

PATENT SPECIFICATION

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(54) COCKROACH TRAP

(71) We, DAINIPPON JOCHUGIKU KABUSHIKI KAISHA, a corporation duly organized under the laws of Japan, of 11 2-chome, Tosaboridori, Nishi-ku, Osaka-shi Osaka-Fu, Japan, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a cockroach trap. Various types of traps have been proposed for capturing cockroaches. However, such traps are designed to capture the cockroaches alive without using any insecticide, so that troublesome problems of disposal of the captured cockroaches are incurred. The capture rates is also low because, in such proposed systems, the cockroaches must force open an entrance door of the trap by their own efforts in order to enter the trap. To solve these problems, there has been proposed to provide a trap in which an adhesive is spread inside a box-like pasteboard structure in the manner of flypaper.

However, it is found that, in the case of cockroaches which differ from flies in many respects, it is difficult to obtain satisfactory results by merely applying an adhesive on the flat base or ground paper. That is, cockroaches are far larger in size than flies, and also, they crawl with the aid of feelers, so that if an adhesive layer is present in front of them, they quickly sense it by their feelers, and even if their feelers or forelimbs should be caught by the adhesive, they can escape by their own strength.

In order to overcome such problems, various proposals have been made, such as employing a strong adhesive, thickening the layer of adhesive, or mixing an insecticide in the adhesive. Nevertheless, none of these proposals has succeeded in obtaining satisfactory results in practical applications.

An object of the present invention is to provide an improved cockroach trap.

According to the present invention, there is provided a cockroach trap comprising a housing having a base and side walls surround-

ing the base, at least one opening in the side walls through which cockroaches can enter said housing in use, the or each opening having sides forming a vertex which is disposed adjacent and directed towards said base, which sides include an angle of 30° to 60°, and an adhesive layer on a surface of the base which is inside the housing.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of one form of cockroach trap according to the present invention,

Figure 2 is a side view thereof of the trap of Figure 1,

Figures 3 to 7 are diagrams showing examples of openings for a cockroach trap according to the present invention,

Figures 8 and 9 are side views of trap walls formed with sesame-seed-sized cockroach entrances together with triangular openings,

Figure 10 is a perspective view showing an example of a trapping plate for use in the cockroach trap of Figures 1 and 2,

Figure 11 is a perspective view, with parts broken away, showing another example of trapping plate,

Figure 12 is a perspective view of another form of cockroach trap according to the present invention,

Figure 13 is a horizontal sectional view taken along the line X—X of Fig. 12,

Figure 14 is a developed view of the structure of Fig. 12,

Figures 15a to 15d show views of various configurations of entrance opening, and

Figure 16 is an enlarged sectional view of a base or ground paper, having a rough surface, for use in a cockroach trap according to the present invention.

It has been often observed that the cockroach allured by a lure would approach the adhesive-spread area, but knowing the presence of the adhesive by its feelers, it would escape. The present inventor has made careful observation of the behaviour of the cockroaches

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which were allured to the trap, and has found that most of the cockroaches which approached the adhesive made their escape even though they had had their feelers and/or forelimbs caught by the adhesive, and that when escaping they did not move backwards but turned their body round to escape. The inventor concluded that, if the trap were to be so constructed that they could not turn round they would have no other alternative but to advance and would necessarily be caught by the adhesive.

Based on these findings, the present inventor has provided openings, or cockroach entrances, of a specific configuration in the side walls of the trap and examined the effect thereof. Unexpectedly excellent results were obtained.

Referring now to Figs. 1 and 2 of the drawings the cockroach trap comprises a housing 1 of the trap having openings or cut-outs 2 (designed to serve as cockroach entrances) in side walls thereof, a layer of adhesive 3 on a base of the housing, and a lure 4. Each opening 2 takes the general form of an inverted triangle having an apical angle of θ . In this particular embodiment, the triangle is truncated to provide a width a at the bottom of the opening which coincides with the base of the housing 1.

The high cockroach capturing ability of the trap provided with the above said entrances is due to the fact that, once the cockroach knows the presence of the adhesive, it is already in a position where it can no longer move back. The angle θ of each opening 2 is from 30 to 60 degrees and the distance a is less than 5 mm. The adhesive layer 3 is arranged so that the horizontal distance b (see Fig. 2) between each opening 2 and an adjacent edge of the adhesive layer 3 is less than 10 mm.

Alternative forms of opening are illustrated in Figs. 3 to 7. In each case the opening is generally in the form of an inverted triangle, i.e. having an apex thereof disposed adjacent and directed towards the base of the housing, the apical angle θ of the triangle being 30° to 60°. The opening shown in Fig. 3 is in the exact form of an inverted triangle. In Fig. 4, the triangle is truncated so that sides thereof are mutually spaced by a distance a where they meet the base. In Fig. 5, the opening is shaped such that the sides of the triangle are stepped; in Fig. 6 the sides of the triangle are mutually convex; and in Fig. 7 the sides of the triangle are mutually concave. When shown in these Figures, the dimension a is less than 5 mm.

Most cockroaches can be captured by a trap of the type described above, but in the case of undersized cockroaches or croton bugs which are the same size as a sesame seed or adzuki bean, they cannot escape if a feeler or a forelimb touches even lightly with the adhesive because they are relatively weak in bodily strength, so that by providing openings 5 of

any suitable shape, such as circular, triangular, polygonal or rectangular (see Figs. 8 and 9) along with the above said openings 2 of specific configuration in each side wall of the trap, it is possible to capture all sorts of cockroaches irrespective of bodily size. One or more openings 2 may be provided in each side wall of the housing 1. If the lure 4 is placed in the centre of the adhesive layer, the capturing effect is enhanced. The adhesive 3 may be applied beforehand on a base sheet and covered with protective paper which is removed just before using the trap. The base paper coated with adhesive may be replaced as required. Alternatively, the adhesive may be contained in a tube so that it is spread on the base sheet just before use. In this event, the base paper may be cardboard or plastics sheet, and its surface is preferably rough to allow a relatively generous application of adhesive.

In the cockroach trap, it is most preferable, for convenience in use, to cover the adhesive surface with protective paper and to remove such protective paper at the time of use. However, in the case where the base sheet on which the adhesive is spread is made of cardboard or plastics sheet, it is technically difficult to employ such a protective paper method. This is because the adhesive is a viscous liquid which has the properties that while showing unyielding resistance when sudden strong force is applied, it tends to flow easily when a weak force is continuously applied. Therefore, if the base sheet is made of cardboard or other thick paper, the adhesive may, in time, soak through the base sheet; whilst, in the case of a flat impermeable sheet such as plastic sheet, if a thick layer of adhesive is applied thereon and covered with protective paper and such assembly is left as it is for a long time, the adhesive could flow out from between the base sheet and protective paper. Thus, the use of protective paper imposes certain restrictions on the amount and thickness of the adhesive that can be applied, and within such limited range of amount and thickness of the adhesive, it is difficult to capture the cockroaches efficiently.

As a result of many studies and experiments, this inventor has found that a closed cell, synthetic resin plate is best suited for use as the base sheet for the adhesive. Open-cell synthetic resin, such as open cell foamed polyurethane, which is widely used as a construction material or a heat insulator, is not suitable as the material of construction of the base sheet as the adhesive penetrates into the open cell structure of such resin with the result that its adhesive power is impaired.

A suitable closed cell synthetic resin plate is made by foaming urea resin, polyethylene, styrene or like resin. Its excellent pliability permits efficient retention of cockroaches by the adhesive so that, once captured, the cockroaches cannot escape. Also, when using such

a closed cell synthetic resin plate, the amount of adhesive required for effective cockroach capturing can be halved as compared with the case of using pasteboard or the like as the base sheet as described below in Test Example 3. Furthermore, the adhesive will not effuse during storage or use because of the good affinity between the closed cell synthetic resin and the adhesive.

The cockroach trap may be made by first forming the body 1 of the trap by using a polystyrene sheet as the closed cellular synthetic resin plate and then applying an adhesive over the bottom of the body 1. It is also possible to prepare separately a replaceable capturing plate such as shown in Figs. 10 and 11 and then locate it in the trap body 1. In the case of Fig. 10, an adhesive 3 is spread over the surface of a synthetic resin plate having closed cells therein and a protective paper 7 is placed thereover to thereby form a capturing plate, and at the time of use, said protective paper 7 is removed and the plate with the exposed adhesive layer thereon is placed in the trap body 1. In the embodiment of Fig. 11, a backing sheet 8 such as kraft paper, cardboard or synthetic resin sheet is further laminated to the reverse side of the closed cellular synthetic resin plate 6 of Fig. 10. The effect of such closed cellular synthetic resin plate as a base is described in Test Example 3 described hereinafter.

The adhesive may be composed mainly of such material as natural rubber, synthetic resin or vinyl acetate or which may be used either singly or in admixture with addition of a minor proportion of tackifier, plasticiser and anti-ageing agent. A cockroach capturing plate may be made by applying an adhesive to a closed cellular synthetic resin plate either directly or through transfer from the protective paper, then applying thereon a sheet of protective paper so as to cover the entire surface of the adhesive, and finally cutting the plate into a desired size and shape.

Referring now to Figs. 12 and 13, a hollow trigonal pyramid-shaped trap body 1 was formed with vertical end faces 11 and sloping side faces 12 inclined at an angle of 25 to 35 degrees relative to a base 13 of the body 1, i.e. relative to the horizontal, as viewed in Fig. 12. Then triangular openings or cockroach entrances 2, 2' having apices with an included angle of 30 to 60 degrees were formed in each of said faces at locations close to the base edge, and an adhesive was spread over the entire surface of the base 13 including the parts immediately below the lowermost apices of said triangular entrances 2, 2' with a lure 4 being placed at the centre of said bottom plate 13 (see Fig. 13).

In this embodiment, a cockroach, attracted by scent of the lure, crawls up the wall of the end face 11 or side face 12 and tries to enter the trap via a suitably wide portion of

one of the triangular openings 2, 2' where the body of the cockroach can pass, but since each end face 11 rises vertically and each side face 12 is inclined relative to the horizontal, the cockroach's feelers for sensing an object ahead cannot touch the base 13, and hence the cockroach tries to move further into the trap from the opening until its feelers or forelimbs reach the bottom to feel for the object. However, as soon as the feelers or forelimbs touch the bottom, they are stuck up by the adhesive on the bottom, so it attempts to escape by rapidly turning back, but as such turn of the body is obstructed by both edges of the equilateral triangular opening, the cockroach is obliged to advance, resulting in all of its limbs sticking to the adhesive. Thus, the cockroach becomes unable to move at all and is captured.

As described above, the cockroach trap according to the present invention is provided with openings or cockroach entrances in all of the four sides of the trap, so that it can be set at any place and in any direction. Also, since each of such openings is provided close to the edge of the bottom plate and has an apical angle of 30 to 60 degrees, it is possible to capture cockroaches of all sizes. The present device therefore can produce far higher practical effect than any of the known types of cockroach traps.

The most important feature of the present device is the provision of triangular or otherwise angularly configured openings 2, 2' close to the edge of the bottom plate such that the interior angle of the vertex of the isosceles is 30 to 60 degrees. Although the inverted equilateral triangular entrances are provided in the embodiments of Figs. 12 and 14, the part of the opening other than the lowermost vertex portion can take any shape as exemplified in Fig. 15a, b, c and d, provided that said vertex has the above-defined interior angle. Provision of said openings close to the bottom edge and selection of the above-defined interior angle of the vertex are intended to permit easy entrance of small-sized cockroaches. Large-sized cockroaches are supposed to creep into the trap from the wider space at the upper part of the opening. The inclination of the sides 12 is intended to facilitate the entrance of the cockroaches into the trap when it is set adjacent a wall or vertically extending structure. But problems occur when the trap is set with one of its vertical end faces 11 facing a wall or like vertically extending structure, and it is desirable to provide a roof 16 which overhangs the vertical end faces 11 and the overhanging portions stop short of the base of the body 1 so that, even if one of the end faces 11 is placed facing the wall, a sufficient space is formed between said end face and wall to allow the cockroaches to pass therethrough and enter the trap from one of the entrances 2.

The cockroach trap of the present invention can be made from paper or plastics sheet. In

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the case of a paper sheet it is preferable to cut such paper sheet to form a pattern such as shown in Fig. 14 so that the user can easily form the trap by bending and applying a pressure-sensitive adhesive to the joined parts. The present device can be also embodied in the form of a hollow pyramid, such as a triangular or quadrangular pyramid. It is preferred that the trap is provided with a roof, but the cockroach capturing efficiency of the present device is not affected if the roof is omitted.

In order to show the effect of the trap device, the following test examples are given.

Text Example 1.

50 imagines and 50 larvae of the smoky-brown cockroach were freed in an about 12 m² area room shut off from external light, and one hour later, 20 different types of traps having cockroach entrances (openings) with different values of a and θ in Fig. 1 but all having a zero value of b (Fig. 2), which were divided into five groups (each group comprising the traps with the same value of θ and assigned as one experimental unit), were set simultaneously in said room. This experiment was repeated five times, and the number of cockroaches captured was counted.

TABLE 1

a	θ	Angle			
		20°	30°	60°	80°
Length of the base of entrance	0mm	46	93	99	68
	3	58	108	106	69
	5	42	97	98	52
	7	33	72	68	36
	10	40	31	39	30

It was observed that if a is larger than 5 mm, there were many cockroaches who turned back at the entrance, and that if θ is either smaller than 30° or greater than 60°, the number of cockroaches captured was markedly reduced. These facts show that the best results are obtained when a is smaller than 5 mm and θ is from 30 to 60°.

Test Example 2.

Four different types of traps having cockroach entrances (openings) with constant values of a and θ ($\theta=60^\circ$) and $a=3$ mm, with which good results were obtained) but varied in the value of b were set in the same room as used in Test Example 1. This experiment was repeated five times, and the number of cockroach captured in each trap was counted.

TABLE 2

b	Number of experiments conducted					Total
	1	2	3	4	5	
0mm	20	19	21	17	18	95
.5	18	22	20	19	23	102
10	17	19	23	13	15	87
15	6	6	11	9	2	36

The catch was few when b was 15 mm. This is probably because the cockroaches, particularly the small-sized ones, which have once entered the trap, turned back without advancing toward the adhesive. For best results, therefore, b should be less than 10 mm.

Test Example 3.

Tests were conducted by using adhesive covered paper sheet or pasteboard (A) and adhesive covered, closed cellular synthetic resin plate (B).

50 imagines and 50 larvae of smoky-brown

cockroach were freed in an about 12 m² area room shut off from external light, and one hour later, the cockroach capturing sheets A and B were set at the same distance from the room wall and at equal intervals from each other. These plates were left in said room for one night, and the number of cockroaches captured by the respective plates was counted. This test was repeated five times.

10 Capturing paper sheet A

An adhesive was applied in an amount of 4 or 8 grams on a 13 cm square paper

sheet, and 1 gram of lure was placed in its centre.

Capturing plate B

The same adhesive as was used on capturing sheet A was applied in an amount of 4 grams on each plate made by laminating a 2 mm thick closed cellular polyethylene sheet (same dimensions as the paper sheet), to a 13 cm square paper sheet, and 1 gram of lure was placed in the centre of the plate.

TABLE 3

	Capturing paper sheets A		Capturing plate B
	4g	8g	4g
1	2	7	8
2	1	6	4
3	3	15	18
4	2	6	9
5	0	10	9
Total	8	44	48

25 The capturing plates B applied with 4 grams of adhesive gave results well comparable with those of the capturing paper sheets A applied with 8 grams of adhesive. The capturing paper sheets A applied with 4 grams of adhesive were so poor in tackiness that the cockroaches could escape.

30 These results show that the amount of adhesive required when using a closed cellular polyethylene sheet can be halved as compared with that required when using conventional cardboard.

Test Example 4.

40 Stability and cockroach capturing rates of the capturing plates prepared by applying an adhesive in an amount of 2 grams, 4 grams and 8 grams, respectively, on the surfaces of the square bases with 13 cm side length were measured.

45 Stability was determined by measuring the distance of displacement or shift of the protective paper which was placed on the adhesive layer and then set on a 30°-gradient slant plate for 24 hours under static load of 30

g/cm². The cockroach capturing rates were determined in the same way as Test Example 3.

About 1 gram of lure was placed in the centre of each plate, and the test was repeated 5 times.

The base sheet base used was as described below, and a vinyl resin was used as adhesive.

Capturing plates A:

Polyvinyl chloride plate with a rough surface (see Fig. 16 where *h* indicates coating thickness and 6' shows polyvinyl chloride plate)

Capturing plates B:

Polyvinyl chloride plate with a smooth surface

Capturing plates C:

Cardboard

Stability is shown in Table 4 and the capturing rates in Table 5 below. (The results in these tables are the averages of 5 tests).

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TABLE 4

Capturing plate	Displacement (mm) in each amount of adhesive		
	2g	4g	8g
A	0	0	0
B	5 mm	18 mm	27 mm
C	0	4 mm	19 mm

TABLE 5

Capturing plate	Number of roaches captured in each amount of adhesive		
	2g	4g	8g
A	3.6	9.6	10.2
B	3.5	8.8	8.7
C	0.2	1.6	8.8

As apparent from the results of Tables 4 and 5, the capturing plates with a smooth surface were poor in stability, and in the case of the capturing plates using cardboard, if the adhesive is applied thick enough to obtain satisfactory capturing rate, the stability is worsened. Also, in such cardboard capturing plates, adhesive could permeate through to the underside of the plate. In contrast with this, the base sheet with a rough surface showed excellent results both in stability and in capturing rate.

WHAT WE CLAIM IS:—

1. A cockroach trap comprising a housing having a base and side walls surrounding the base, at least one opening in the sidewalls through which cockroaches can enter said housing in use, the or each opening having sides forming a vertex which is disposed adjacent and directed towards said base, which sides include an angle of 30° to 60°, and an adhesive layer on a surface of the base which is inside the housing.

2. A cockroach trap as claimed in claim 1, wherein the base is square in shape and is surrounded by two pairs of opposed side walls, the side walls of one pair each being substantially in the form of an isosceles triangle and extending perpendicularly from said base, the side walls of the other pair each being inclined at an acute angle to said base.

3. A cockroach trap as claimed in claim 2, wherein at least one opening is provided in each inclined side wall.

4. A cockroach trap is claimed in claim 2

or 3 wherein each inclined wall has a portion which overhangs each perpendicular wall.

5. A cockroach trap as claimed in claim 1, wherein each side wall extends perpendicularly from said base.

6. A cockroach trap as claimed in any preceding claim, wherein the or each opening is generally in the form of a triangle.

7. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said triangle is truncated and said sides of said opening are spaced apart at said base.

8. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said sides thereof are each stepped.

9. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said sides thereof are mutually concave.

10. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said sides thereof are mutually convex.

11. A cockroach trap as claimed in any preceding claim wherein said adhesive layer comprises a replaceable sheet on said inside surface of the base, said sheet having adhesive on a surface thereof which faces away from the base.

12. A cockroach trap as claimed in claim 11 wherein said replaceable sheet is formed of a closed cell synthetic resin.

13. A cockroach trap as claimed in claim 11 or 12 wherein said replaceable sheet has a rough surface.

14. A cockroach trap as claimed in any preceding claim, wherein each opening has a width of less than 5 mm. at the level of said base.

TABLE 4

Capturing plate	Displacement (mm) in each amount of adhesive		
	2g	4g	8g
A	0	0	0
B	5 mm	18 mm	27 mm
C	0	4 mm	19 mm

TABLE 5

Capturing plate	Number of roaches captured in each amount of adhesive		
	2g	4g	8g
A	3.6	9.6	10.2
B	3.5	8.8	8.7
C	0.2	1.6	8.8

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2. A cockroach trap as claimed in claim 1, wherein the base is square in shape and is surrounded by two pairs of opposed side walls, the side walls of one pair each being substantially in the form of an isosceles triangle and extending perpendicularly from said base, the side walls of the other pair each being inclined at an acute angle to said base.

3. A cockroach trap as claimed in claim 2, wherein at least one opening is provided in each inclined side wall.

4. A cockroach trap is claimed in claim 2

or 3 wherein each inclined wall has a portion which overhangs each perpendicular wall.

5. A cockroach trap as claimed in claim 1, wherein each side wall extends perpendicularly from said base.

6. A cockroach trap as claimed in any preceding claim, wherein the or each opening is generally in the form of a triangle.

7. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said triangle is truncated and said sides of said opening are spaced apart at said base.

8. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said sides thereof are each stepped.

9. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said sides thereof are mutually concave.

10. A cockroach trap as claimed in claim 6 wherein the or each opening is shaped so that said sides thereof are mutually convex.

11. A cockroach trap as claimed in any preceding claim wherein said adhesive layer comprises a replaceable sheet on said inside surface of the base, said sheet having adhesive on a surface thereof which faces away from the base.

12. A cockroach trap as claimed in claim 11 wherein said replaceable sheet is formed of a closed cell synthetic resin.

13. A cockroach trap as claimed in claim 11 or 12 wherein said replaceable sheet has a rough surface.

14. A cockroach trap as claimed in any preceding claim, wherein each opening has a width of less than 5 mm. at the level of said base.

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5 15. A cockroach trap as claimed in any preceding claim, wherein the distance between the or each opening and an adjacent edge of said adhesive layer, as measured parallel to the base, is less than 10 mm.

16. A cockroach trap as claimed in any preceding claim, wherein said adhesive layer is covered with a protective sheet which is removed before use of the trap.

10 17. A cockroach trap as claimed in any preceding claim wherein the base and the side walls are folded to shape from a cardboard synthetic paper or polystyrene sheet.

18. A cockroach trap substantially as hereinbefore described with reference to Figures 1 and 2 or Figures 12 to 14 and modifications thereof in Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 15a, Figure 15b, Figure 15c, Figure 15d, or Figure 16 of the accompanying drawings. 15 20

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