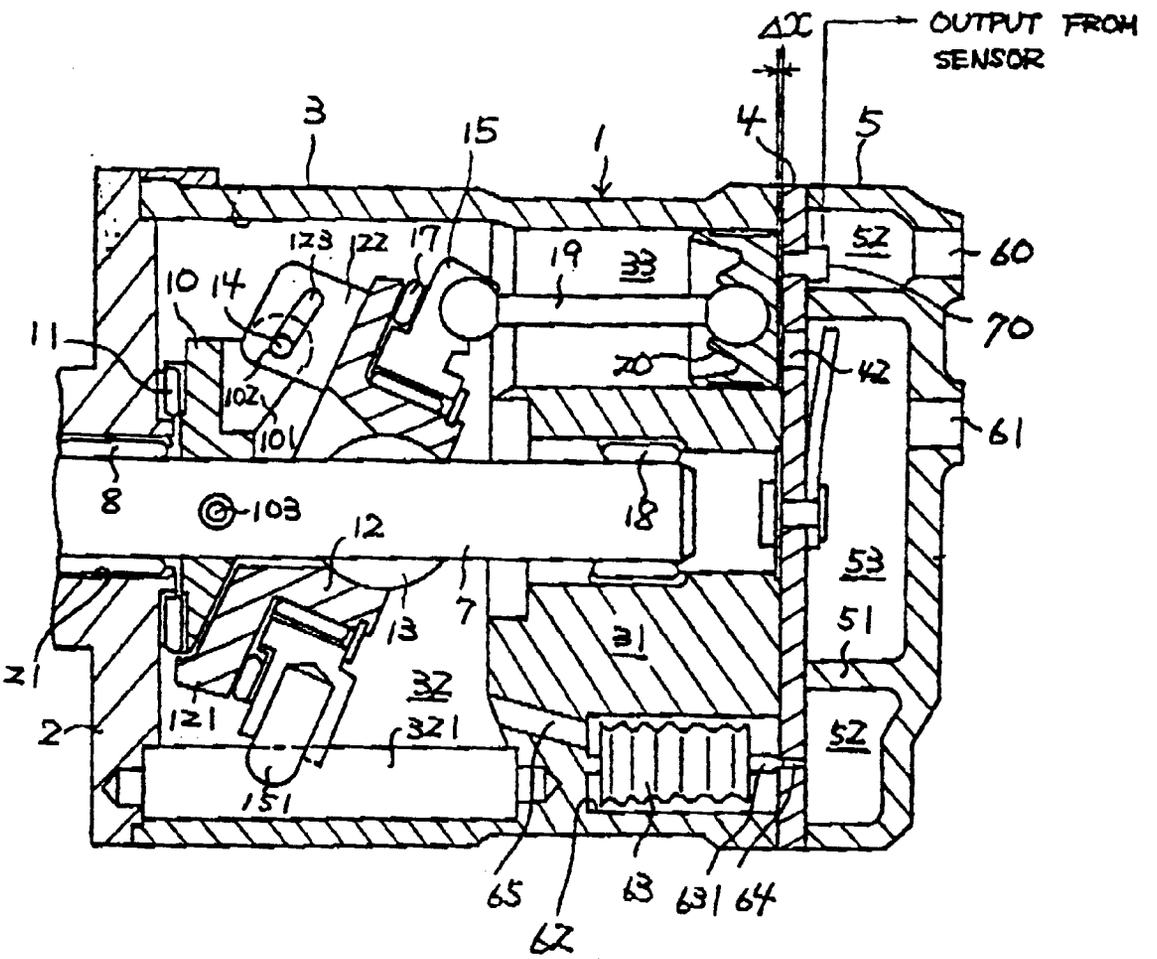
ΔX
OUTPUT FROM SENSOR
3
15
1
4
5
123
122
17
19
33
52
60
10
14
70
11
20
42
102
101
61
8
103
18
12
53
7
13
31
51
21
32
121
321
2
52
151
65
62
63
631
64

FIG. 1

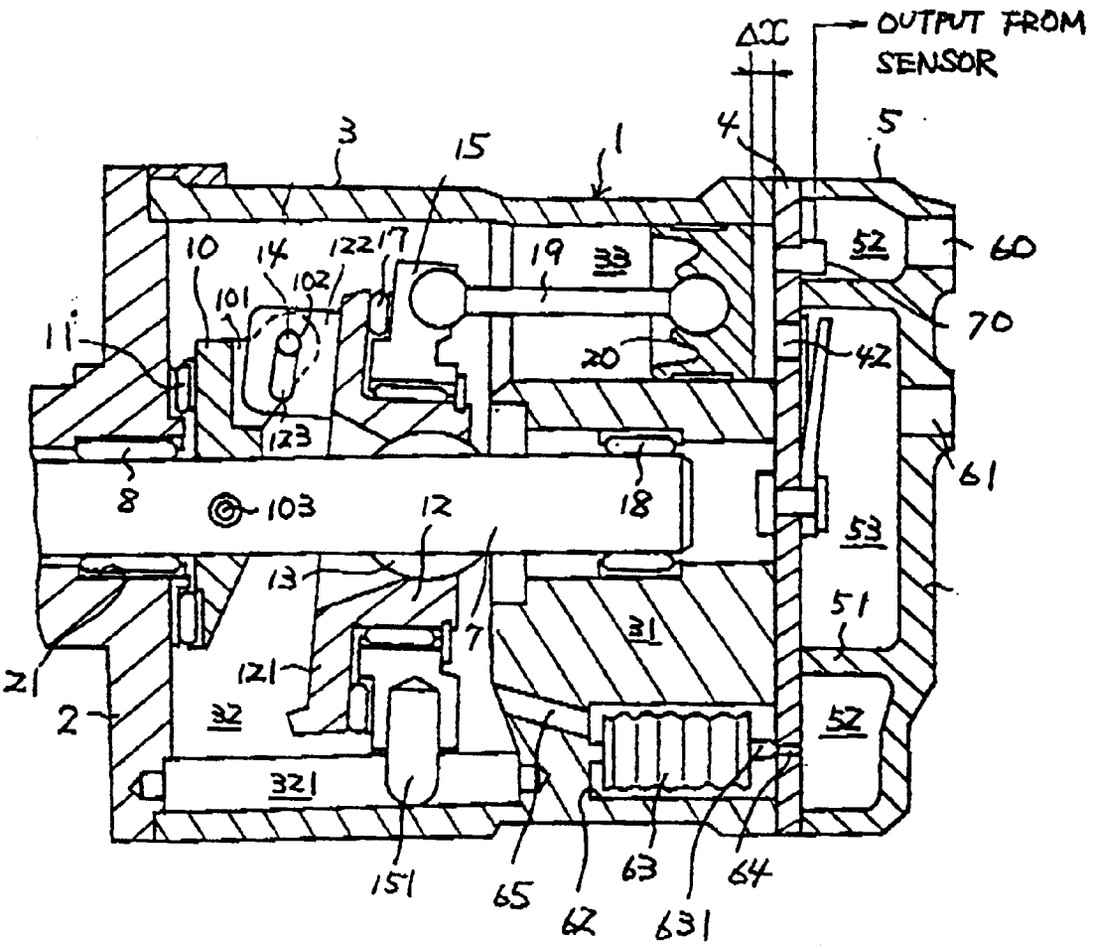
ΔX
OUTPUT FROM SENSOR
3
15
1
4
5
10
14
122
17
19
33
52
60
101
102
70
11
20
42
123
8
103
12
18
61
53
13
7
31
51
21
121
2
32
52
321
151
65
62
63
631
64

FIG. 2

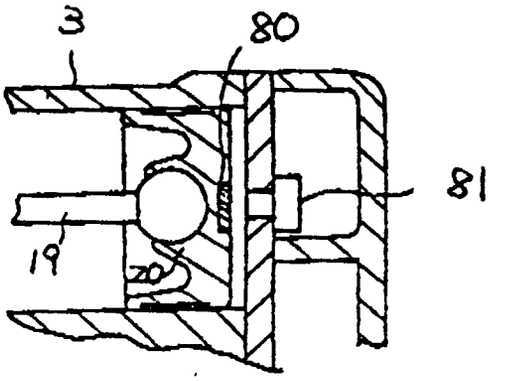

FIG. 3

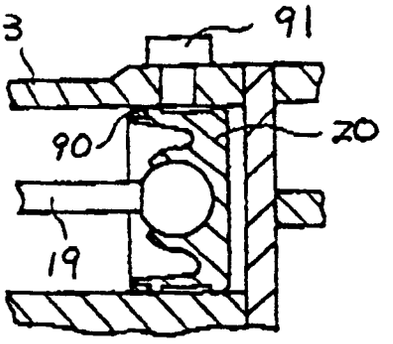

FIG. 4

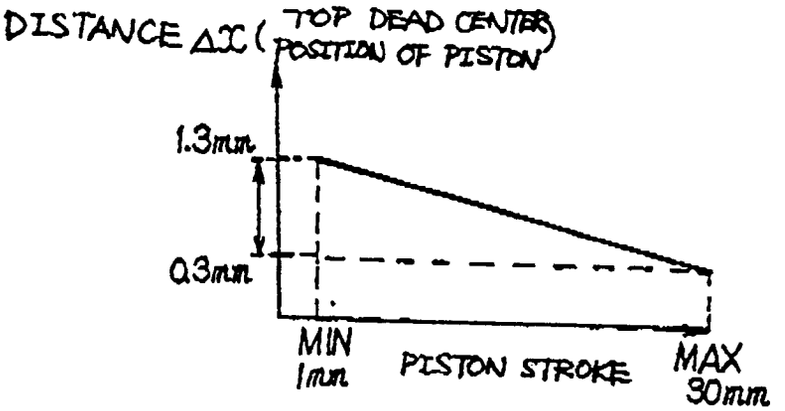

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 3249

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)
Y	US-A-4 822 252 (ISHIKAWA ET AL.) * column 1, line 45 - column 2, line 6; figures 1-3 *	1,2,4	F04B1/28 F04B49/10
Y	EP-A-0 183 295 (DOWELL SCHLUMBERGER) * page 2, line 28 - page 3, line 4 * * page 5, line 9 - line 12 * * page 10, line 7 - line 17; figures 1,2,4 *	1,4	
Y	EP-A-0 264 148 (PUMPTECH) * column 3, line 1 - line 18; figure 2 *	2	
A		1	
A	US-A-4 737 079 (KUROSAWA) * column 5, line 15 - line 29; figure 1 *	1	
A	EP-A-0 342 928 (HONDA GIKEN) * column 3, line 8 - line 39; figure 1 *	1	
A	DE-A-4 015 006 (KABUSHIKI KAISHA) * column 5, line 6 - line 22; figure 1 *	1	
A	EP-A-0 282 190 (SANDEN CORPORATION)		TECHNICAL FIELDS SEARCHED (Int. Cl.5) F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 JUNE 1992	GATTI Carlo

CATEGORY OF CITED DOCUMENTS

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