Comparison of short circuit current by difference of gap length between wall outlet and tracking resistance plug

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***Abstract* – A fire by tracking is generated occasionally in Japan. This problem is very serious. The cause of tracking is a dust of space between a wall outlet and a plug. Such fire occurs in the hidden wall outlet. Therefore, the determination of the fire, whether the fire occurs, is not so easy in the early stages.**

Recent, tracking resistance plug is used for preventing the fire in Japan. The experimental objective is to compare the short circuit current by the difference of the gap length between the wall outlet and the plug. It is possible that a fire occurs by the condition in gap length between the plug and the wall outlet. It is necessary to consider the short circuit current by different gap length between the wall outlet and the plug. Therefore, we have experimented by changing the gap between the wall outlet and the plug. Results, we will get the ways to reduce the accidents caused by tracking.

I. INTRODUCTION

Tracking [1], [2] is one of the causes of fire in a home [3], [4]. Dust is accumulated in plug that is plugged to a wall outlet. That portion is wetted by condensation and moisture. The part, which is between a wall outlet and plugs, collects a dust gradually when the cleaning does not carry out. If the part is wetted by condensation and moisture, a small short circuit current produces between the electrodes of the plug. By this, insulation part of the wall outlet and the plugs are carbonized gradually. Eventually, fire occurs cause insulation deterioration.

A fire by the tracking generated between a home wall outlet and plugs is often caused. Fire accident by tracking are caused of 50 cases every year in Tokyo. The fire accident does not decrease because we can not cleaning of the wall outlet and the plugs. The fire accident of tracking does not decrease because we can not easily cleaning of the wall outlet and plugs. Thus, there is some tracking resistance plugs for preventing the tracking. However, it is unclear whether to complete prevention of fire by using the tracking resistance plug.

We had been studying the tracking by pinching the dust between the wall outlet and the tracking resistance plug. And we have dropped ammonium chloride aqueous solution in this space. For this reason, it is needed for the study on the tracking to prevent the fire accident. However, when using the dust, a quantitative measurement is difficult because the components of the dust are different. Component of dust is often cotton. Therefore, we are using cotton instead of the dust.

Safety of tracking resistance plug is guaranteed by each institution study. However, actually of between wall outlet and tracking resistance plug in the home is not performed. In this paper, we use tracking resistance plug and 100V wall outlet. And we are using cotton instead of the dust. We have dropped a liquid having a constant conductivity there. In addition, we have measured the effective value of the current by varying the distance between the wall outlet and the tracking resistance plug. We report the results.

II. EXPERIMENTAL METHOD

Electrical resistivity use those that are standardized in the Japanese Industrial Standards (JISC2134). Ammonium chloride was dissolved into the purified water. And, ammonium chloride aqueous solution of 1.98(Ωm, 20℃) was generated. Fig. 1 shows the experimental circuit. The experimental circuit consists of constant voltage (100V), a wall outlet and plug, and an electrical load of 200W. The electrode between the wall outlet and plug is covered with cotton of 0.5 mg. Table 1 shows the properties of materials tested. Tracking resistance plug is installed the cap of insulation (see Fig. 2). If the load changes, then the current does not change. We use constant load (incandescent bulb 200W).

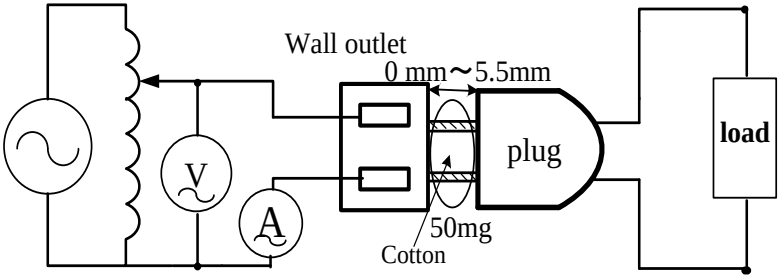

Fig.1 experimental circuit

Table 1. Properties of materials tested

	Wall outlet (Panasonic WK1012W)	Plug (Panasonic WH5515)	Insulation cap (SOFT HANDS Co. Ltd)
Material	Urea resin	Polyvinyl chloride	Nylon resin (Polyamide resin)
Heatproof temperature	About 80℃	About 70℃	-
Other	Normal insulating	Normal insulating	CTI: 600<

※CTI: Comparative Tracking Index

Fig. 3 shows the state of measurement. The wall outlet and the plug are installed perpendicular to the experiment desk. The plug is fitted “tracking resistance cap” of SOFT HANDS Co. We measured the short circuit current by changing the distance (0.00mm, 1.00mm, 2.00mm, 3.00mm, 4.00mm, 4.50mm 5.50mm) between the plug and wall outlet. And, we have dropped the ammonium chloride aqueous solution of about 0.04ml in the space of the gap length.

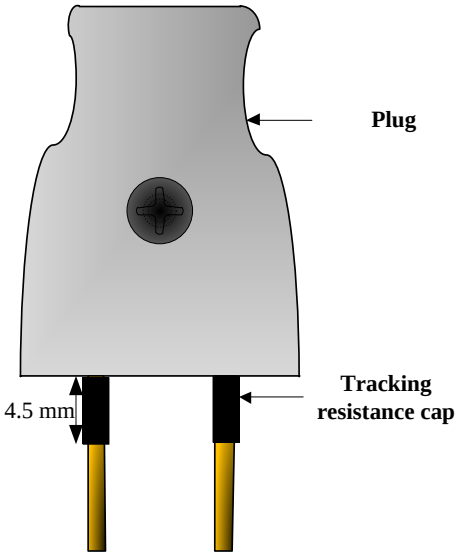

Fig.2 Tracking resistance plug

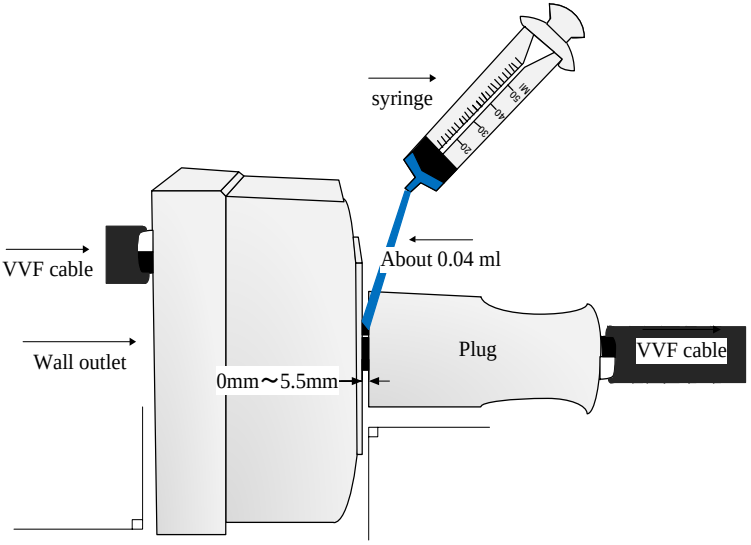

Fig.3 The representation of the experiment setup

III. Experimental Results And Discussion

a) The gap length *D* between a wall outlet and plug: 0 .00mm≦D <4.50 mm

Fig. 4 shows the wall outlet and the plug. The short circuit current does not occur in the gap length *D* of less than 4.5 mm. The reason is that the short circuit current does not occur because an electrode is covered with a tracking resistance cap.

Fig.4 Electrode part of the plug covered completely by the tracking resistance cap

b) The gap length *D*: 4.50 mm

Fig. 5 shows the result in the effective value of current when the ammonium chloride aqueous solution (1 drop, 0.04 ml) of electrical resistivity of 1.98 Ωm dropped in the gap. The effective value of current is 1.730 A when an experiment begins. The peak value of current is 1.814 A. The current keeps the value at a constant current of around 1.745 A after an approximately 148 s.

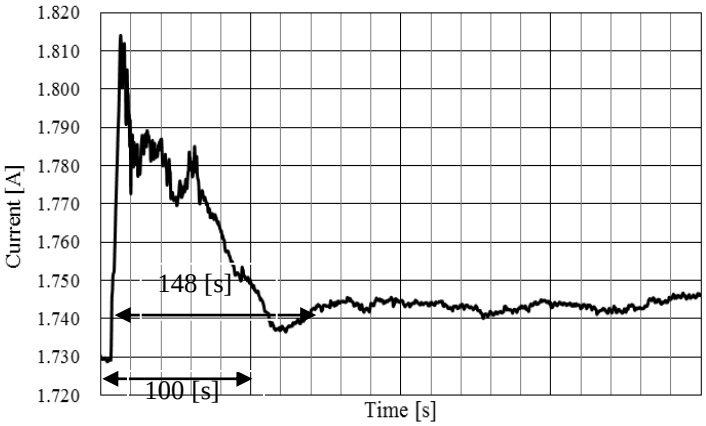

Fig.5 The effective value of the current in the gap length of 4.50 mm

c) The gap length *D*: 5.50 mm

Fig. 6 shows the result in the effective value of current when the ammonium chloride aqueous solution (1 drop, 0.04 ml) of electrical resistivity of 1.98 Ωm dropped in the gap. The effective value of current is 1.732 A when an experiment begins. The peak value of

current is 1.788 A. The current keeps the value at a constant current of around 1.729 A after an approximately 342 s. Table 2 shows the results of measured currents.

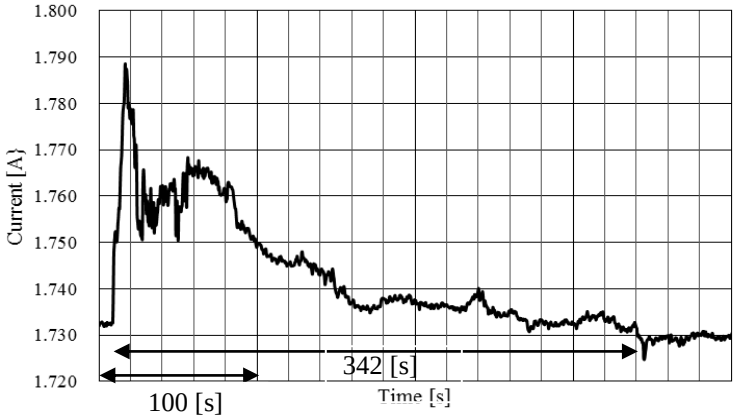

Fig.6 The effective value of the current in the gap length of 5.50 mm

Table.2 Comparison of changing the gap length

Gap length	Current before measurement [A]	Peak current [A]	Time of the short circuit current [s]
0.00mm<4.50mm	1.734	1.738	0
4.50mm	1.730	1.814	148
5.50mm	1.732	1.788	329

The results show the peak value of current becomes smaller as exposed portion of the electrode is small. Also, we could see that the exposed portion of the electrode is increased, the peak value of the current is lower, however duration time of the short circuit current becomes longer. The part when the short circuit current occurs rusts. However, we cannot see the carbonization and the breakdown of an insulated part of plug.

IV. CONCLUSION

We clear the following characteristics of current when a liquid of constant resistivity dropped in a gap length with cotton between a wall outlet and plug.

a) The solution of dust and water becomes characteristics of conductivity.
b) The short circuit current does not occur in the gap length of less than 4.5 mm
c) The short circuit current a part of exposed electrode in the range of 0 mm to 0.05 mm becomes the largest current. The current decreases as the part increases.
d) If a wet cotton exists between the wall outlet and plug, a value of the current is independent of an electrical load.

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