

12

EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

21 Application number: 84901403.0

51 Int. Cl.⁴: **G 10 K 11/16**
E 04 B 1/86

22 Date of filing: 30.03.84

Data of the international application taken as a basis:

86 International application number:
PCT/JP84/00153

87 International publication number:
WO84/03982 (11.10.84 84/24)

30 Priority: 30.03.83 JP 46158/83 U
05.03.84 JP 32236/83 U

43 Date of publication of application:
08.05.85 Bulletin 85/19

84 Designated Contracting States:
DE FR GB

71 Applicant: **SHIN NIPPON CORE CO. LTD.**
5-1, Akebono 5-jyo 5-chome Nishi-ku
Sapporo-shi Hokkaido 061-24(JP)

72 Inventor: **MAYUMI, Toshio Shin Koshigaya Sky Heights**
323
6-86, Minami-koshigaya 1-chome, Koshigaya-shi
Saitama 343(JP)

74 Representative: **Riederer Freiherr von Paar zu Schönaue,**
Anton
Freyung 615 Postfach 2664
D-8300 Landshut(DE)

54 **SOUND-ADJUSTING PLATE.**

57 A sound-adjusting plate constituted by a member with a hollow laminated structure. This plate can be employed as a support for a speaker unit, or it can be provided behind a speaker unit to absorb or dampen the sound energy coming from the speaker unit, to reduce any adverse effects due to the sound. For this purpose, paper roll cores (11) are used as a core material, and the surface of the openings (14) thereof on one side is covered with a porous cover sheet (12) such as a napped cloth, a flocked cloth, or felt, while the surface (15) of the other openings thereof is covered with a sheet (13) which is impermeable to air, such as lead sheeting or a plastic sheet containing iron powder. Sound within the treble region is absorbed by the porous cover sheet (12), while sounds in the middle and bass regions are absorbed by cells (18) and gaps (19) formed by the roll cores (11). Both the roll cores (11) and the impermeable sheet (13) act as vibration dampers to prevent the propagation of vibrations due to low-pitched sounds to the walls or floor.

FIG. 1

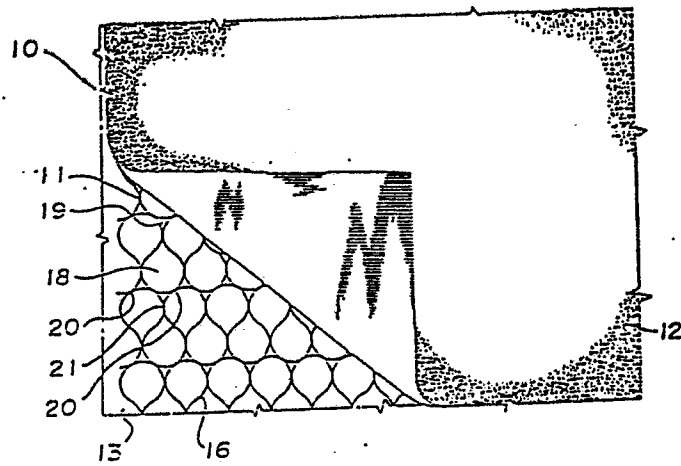
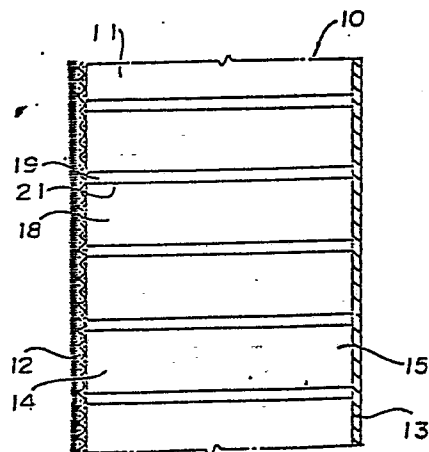


FIG. 2



SPECIFICATION

SOUND REGULATING PANEL

TECHNICAL FIELD

The present invention relates to a sound regulating panel comprising a cavernous member sandwiched between two sheets. More particularly the invention relates to a sound regulating panel which obviates adverse effects of sounds emanating from the bottom or rear part of a speaker unit.

BACKGROUND OF THE INVENTION

In a listening room, a speaker unit is mounted on a supporting base made of bricks, concrete blocks or the like so that vibration energy generated by the sound source and transmitted to a floor is absorbed thereby. As the mass of the supporting base is increased, it attenuates resonance more effectively. However, such a supporting base is limited in its size and mass, and cannot give a satisfactory result. Moreover, sound waves emanating from the rear part of the speaker unit are reflected by a wall behind the speaker unit and interfere with sound waves coming out of the front face of the speaker, thereby causing

noises. An insulation board, plywood or the like is arranged behind the speaker unit, or a panel comprising a fibrous member of honeycomb cores sandwiched between front and rear perforated plates is often disposed beside and behind the speaker unit so as to absorb sound waves emitted from all sides, except the front side, of the speaker unit and eliminate adverse effects of the sounds. However, such a panel can absorb sound waves in a middle or low frequency range only, and does not have an appropriate sound absorbing effect nor ensures clear sounds. One of known panels using honeycomb cores is a sound attenuating structural panel (U.S. Patent No. 4,291,080) comprising a honeycomb structure having at least three different cell sizes, said honeycomb structure being sandwiched between two sheet-like layers, so as to absorb sound waves in middle and low frequency ranges. Said panel is disposed around an engine duct at a jet engine test to absorb sound energy having a high temperature and a high speed to prevent noises from dispersing to surroundings. Therefore, the panel is required to have high mechanical strength and heat resistance. Even if the panel having such a construction is used as a sound absorbing member in a listening room, it cannot perform the fine regulation of sounds.

It is an object of this invention to provide a sound regulating panel which can remove said disadvantages of the speaker supporting base or the sound absorbing panel of the prior art. It is a further object of the invention to provide a sound regulating panel which is light in weight, less expensive, and has excellent sound absorbing characteristics.

DISCLOSURE OF THE INVENTION

The present invention relates to a sound regulating panel wherein a roll core made of paper is laid between a napped or flocked porous cover sheet and a sheet impermeable by air such as a thin lead plate. Due to this construction, the panel can absorb sound waves in middle and low frequency ranges discharged from a speaker unit and perform the vibration damping of sound energy transmitted from the lower part of the speaker unit to the floor, thereby improving the acoustic characteristics of a stereo listening room.

The size of the paper roll core can be selected optionally. However, the result of experiment shows that it is desirable to use a roll core having a cell diameter of about 14mm and a thickness of about 20 to 90mm, preferably 50-90mm. Napped or flocked cloth or felt having an air permeability of 5-15 cc/cm²/sec measured by,

for example, a Frazier type tester is suitable for use as the porous cover sheet. Materials having no resonance frequencies in an audible frequency range, such as a lead plate of more than 0.3 mm in thickness and a thermoplastic sheet containing powdered iron such as a vinyl chloride sheet mixed with powdered iron are suitable for use as said impermeable sheet. The porous cover sheet, cells of the roll core and gaps between the cells have a relatively high absorptivity with respect to high-, low- and middle-pitched sound ranges respectively, and consequently the panel as a whole demonstrates a uniformly high absorptivity over the full sound range. In addition, the roll core and impermeable sheet act as a vibration damping member to prevent vibration generated by sounds (especially by low-pitched sound) from being transmitted to a wall or floor. The impermeable sheet and cover sheet respectively have reflection and irregular reflection effects of sounds.

Thus, the sound regulating panel of the invention can provide excellent effects on the clearness of sound, orientation of sound image and reverberation, thereby resolving above mentioned problems of the prior art. If the permeability of the cover sheet is insufficient, sounds are confined and the effect of panel is disturbed.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a front elevation, partially broken away, of a preferable sound regulating panel in accordance with the invention,

Fig. 2 is a cross sectional side view of the same,

Fig. 3 is a plan view illustrating the panel in use,

Fig. 4 is a sectional view along the line IV-IV of Fig. 3, and

Fig. 5 is a diagram showing sound absorptivity.

PREFERRED EMBODIMENT OF THE INVENTION

Now the invention is hereunder explained in detail referring to attached figures. Fig. 1 is a front elevation of a sound regulating panel 10, where one (a porous cover sheet 12) of sheet-like layers is broken away, and Fig. 2 is an enlarged sectional view of the panel.

The sound regulating panel 10 comprises a cavernous member sandwiched between two shell-like layers, said cavernous member being a roll core 11 made of paper, and said sheet-like layers being a porous cover sheet 12 and an impermeable sheet 13.

The roll core 11 used in a preferred embodiment has a cell size of 14mm and a thickness of 90 or 50mm. The cover sheet 12 may be air-permeable napped cloth such

as French pile and covers one open face 14 of the roll core 11. As shown in Table 1 below, the napped cloth may be replaced by felt. The impermeable sheet 13 may be a lead plate having a thickness of 0.3 mm, for example, and covers the other open face 15 of the roll core 11. As illustrated in Fig. 1, the roll core 11 is formed by laying a roll core element 16 of each stage upon another, the roll core elements 16 being bonded to each other at part 20. As a result, cells having different volumes, namely original cells 18 and gaps 19, are formed in each element. In each element 16, adjacent cells 18 contact each other at part 21 without adhesives.

The sound regulating panel is arranged under and behind a speaker unit 26 in a listening room 25 as shown in Figs. 3 and 4. Each sound regulating panel 10 serving as a speaker supporting base has a roll core thickness of 90 mm, and sound regulating panels 30 arranged at the back and sides of the speaker have a roll core thickness of 50 mm.

The sound regulating panels 10 and 30 in the above embodiment have an average absorbing effect over the whole sound range. Namely, cells 18 having a large volume, gaps 19 having a small volume and the cover sheet 12 of air-permeable napped cloth show a relatively high sound absorptivity with respect to low-, middle- and high-

pitched sound ranges respectively. Therefore, the panels have an average sound absorptivity over the whole sound range. Fig. 5 shows the sound absorptivity of the sound regulating panel (the area of the test piece: 9.4m^2) used as a speaker supporting base, the measurement being performed in accordance with the reverberation method specified in JIS A1409-1977.

The sound regulating panel in the above embodiment has a vibration damping effect of preventing vibration generated by sounds (especially by low-pitched sound) from propagating to a wall or floor, because the roll core 11 of the panel acts as a vibration damping member. In addition, the panel has an excellent sound reflection effect because one open face of the roll core is covered with the impermeable sheet 13 of lead. Moreover, the panel has an irregular sound reflection effect, which realizes an excellent sound dispersion effect, because the other open face of the roll core is covered with the air-permeable napped cloth.

The comparison between the effects of sound regulating panels is shown hereunder.

Table 1

Sound Regulating Panels Arranged Behind Speaker Unit

Kind	Roll core (1)				Corru- gated core (2)	Roll core + cellu- lose fiber (3)	Insu- lation board (4)	Ply- wood (5)	
Cloth	Air-permeable napped cloth (6)				Felt	Air- perme- able napped cloth (7)	Air perme- able napped cloth		
Core thick- ness	50	70	90	150 mm	75	90	90	12	9
Test item									
Clear- ness of sound	⊙	⊙	⊙	○	○	○	○	○	○
Orien- tation of sound image	○	⊙	⊙	⊙	○	Δ	Δ	Δ	Δ
Rever- bera- tion	○	⊙	⊙	⊙	○	Δ	Δ	X	X

Note

(1) Sound regulating panel in accordance with the present invention

(3) Roll core filled with cellulose fiber

(1) - (3) One side of core is covered with a lead plate.

(4) & (5) are single plates.

(6) Weight: 100g/m^2 ; thickness : 0.3mm

(7) Weight: 210g/m^2 ; thickness : 1mm

It can be said from the above result that the sound regulating panel in accordance with this invention is satisfactory in the clearness and diffusion of sounds and reverberation in comparison with comparative examples. Particularly when the roll core thickness is 75 to 90mm, the sound regulating panel of the invention is remarkably excellent in any of said points. One of the reasons why sounds having a good image orientation, depth and width have been obtained seems to be that the cells of the roll core are bonded airtight to each other at part 20 as shown in Fig. 1 but they are only in pressing contact with each other at part 21 so that the cells 18 and gaps 19 can communicate with each other.

0139765

Tabel 2

Sound Regulating Panels Used as Supporting Base of Speaker Unit

	Concrete block	Embodi-ment	Note
(1) Vibra- tion damping factor	0.01	0.157	Sound absorptivity is excellent as rubber.
(2) Compres- sion elastic modulus	1.5×10^5 kg/cm ²	4.2×10^2 kg/cm ²	The panel has a rigidity sufficient to resist any impact sounds of speaker. By means of impregnation of resin, the compression elastic modulus can be increased to 4.2×10^3
(3) Sound absorp- tion factor	Nearly nil	Refer to Fig. 5	The panel has an average sound absorbing effect over the whole frequency range.
(4) Accuracy not to cause play	Good	Good	The panel is in close contact with a cloth surface speaker.
(5) Appear- ance as interior goods	Poor	Good	The panel is free in selecting its color and shape.

(Measurements of embodiment: 450 x 300 x 91mm;
inside core thickness: 90mm)

Comparison of Effects

	Concrete block	Embodiment
Clearness of sound	Δ	⊙
Orientation of sound image	○	⊙
Reverberation	Δ	⊙

As described above, in the sound regulating panel of the invention, one open face of the roll core is covered with the air-permeable cloth and the other open face of the roll core is covered with the impermeable sheet. Therefore, the panel uniformly absorbs and suitably reflects sounds from low to high frequencies so as to obtain clear sounds. Since the sound absorbing material has the vibration damping effect, the panel can prevent the sounds of the speaker from vibrating a wall, floor, etc. Although the use of the sound regulating panel as a supporting base of the speaker unit is sufficient to improve the characteristics of the speaker, it is more preferable to dispose an additional panel at the back of the speaker unit. When the panel is used as a wall material, a sound insulation wall having a sound reflecting effect can be obtained, which is suitable for use in a room for exercising musical instruments.

CLAIMS

1. A sound regulating panel comprising a roll core made of paper, one open face of said roll core being covered a porous cover sheet and the other open face of said roll core being covered with a sheet impermeable by air.
2. A sound regulating panel in accordance with Claim 1, wherein said porous cover sheet is made of napped cloth, flocked cloth or felt permeable by sound waves.
3. A sound regulating panel in accordance with Claim 1, wherein said sheet impermeable by air is a lead plate.
4. A sound regulating panel in accordance with Claim 1, wherein said sheet impermeable by air is a thermoplastic sheet mixed with powdered iron.

FIG. 1

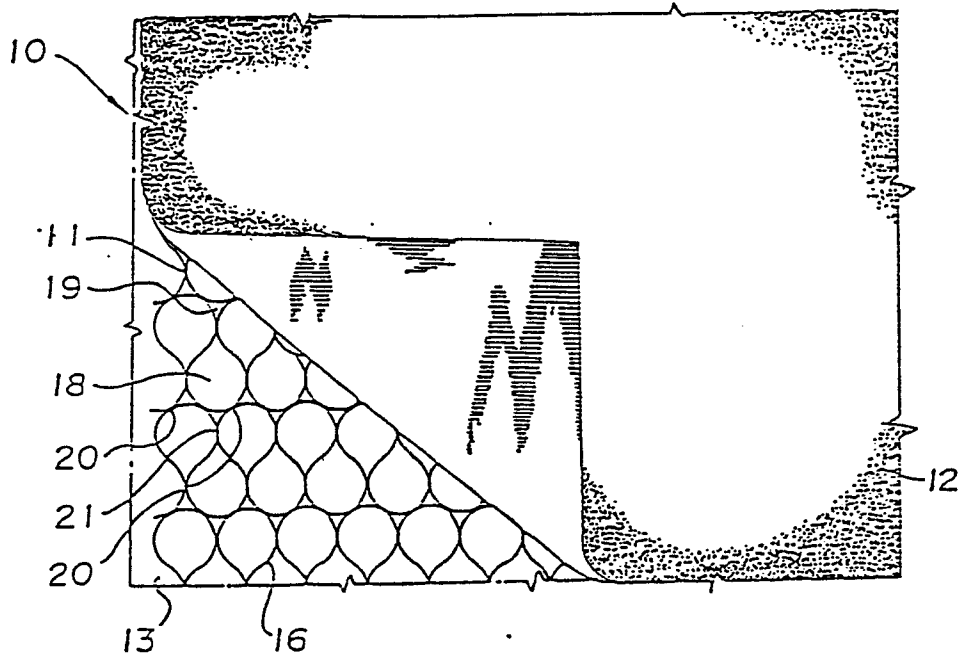


FIG. 2

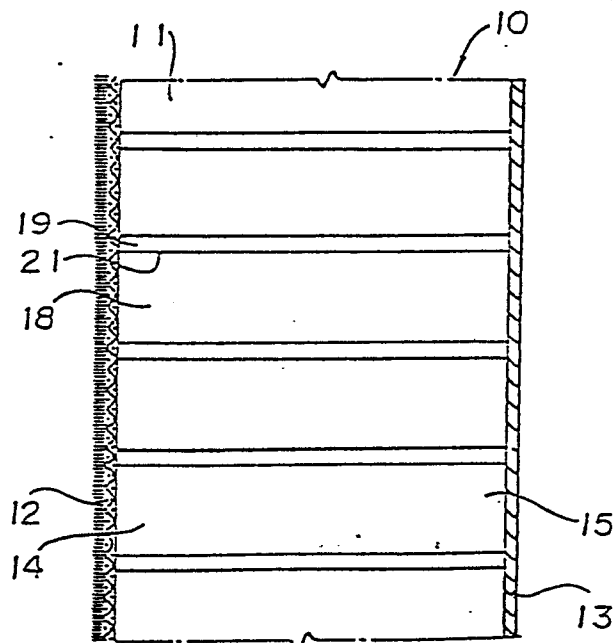


FIG. 3

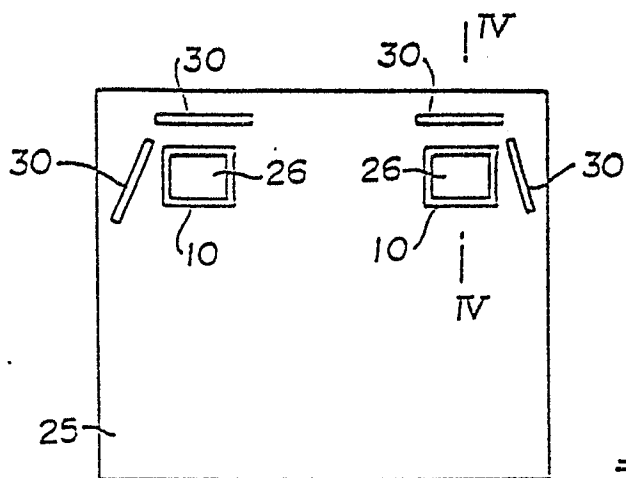


FIG. 4

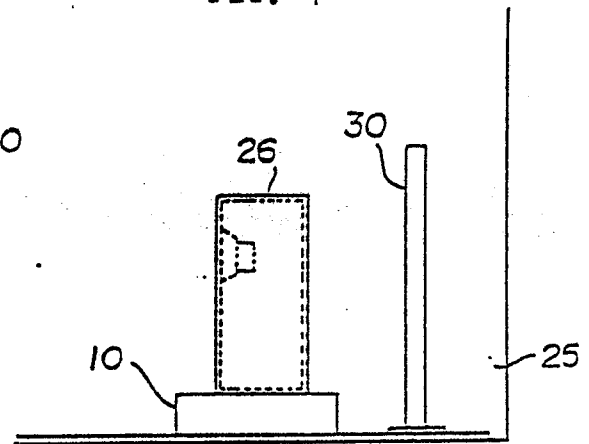
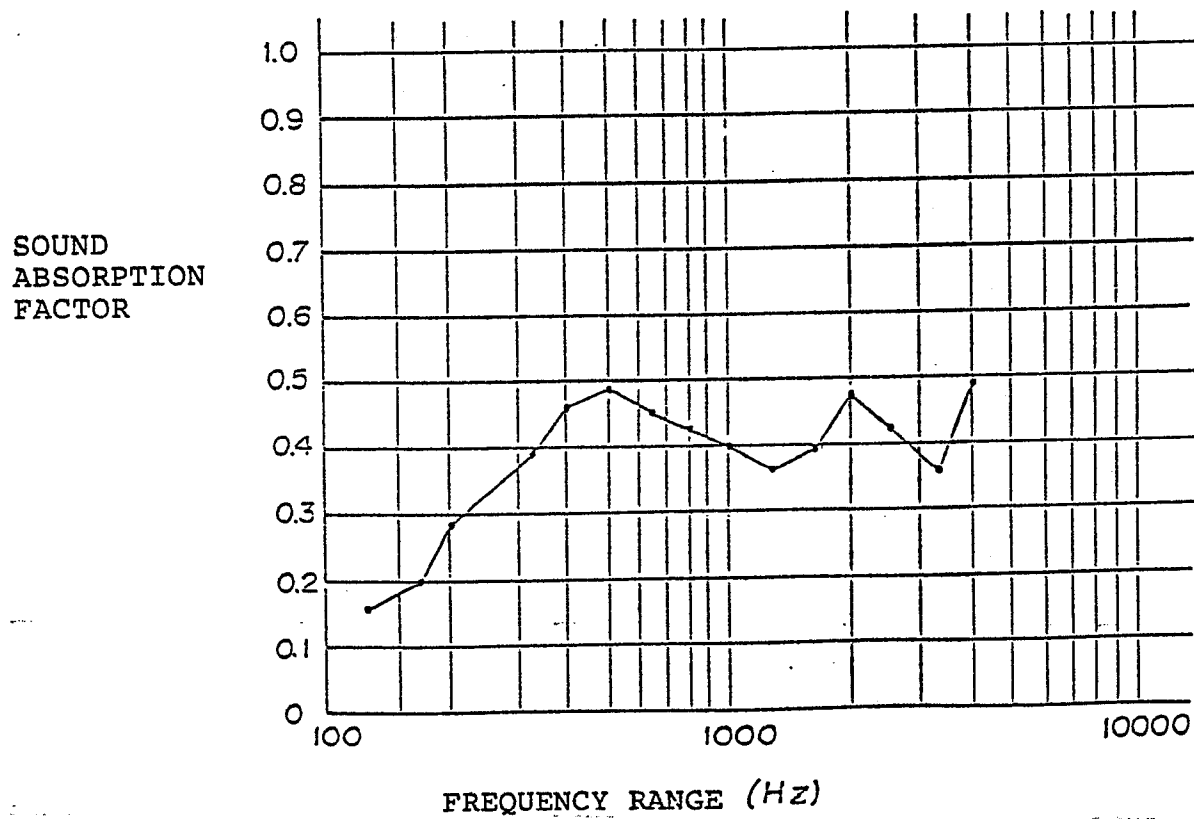


FIG. 5



10 and 30: Sound ragulating panel

11: Roll core

12: Porous cover sheet

13: Impermeable sheet

14 and 15: Open face

16: Roll core element

18: Cell

19: Gap

20 and 21: Part

25: Listening room

26: Speaker unit

INTERNATIONAL SEARCH REPORT

0139765

International Application No. PCT/JP84/00153

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)¹

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl³ G10K 11/16, E04B 1/86

II. FIELDS SEARCHED

Minimum Documentation Searched⁴

Classification System

Classification Symbols

IPC

G10K 11/16, E04B 1/86

Documentation Searched other than Minimum Documentation
to the extent that such documents are included in the Fields Searched⁴

Jitsuyo Shinan Koho 1950 - March, 1984

Kokai Jitsuyo Shinan Koho 1971 - March, 1984

III. DOCUMENTS CONSIDERED TO BE RELEVANT¹⁴

Category ¹⁵	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	JP, Y2, 53-38336 (Iei Seiko Kabushiki Kaisha) 18. September, 1978 (18. 09. 78)	1, 2
X	JP, B2, 55-46866 (American Cyanamid Co.) 26. November, 1980 (26. 11. 80) & CA, A, 956895 & FR, B1, 2118168	1, 3
Y	JP, A, 54-13301 (System Layout Kabushiki Kaisha) 31. January, 1979 (31. 01. 79) P.2, lower left column, lines 9 to 13	1
X	JP, Y2, 52-2401 (Toyoda Boshoku Kabushiki Kaisha) 20. January, 1977 (20. 01. 77) Column 2, lines 1 to 5	2
X	JP, Y2, 51-52322 (Riken Kabushiki Kaisha) 15. December, 1976 (15. 12. 76) Column 1, lines 16 to 22	3
X	JP, Y2, 48-6820 (Toyo Rinoileum Kabushiki Kaisha) 21. February, 1973 (21. 02. 73) Column 2, lines 25 to 26	4

¹⁵ Special categories of cited documents:¹⁶ "A" document defining the general state of the art which is not
considered to be of particular relevance¹⁷ "E" earlier document but published on or after the international
filing date¹⁸ "L" document which may throw doubts on priority claim(s) or
which is cited to establish the publication date of another
citation or other special reason (as specified)¹⁹ "O" document referring to an oral disclosure, use, exhibition or
other means²⁰ "P" document published prior to the international filing date but
later than the priority date claimed²¹ "T" later document published after the international filing date or
priority date and not in conflict with the application but cited to
understand the principle or theory underlying the invention²² "X" document of particular relevance: the claimed invention cannot
be considered novel or cannot be considered to involve an
inventive step²³ "Y" document of particular relevance: the claimed invention cannot
be considered to involve an inventive step when the document
is combined with one or more other such documents, such
combination being obvious to a person skilled in the art²⁴ "Z" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search²⁵
June 20, 1984 (20.06.84)Date of Mailing of this International Search Report²⁶
July 2, 1984 (02.07.84)

International Searching Authority

Japanese Patent Office

Signature of Authorized Officer²⁷

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X	JP, Y2, 51-24241 (Chisso Corp.) 22. June, 1976 (22. 06. 76) Column 1, lines 12 to 13, column 1, line 34 to column 2, line 1	4
---	---	---

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE¹¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers because they relate to subject matter¹² not required to be searched by this Authority, namely:
2. ☐ Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out¹³, specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING¹¹

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims: it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest
- ☐ No protest accompanied the payment of additional search fees