

TITLE OF THE INVENTION:

ON-LOAD TAP CHANGER ATTACHED STATIONARY INDUCTION APPARATUS

FIELD OF THE INVENTION:

5 The present invention relates to a fire retardant liquid charged stationary induction apparatus, which has an on-load tap changer and contains a fire-retardant insulating liquid material as an insulating/cooling medium.

10 BACKGROUND OF THE INVENTION:

As an insulating/cooling medium for transformers, which are stationary induction apparatuses wherein the insulating/cooling medium is used, insulating oils such as mineral oil have been hitherto used.

15 When a fire retardant silicon liquid is used, as an insulating/cooling medium for transformers, instead of the mineral oil, the fire retardancy of the transforms can be improved. With the improvement, a better fire retardancy is desired also for an on-load tap changer fitted to transformers
20 in order to adjust the voltage of the transformers.

An on-load tap changer is composed mainly of a changeover switch section and a tap selector section. Patent Document 1 listed up below discloses an on-load tap changer having a changeover switch section wherein an ester oil or liquid silicone
25 having a flash point higher than 250°C is used and a tap selector

section wherein a natural ester oil having a flash point higher than 250°C is used. Patent Document 1 also discloses the use of a synthetic ester oil instead of the natural ester oil. Furthermore, Patent Document 1 discloses an on-load tap changer
5 of a low sliding resistance type which has: a changeover switch section wherein a liquid silicone having a flash point higher than 250°C is used; and a tap selector section wherein a liquid silicone having a flash point higher than 250°C is used.

Suggested is also an on-load tap changer using a vacuum
10 switch in order to prevent an arc from being radiated in a medium in the changer. The on-load tap changer has been put into practical use.

Patent Document 1: Japanese Patent Application Laid-Open
(JP-A-) No. 2006-114615

15 In the case of using a liquid silicone in a changeover switch section in accordance with the method described in Patent Document 1, the liquid silicone may be polymerized when an arc is generated. As a result, an insulator may be generated so that a poor contact may be caused in the changeover switch section.
20 In the case of using, in a tap selector section, a liquid silicone, which is poor in lubricity in a sliding region between metal members, the metal in the tap selector section may be worn away even if a low sliding resistance type tap changer is used. In the case of using a natural or synthetic ester oil in a changeover
25 switch section or a tap selector section, the apparatus having

the section is not easily made fire retardant. Additionally, the volume resistivity thereof is low and the oil is deteriorated by hydrolysis thereof, so that the insulating characteristic may lower.

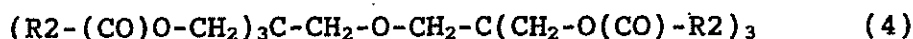
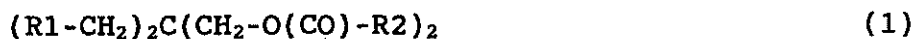
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SUMMARY OF THE INVENTION:

An object of the present invention is to provide a stationary induction apparatus having on-load tap changers, which is excellent in fire retardancy and exhibits an operating
10 characteristic stability over a long term.

Accordingly, the invention provides an on-load tap changer attached stationary induction apparatus, including a tank, an electromagnetic induction device which is put, together with a liquid insulating material having a flash point higher
15 than 250°C, in the tank, and an on-load tap changer for adjusting the voltage of the electromagnetic induction device, wherein the on-load tap changer has a changeover switch section and a tap selector section, and the following medium is used as an insulating medium at least for the tap selector section:
20 a medium in which in a silicone liquid having a flash point higher than 250°C is dissolved a polyol ester having a flash point higher than 250°C in a proportion of 5 to 30% by weight of the insulating medium. The polyol ester is preferably one or more polyol esters selected from the group consisting of
25 aneopentylglycol type polyol ester represented by the following

formula (1), a trimethylolpropane type polyol ester represented by the following formula (2), a pentaerythritol type polyol ester represented by the following formula (3), and a dipentaerythritol type polyol ester represented by the following formula (4):



wherein R1 represents hydrogen or an alkyl group having 1 to 3 carbon atoms, and R2 represents one or more alkyl groups having 5 to 12 carbon atoms.

According to the invention, it is possible to provide an on-load tap changer attached stationary induction apparatus which contains a silicone liquid and has a changeover switch section satisfying a required insulating characteristic and arc resistance, and a tap selector section satisfying a required insulating characteristic and sliding characteristic so as to exhibit an excellent fire retardancy.

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BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 is a schematic view of an on-load tap changer attached transformer containing a silicone, which is an example of the invention, has a changeover switch section satisfying required insulating property and arc resistance and a tap

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selector section satisfying required insulating property and sliding characteristic, and is excellent in fire retardancy;

Fig. 2 is a schematic view of a vacuum switch type on-load tap changer to which the invention is applied; and

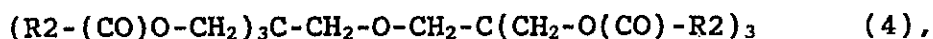
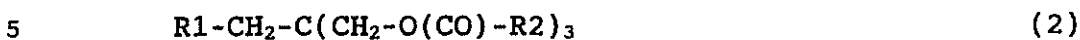
5 Fig. 3 is a schematic view of a resistor type on-load tap changer to which the invention is applied.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS:

With reference to the attached drawings, electrical
10 apparatuses which each contain a silicon liquid according to examples of the invention will be described hereinafter; before the description, embodiments of the invention are exemplified just blow.

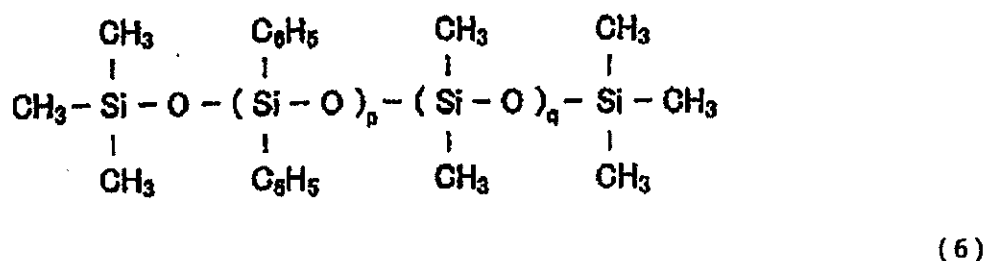
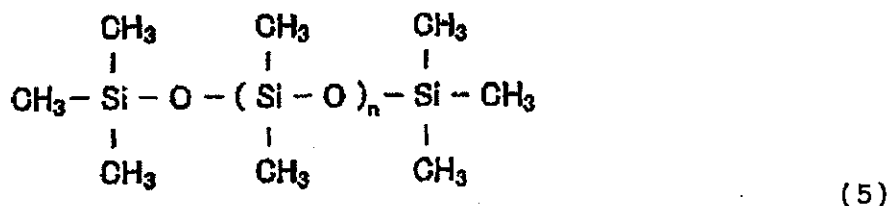
(1) An on-load tap changer attached stationary
15 induction apparatus, comprising a tank, an electromagnetic induction device which is put, together with a liquid insulating material having a flash point higher than 250°C, in the tank, and an on-load tap changer for adjusting the voltage of the electromagnetic induction device, wherein the on-load tap
20 changer has a changeover switch section having a vacuum switch and a tap selector section, and the following medium is filled as an insulating medium at least for the tap selector section:
a silicone liquid to which a polyol ester having a flash point higher than 250°C is added in a proportion of 5 to 30% by weight
25 of the insulating medium.

(2) The polyol ester oil is preferably one or more selected from the group consisting of polyol esters represented by the following formulae (1), (2), (3) and (4):



wherein R1 represents hydrogen or an alkyl group having 1 to 3 carbon atoms, and R2 represents one or more alkyl groups having 5 to 12 carbon atoms, that is, hindered type polyol esters.

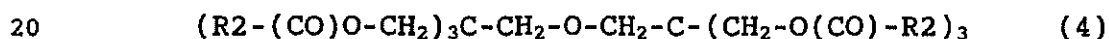
(3) The silicon liquid is one or more selected from the group consisting of dimethylsilicone represented by the following formula (5), wherein side chains of a polysiloxane are each a methyl group, and methylphenylsilicone represented by the following formula (6), wherein side chains of a polysiloxane are partially phenyl groups:



wherein n, p and q are each an integer of 1 or more.

(4) The silicone liquid is preferably a silicon liquid having a kinematic viscosity coefficient of 50 mm²/s or less at 25°C.

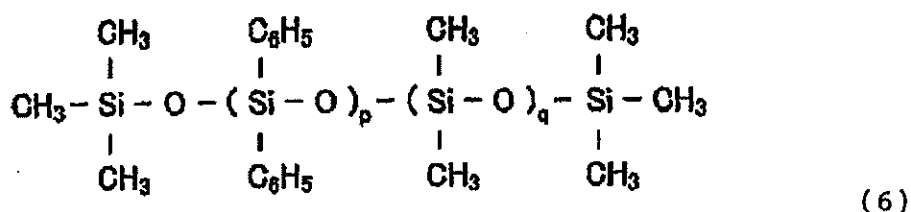
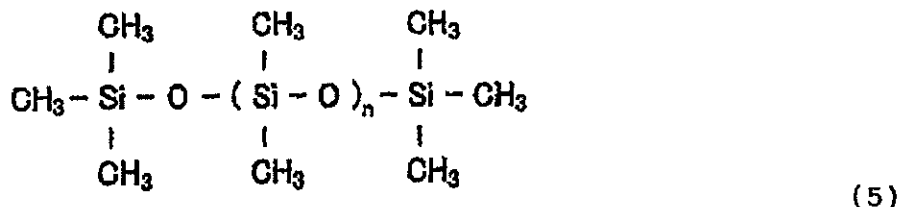
(5) An on-load tap changer attached stationary
 5 induction apparatus, comprising a tank, an electromagnetic
 induction device which is put, together with an insulating medium
 containing a silicone liquid, in the tank, and an on-load tap
 changer which has a changeover switch section and a tap selector
 section in order to adjust the voltage of the electromagnetic
 10 induction device, wherein the on-load tap changer is a vacuum
 switch, and an insulating medium for the tap selector section
 in the on-load tap changer is a silicone liquid to which the
 following is/are added: one or more selected from the group
 consisting of synthetic polyolesters having a flash point higher
 15 than 250°C and represented by the following formulae (1) to
 (4):



wherein R1 represents hydrogen or an alkyl group having 1 to
 3 carbon atoms, and R2 represents one or more alkyl groups having
 5 to 12 carbon atoms.

(6) The silicone liquid is preferably one or more
 25 selected from the group consisting of silicones represented

by the following formulae (5) and (6):



5 wherein n, p and q are each an integer of 1 or more.

(7) The content by percentage of the synthetic polyol ester is preferably from 5 to 30% by weight of the insulating medium.

(8) The kinematic viscosity coefficient of the silicone
10 liquid is 50 mm²/s or less at 25°C.

The invention will be described in detail by way of the following examples.

Examples 1 to 5, and Comparative Examples 1 to 5:

Referring to Fig. 1, an on-load tap changer 16 is roughly
15 composed of a changeover switch section 17 and a tap selector section 18. The on-load tap changer 16 used in Examples 1 to 5 was a vacuum switch type on-load tap changer wherein a vacuum switch was used as the changeover switch section 17. A schematic view of the vacuum switch type on-load tap changer is illustrated
20 in Fig. 2. In Figs. 1 and 2, a transformer wherein a primary

winding 3 and a secondary winding 4 are fitted onto an iron core 2 is put into a tank 1 in which an insulating/cooling liquid medium 6 is charged. The windings are each inserted into an insulating cylinder 5. The iron core 2 is tightly fastened with insulators 11, 12, 13 and 14 positioned on the upper and lower ends of the windings, and metallic fasteners 10a and 10b. A breather is used to put dry air into an LTC room. Alternatively, the LTC room is made into an air-tightly closed space, which is shut out from the outside air, and further an inert gas (such as nitrogen gas, SF_6 gas or CF_3I gas) is enclosed into the room in order to prevent disasters.

When a vacuum switch is used as the changeover switch section 17, it is unnecessary to enclose any insulating/cooling medium into the changeover switch section.

A circuit diagram when vacuum switches are used as changeover switches is illustrated in Fig. 2. In Fig. 2, vacuum switches 22a and 22b are set in a changeover switch section 17a, and the vacuum switches 22a and 22b are connected to a current limiting resistor 21 in series. Thereto are connected a tap selector section 18 and a tap winding 20 in parallel.

Fig. 3 illustrates a schematic structure of a resistor type on-load tap changer as a switch section. An insulating/cooling medium 19a is enclosed in a tank in a changeover switch section 17b. The switching of contact points is attached between movable arc contacters 24 and fixed arc

contacters 23. The other structures of the changer are substantially the same structures as illustrated in Fig. 2. However, in the changer illustrated in Fig. 3, arcs may be generated at the time of the switching of the contact points; therefore, the insulating/cooling medium 19a is required to have arc resistance.

Returning to Fig. 1, cooling pipes 9a and 9b are used to circulate the insulating/cooling medium 6 in the transformer. The warmed medium 6 is discharged from the upper portion of the tank, and is cooled with a cooler 8. The medium 6 is passed in a pipe 9b positioned in the lower portion of the tank, and returned into the tank.

An oil channel 15 is made in the center of the iron core 2, and the cooled medium 6 rises up in this oil channel 15 while the cooled medium 6 cools the iron core 2.

The tap selector section is filled with the insulating medium 19. The used insulating medium 19 is a silicone liquid, which a polyol ester is mixed with (dissolved in). The mixed polyol ester is preferably a hindered type polyol ester, which is synthesized from a polyhydric alcohol and a monovalent aliphatic acid and is excellent in thermal stability and hydrolysis resistance.

Examples of the polyhydric alcohol include neopentyl glycol, trimethylolpropane, and pentaerythritol. Examples of the monovalent aliphatic acid include pentanoic acid, hexanoic

acid, heptanoic acid, octanoic acid, 2-methylbutanoic acid,
2-methylpentanoic acid, 2-methylhexanoic acid,
2-ethylhexanoic acid, isooctanoic acid, and
3,5,5-trimethylhexanoic acid. These may be used alone or in
5 combination.

In the invention, it is preferred to use one or more polyol
esters represented by the formulae (1), (2), (3) and/or (4),
which each have in the molecule thereof at least two ester groups.
The formula (1) represents a neopentyl glycol type polyol ester;
10 the formula (2) represents a trimethylolpropane type polyol
ester; the formula (3) represents a pentaerythritol type polyol
ester; and the formula (4) represents a dipentaerythritol type
polyol ester. These polyol esters may be used alone, or in
the form of a mixture of two or more thereof. The amount of
15 the polyol ester(s) in the insulating medium 19 is preferably
5% or more by weight, more preferably 10% or more by weight.
If the amount is less than 5% by weight, a sufficient lubricity
is not obtained. Even if the amount is 30% or more by weight,
the lubricity is not remarkably improved. On the other hand,
20 the amount of the added polyol ester(s) is preferably as small
as possible since the combustion heat of the polyol ester is
larger than that of the silicone liquid. Thus, the amount of
the polyol ester(s) is preferably 30% or less by weight, more
preferably 20% or less by weight.

25 The silicone liquid is preferably dimethylsilicone

represented by the formula (5), or methylphenylsilicone represented by the formula (6).

As the insulating medium 19, a medium having a flash point higher than 250°C is used. It is preferred that the flash point
5 of each of the silicone liquid and the polyol ester(s) to be mixed is higher than 250°C.

It is allowable to incorporate, into the insulating medium 19, an antioxidant, an acid trapping agent, an antifoamer, a metal inactivating agent, or the like. In each of Examples
10 1 to 5 and Comparative Examples 1 to 5, the insulating medium 19 used in the tap selector section is shown in Table 1.

Table 1

	Insulating medium in the tap selector section				Viscosity (mm ² /s) of the insulating medium at 40 °C	Volume resistivity (Ω·cm) of the insulating medium at 80°C	Flash point of the insulating medium (°C)	Lubricity
	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	95% by weight	Mixed branched-chain aliphatic esters A of pentaerythritol type Viscosity: 68.1 mm ² /s at 40°C	5% by weight				
Example 1	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	95% by weight	Mixed branched-chain aliphatic esters A of pentaerythritol type Viscosity: 68.1 mm ² /s at 40°C	5% by weight	16.0	4.2×10 ¹⁵	250<	Good
Example 2	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	90% by weight	Mixed branched-chain aliphatic esters A of pentaerythritol type Viscosity: 68.1 mm ² /s at 40°C	10% by weight	16.3	1.3×10 ¹⁵	250<	Good
Example 3	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	70% by weight	Mixed branched-chain aliphatic esters A of pentaerythritol type Viscosity: 68.1 mm ² /s at 40°C	30% by weight	20.7	2.6×10 ¹⁴	250<	Good
Example 4	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	90% by weight	Mixed branched-chain aliphatic esters B of neopentyl glycol type Viscosity: 15.1 mm ² /s at 40°C	10% by weight	14.8	9.0×10 ¹³	250<	Good

(to be continued)

Example 5	Dimethylsilicone liquid Viscosity: 50 mm ² /s at 25°C Flash point:>250°C	90% by weight	Mixed branched-chain aliphatic esters C of pentaerythritol type Viscosity: 30.2 mm ² /s at 40°C	10% by weight	30.6	1.2x10 ¹⁵	250<	Good
Comparative Example 1	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	100% by weight	-	-	14.8	1.2x10 ¹⁵	250<	Poor
Comparative Example 2	Dimethylsilicone liquid Viscosity: 50 mm ² /s at 25°C Flash point:>250°C	100% by weight	-	-	38.6	1.4x10 ¹⁵	250<	Poor
Comparative Example 3	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	95% by weight	Methyl ricinoleate	5% by weight	- Insoluble	-	-	-
Comparative Example 4	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	95% by weight	Mixed unsaturated aliphatic esters D of glycerin type Viscosity: 33.0 mm ² /s at 40°C	5% by weight	- Insoluble	-	-	-

It is understood that in each of Examples 1 to 5, the insulating medium used in the tap selector section had a flash point higher than 250°C and a volume resistivity of 1.0×10^{13} Ohm-cm or more so as to have a sufficient insulating property.

5 It is also understood that each of the insulating media had an excellent lubricity.

When a vacuum switch is used as the changeover switch section in the tap changer in the apparatus illustrated in Fig. 1, any arc and the cooling medium do not contact each other;

10 therefore, the vacuum switch has a structure wherein an arc from the changeover switch is generated in a vacuum inside the vacuum valve of the vacuum switch while no arc is generated outside the vacuum valve. Moreover, a silicone liquid is preferably used as the insulating/cooling medium enclosed in

15 the tank for receiving an induction device such as a transformer. However, a different insulating/cooling medium, such as mineral oil, may be used although the use is not preferred for incombustibility.

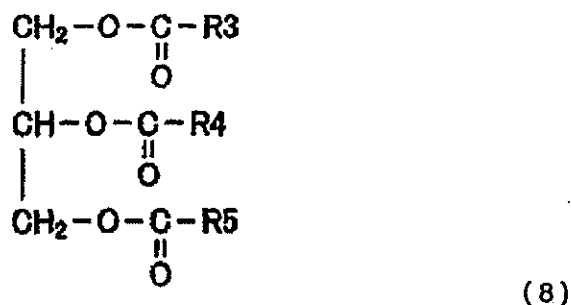
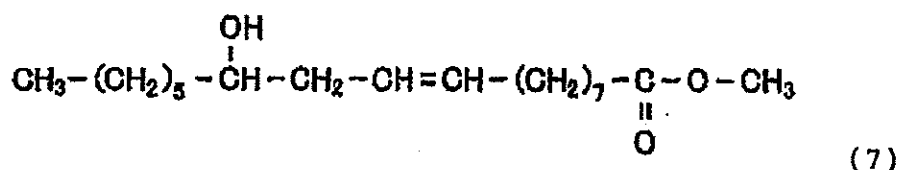
In Comparative Examples 1 and 2, two dimethylsilicone

20 liquids having viscosities different from each other were investigated as the insulating medium used in the tap selector section. The dimethylsilicone liquids did not give a sufficient lubricity although the liquids each had a flash point higher than 250°C and a volume resistivity of 1.0×10^{13} Ohm-cm

25 or more at 80°C.

In Comparative Examples 3 and 4, investigated were methyl ricinoleate, which is a linear aliphatic acid ester represented by a formula (7) illustrated below, and an aliphatic acid ester of glycerin represented by a formula (8) illustrated below.

5 Each of the esters was incorporated in an amount of 5% by weight of the whole of the insulating medium. However, methyl ricinoleate was dissolved in only an amount of 2% by weight. The entire amount (5% by weight) of the aliphatic acid ester of glycerin was not dissolved, either. Each of methyl
10 ricinoleate and the aliphatic acid ester of glycerin represented by the formula (8) was not dissolved up to 5% by weight in the insulating medium made mainly of the silicone liquid, and a sufficient lubricity was not obtained.



15 wherein R3, R4 and R5 are each an alkyl group having one or more carbon atoms.

As described above, by use of a vacuum switch as an on-load tap changer as illustrated in Fig. 1, arc is prevented from

being radiated in a medium therein, thereby making it possible to make the changer incombustible. Furthermore, by filling, as an insulating medium in its tap selector section, a silicone liquid into which one or more synthetic polyol esters represented by the formulae (1), (2), (3) and/or (4), wherein R1 represents hydrogen or an alkyl group having 1 to 3 carbon atoms and R2 represents one or more alkyl groups having 5 to 12 carbon atoms, are incorporated, the insulating property and the sliding characteristic required for the tap selector section are satisfied so that the fire retardancy of the on-load tap changer can be improved.

Examples 6 to 9:

In each of Examples 6 to 9, in the on-load tap changer attached transformer in Fig. 1, which is one example of the invention, a resistor type on-load tap changer using a current limiting resistor was used as the changeover switch section 17. The resistor type on-load tap changer is schematically illustrated in Fig. 3. In the resistor type on-load tap changer, an insulating medium 19a is used in the changeover switch section 17. In each of Examples 6 to 9, a polyol ester oil was used as an insulating medium in the tap selector section. Each insulating medium used in the tap selector section is shown in Table 2, and each insulating medium used in the changeover switch section is shown in Table 3.

Table 2

Insulating medium in the tap selector section					Viscosity (mm ² /s) of the insulating medium at 40 °C	Volume resistivity (Ω·cm) of the insulating medium at 80°C	Flash point of the insulating medium (°C)	Lubricity
Example 6	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	90% by weight	Mixed branched-chain aliphatic esters A of pentaerythritol type Viscosity: 68.1 mm ² /s at 40°C	10% by weight	16.3	1.3×10 ¹⁵	250<	Good
Example 7	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	90% by weight	Mixed branched-chain aliphatic esters B of neopentyl glycol type Viscosity: 15.1 mm ² /s at 40°C	10% by weight	14.8	9.0×10 ¹³	250<	Good
Example 8	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	90% by weight	Single branched-chain aliphatic acid ester E of trimethylolpropane type Viscosity: 16.1 mm ² /s at 40°C	10% by weight	14.9	1.3×10 ¹⁵	250<	Good
Example 9	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C Flash point:>250°C	90% by weight	Mixed branched-chain aliphatic esters F of neopentyl glycol type Viscosity: 15.8 mm ² /s at 40°C	10% by weight	14.9	1.4×10 ¹⁵	250<	Good

Table 3

	Insulating medium in the changeover switch section	Viscosity (mm ² /s) of the insulating medium at 40 °C	Volume resistivity ($\Omega \cdot \text{cm}$) of the insulating medium at 80°C	Flash point of the insulating medium (°C)
Example 6	Mixed branched-chain aliphatic esters A of pentaerythritol type	68.1	4.8×10^{13}	250<
Example 7	Mixed branched-chain aliphatic esters C of pentaerythritol type	30.2	1.0×10^{14}	250<
Example 8	Mixed branched-chain aliphatic esters A of pentaerythritol type	68.1	4.8×10^{13}	250<
Example 9	Mixed branched-chain aliphatic esters C of pentaerythritol type	30.2	1.0×10^{14}	250<

It is understood that in each of Examples 6 to 9, the insulating medium used in the tap selector section had a flash point higher than 250 °C and a volume resistivity of 1.0×10^{13} $\Omega \cdot \text{cm}$ or more so as to have a sufficient insulating property. It is also understood that each of the insulating media had an excellent lubricity.

It is also understood that in each of the same examples, the insulating medium used in the changeover switch section

had a flash point higher than 250°C and a volume resistivity of 1.0×10^{13} Ohm-cm or more so as to have a sufficient insulating property.

Example 10 and Comparative Examples 5 to 9:

The flammability of insulating media was evaluated by a cone calorimeter method. A radiated calorie of 50 kW/m² was applied to each of the insulating media. At this time, the maximum heat generation rate was measured. The measured results are shown in Table 4.

Table 4

	Insulating medium	Maximum heat generation rate (kW/m ²)
Example 10	Dimethylsilicone liquid/mixed branched-chain aliphatic acid esters A of pentaerythritol type =90wt%/10wt%	242
Comparative Example 5	Mineral oil	1410
Comparative Example 6	Dimethylsilicone liquid Viscosity: 20 mm ² /s at 25°C	230
Comparative Example 7	Dimethylsilicone liquid Viscosity: 50 mm ² /s at 25°C	203
Comparative Example 8	Mixed branched-chain aliphatic acid esters A of pentaerythritol type	770
Comparative Example 9	Mixed branched-chain aliphatic acid esters C of pentaerythritol type	744

It is understood that the maximum heat generation rate of synthetic polyol esters is lower than that of mineral oil

and the maximum heat generation rate of silicone liquids is even lower.

The result obtained by measuring the maximum heat generation rate of a system wherein mixed branched-chain aliphatic acid esters C of pentaerythritol type were added to a dimethyl silicone liquid so as to set the amount of the esters C to 10% by weight is also shown as an example in Table 4. It is understood that the maximum heat generation rate is very small, on which the fire retardancy of the dimethyl silicone liquid is reflected.

The maximum heat generation rate of synthetic polyol ester would hardly be varied in accordance with the species thereof; therefore, the maximum heat generation rate of a system wherein synthetic polyol ester is added to the silicone liquid would not be largely varied from the values in Table 4.

As described above, by filling, as an insulating medium in a tap selector section as illustrated in Fig. 1, a silicone liquid having a fire point higher than 250°C into which one or more synthetic polyol esters represented by the formulae (1), (2), (3) and/or (4), wherein R1 represents hydrogen or an alkyl group having 1 to 3 carbon atoms and R2 represents one or more alkyl groups having 5 to 12 carbon atoms, are incorporated, the insulating property and the sliding characteristic required for the tap selector section are satisfied so that the fire retardancy of the on-load tap changer

can be improved.

The invention is concerned with a
silicon-liquid-containing stationary induction apparatus
which has a on-load tap changer and contains a silicone liquid
5 as an insulating/cooling medium, and a technique for improving
the fire retardancy, the arc resistance and the sliding
characteristic of the apparatus. The invention is applicable
to an electrical apparatus using a silicone liquid, such as
a silicone-liquid-containing transformer.

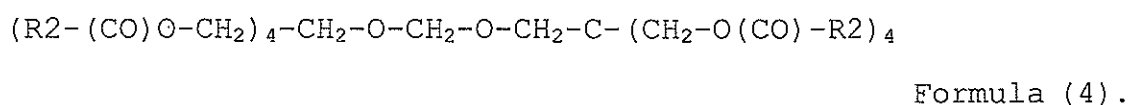
Claim 1

A stationary electric induction apparatus with an on-load tap changer comprising a tank, an electro-magnetic induction apparatus disposed in the tank together with a liquid insulating material having a flashing point higher than 250 °C, and an on-load tap changer for controlling a voltage of the electromagnetic induction apparatus, wherein the on-load tap changer comprises a tap switching section and a tap selector, characterized in that the liquid insulating material for at least the tap selector is a silicone liquid having a flashing point higher than 250 °C in which a synthetic polyol-ester having the flashing point higher than 250 °C is dissolved in an amount of 5 to 30 % by weight per the total weight of the liquid insulating material.

Claim 2

A stationary electric induction apparatus with an on-load tap changer comprising a tank, an electro-magnetic induction apparatus disposed in the tank together with a liquid insulating material having a flashing point higher than 250 °C, and an on-load tap changer for controlling a voltage of the electromagnetic induction apparatus, wherein the on-load tap changer comprises a tap switching section and a tap selector,

characterized in that the liquid insulating material for at least the tap selector is a silicone liquid having a flashing point higher than 250 °C in which a synthetic polyol-ester having a flashing point higher than 250 is dissolved in an amount of 5 to 30 % by weight per the total weight of the liquid insulating material, wherein the synthetic polyol-ester is at least one member selected from the group consisting of

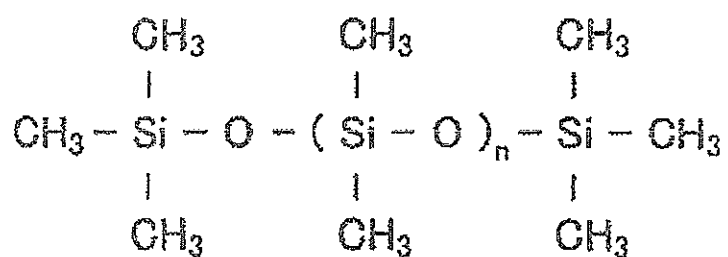


Claim 3

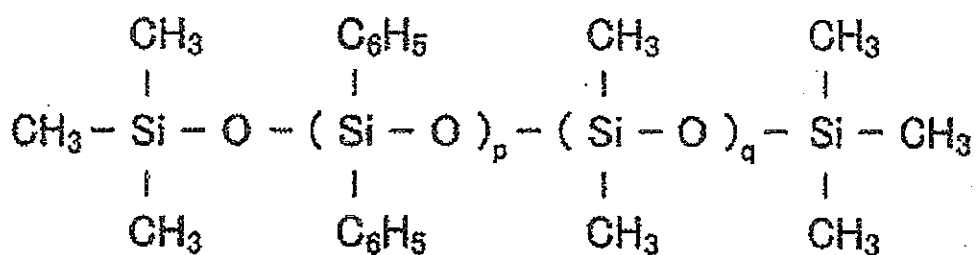
The stationary electric induction apparatus with the on-load tap changer according to claim 1 or 2, wherein the tap switching section is a vacuum switch.

Claim 4

The stationary electric induction apparatus with the on-load tap changer according to claim 1 or 2, wherein the silicone liquid is at least one member selected from the group consisting of formulae (5) and (6).



Formula (5)



Formula (6)

Claim 5

The stationary electric induction apparatus with the on-load tap changer according to claim 1 or 2, wherein the silicone liquid has a dynamic viscosity coefficient of 50 mm²/s at 25 °C.

Claim 6

The stationary electric induction apparatus with the on-load tap changer according to any one of claims 1 to 5, wherein an amount of the synthetic polyol-ester is 10 to 20 % by weight.