CAR-TOP INSECT TRAP WITH TERMINAL CAGE IN AUTO

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The multiple funnel-trap described below was developed to obtain information on biting fly activity and to double check the species attractability of stationary mosquito traps being used in Alaska. Several species not attracted to the stationary traps were captured in this mobile unit, along with males, unfed, engorged, and gravid females and, of course, other insects.

The vehicle was driven at a speed of 25 m.p.h. when trapping, but further experimentation and modification might produce a trap that would function properly at faster speeds. In daylight the driver-trapper could see what was being caught, when and where, because the insects were diverted from their flight path into a small cage attached to the sunshade inside the vehicle. The cage could be exchanged conveniently as desired, usually at 15 minute intervals during the peak of activity. The funnel in the cage bottom was plugged with cotton, and the cage of insects then placed in a cardboard carton containing a layer of freshly-pulled grass. Each carton accommodated six cages. During trapping and transportation to the laboratory the insects survived in excellent condition in this dark, damp environment.

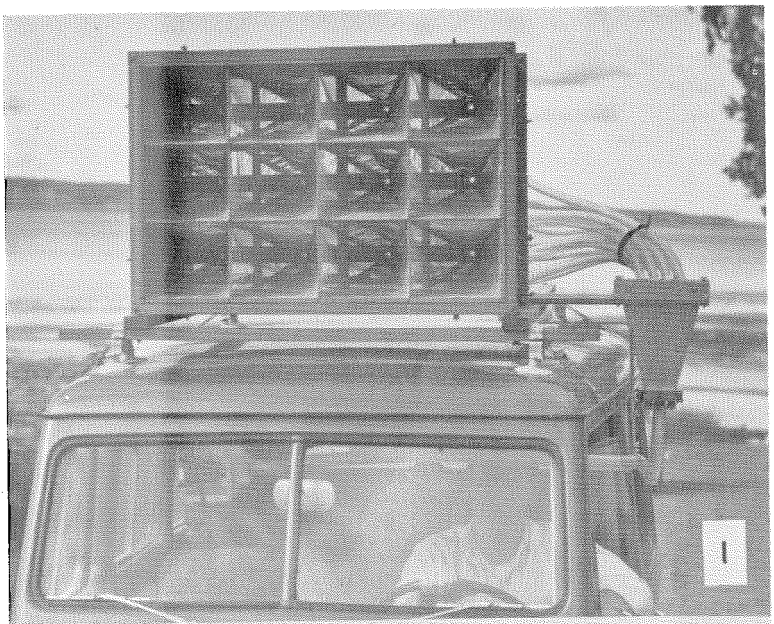
The general features of the complete trap ready for operation are shown in Figures 1, 2 and 3. The trap consists of two portable sections, a collecting unit and a conducting unit, both mounted on a base frame. There are also one or two dozen small cages in cardboard cartons. The collecting unit is the open box-like structure containing 12 rectangular funnels as shown in Figure 1. The conducting unit consists of a concentrating funnel (shown on the driver's left in Figures 1 and 2) with 12 flexible entrance tubes at the top and single flexible exit tube at the bottom. The exit tube, supported by a flat metal holder outside the left window, extends through the wind vane into the automobile as shown in Figure 3.

The base frame, which supports the trap, consists of two pieces of wood bolted lengthwise to the cross pieces of a conventional car-top carrier, best shown in rear view, Figure 4. This frame was left on the vehicle throughout the trapping season.

Installation of the trap requires no alteration of the automobile; one person can install it on the base frame in less than a half hour. The collecting unit and board supporting the conducting unit are each attached to the base frame with four bolts. The two units are then joined by slipping three beams containing the 12 entrance tubes, Figure 2, into aluminum sleeves on each side at the rear of the collecting unit, Figure 4, and tightening six wing nuts. The flat metal holder containing the exit tube is then attached to the base frame with two bolts as shown in Figure 1. Three rubber bands on the exit tube are slipped over the left sunshade; then a cage is inserted in the cage holder under the double loop of ribbon elastic; and the single loop of ribbon elastic on the right sunshade is slipped over the cage as shown in Figure 3, keeping the cage and holder in place on the sunshade.

This trap was designed to be light enough for handling by one person, yet sturdy enough to withstand rough roads. With the exception of the flexible tubing, the trap was built from materials readily available. Both the weight and expense of the trap might be reduced by mounting the concentrating funnel horizontally on top of the base frame, centering it behind the collecting unit, thereby reducing the length of entrance tubing needed, while increasing the length of the exit tube by only a few feet.

The collecting unit was originally con-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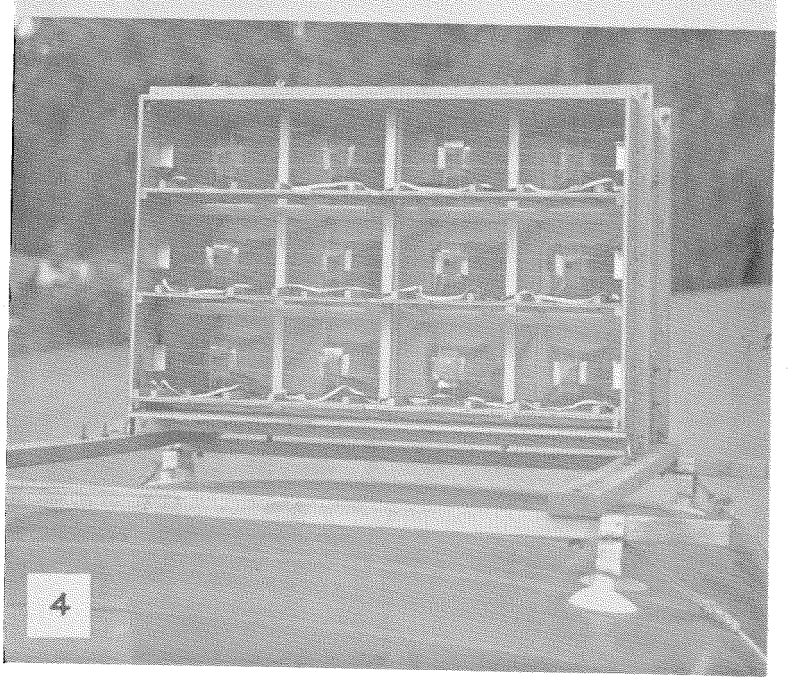
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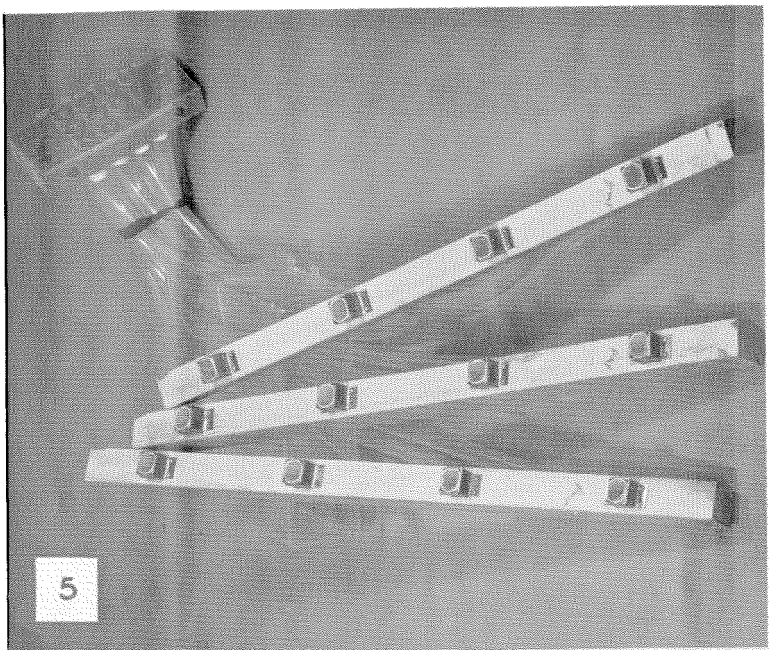
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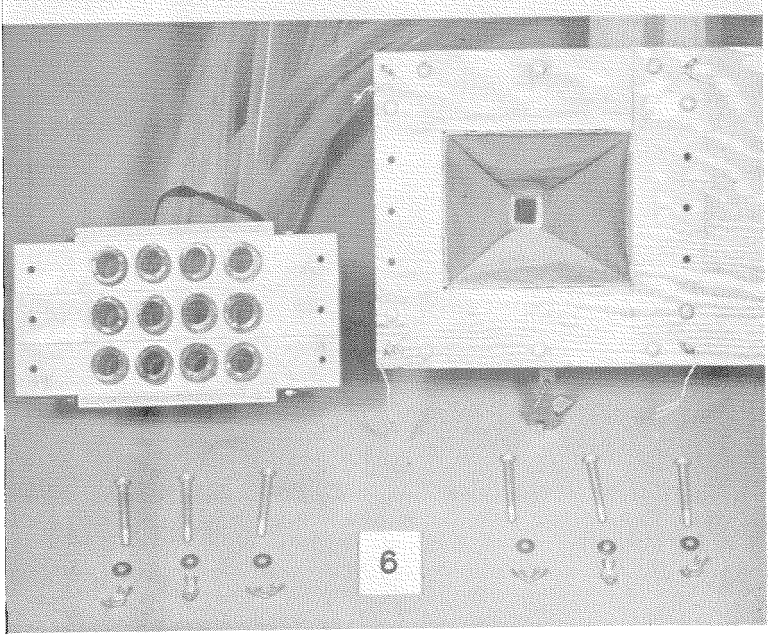
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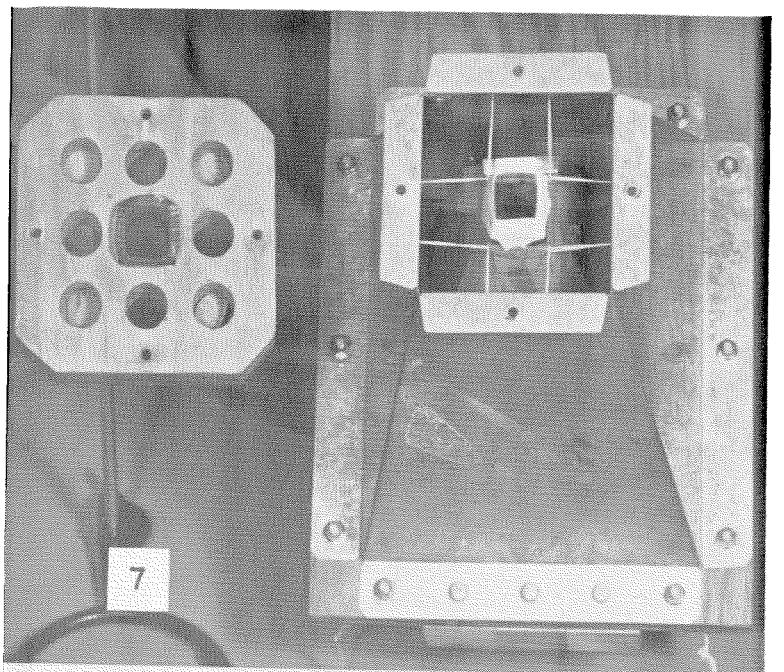
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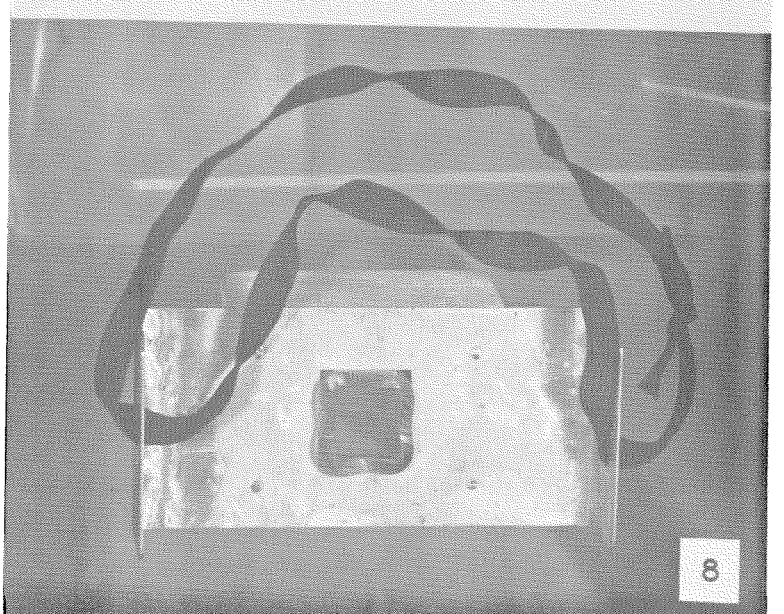
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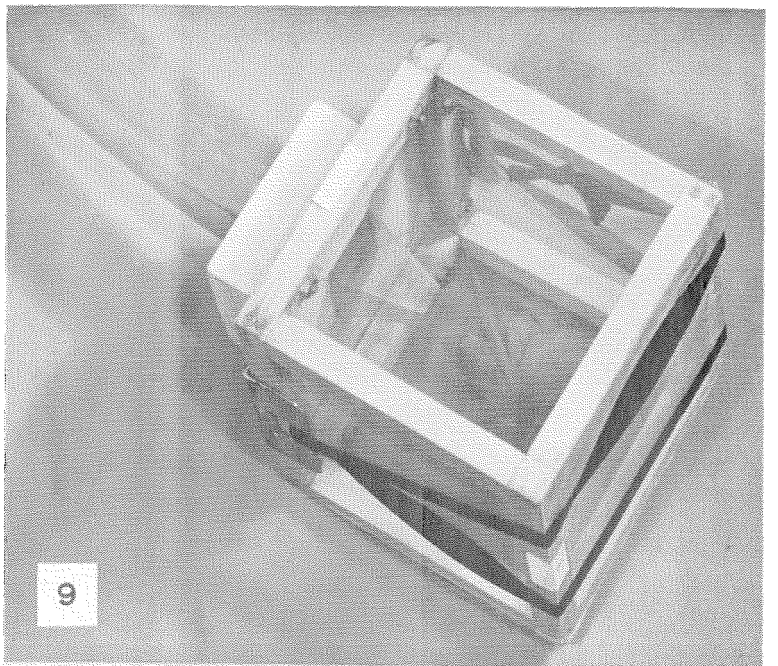
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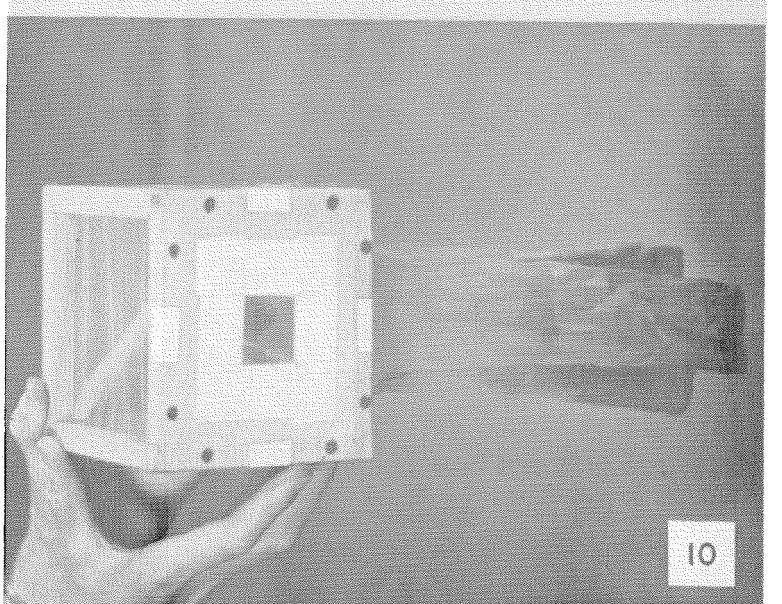
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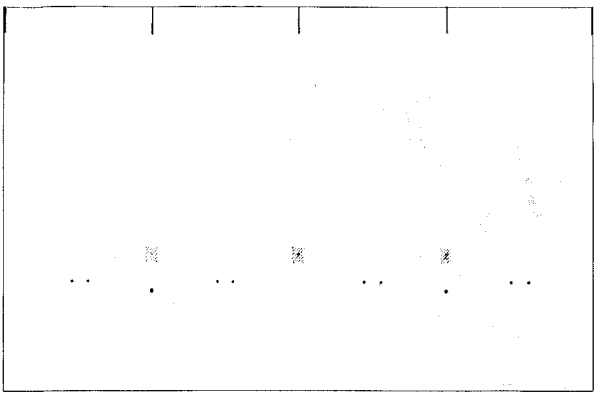

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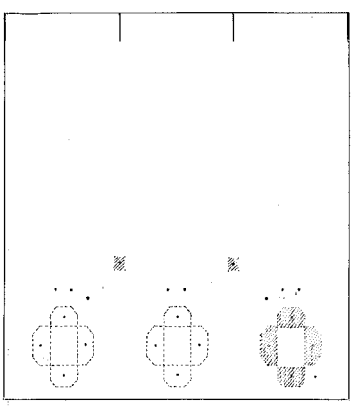

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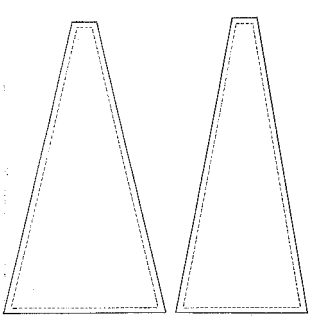

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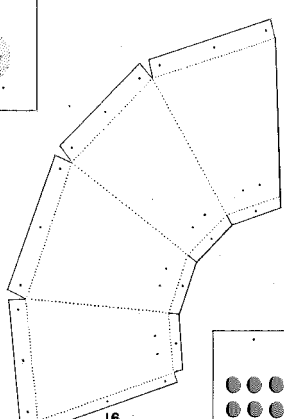

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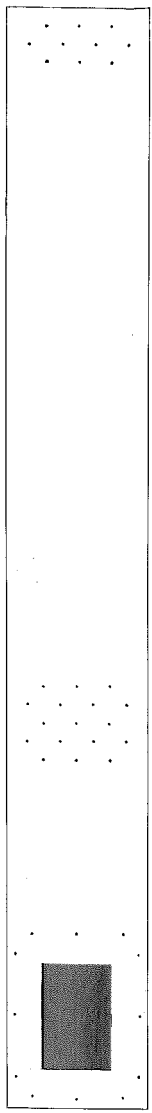

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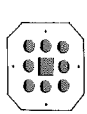

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structed to accommodate 12 small cages, one at the back of each funnel, and these cages were changed at hourly intervals at the peak of activity. The trap was later modified by addition of the conducting unit to provide more specific collecting data. The three shelves and ribbon elastic that held the cages in place were left intact as shown in Figure 4, in case the conducting unit did not function as anticipated. These shelves with their center supports, and the front external reinforcing frame, all present in the photographs, were removed from the modified trap, and are omitted from the description.

Figures 4 through 19 show the details of the trap and patterns. The materials and procedures used during the construction of this trap, and the specifications of the parts, follow.

The base frame consisted of two pieces of wood 54″ x 2″ x 1″ with bolt holes for attachment to the car-top carrier and to the trap.

The collecting unit was supported by four L-shaped iron legs extending 1¼″, and bolted to the sides of the shell as indicated in Figure 12. These legs were 1″ x ⅛″ x 5½″ with feet 1¼″ that contained a bolt hole for attachment to the base frame.

The shell of the collecting unit was made of ⅜″ plywood, with top and bottom overlapping the two sides. The finished *inside* measurements were 36″ x 21″ x 21″ as indicated in Figures 11 and 12. Internal reinforcement consisted of four pieces of angle aluminum ⅝″ x 3/32″ x 18″, which extended along the seams to within an inch of the rear margin and within 2 inches of the front margin. These were held in place by five screws along each side of each angle. As shown in Figure 4, there were also two horizontal and three vertical internal wooden reinforcements ¾″ square with lapped joints. These were placed so that the front margin was 13¼″ from the front of the shell as indicated in Figures 11 and 12. External reinforcement consisted of a quadrangular wooden frame 1″ x 1″ fitted around the shell. Its lapped joints had a bolt hole through the center. As shown in Figures 4, 11 and 12, two bolts extend through each frame piece and through the plywood shell, holding the frame firmly in place with its front margin 15″ from the front of the shell.

The partitions in the front of the shell separating the twelve 9″ x 7″ openings were cut from 1/16″ aluminum. The four horizontal strips were 37½″ x 1½″, and the five vertical strips 22½″ x 1½″. These were slotted half-way through their width to correspond with the slits at the front of the shell as indicated in Figures 11 and 12. The end slits were ¾″ from the end of the strip. The strips were fitted together and inserted into the slits at the front of the shell and held there snugly by bending the ⅜″ extruding ends against the external surface of the shell.

The rectangular funnels in the collecting unit were made of nylon organdy having approximately 80 threads per inch. Because nylon stretches when damp, dacron organdy might be better if it is available. The finished dimensions of the funnels, as indicated in Figure 13 by broken lines, are 7″ x 9″ at the front margin, 1″ x 1″ at the rear margin, and 15⅜″ along each of the four seams. The paper pattern (Figure 13) was made by drawing two horizontal lines, one 9″ and one 7″ long, then setting a compass with a radius of 15⅜″ at the ends of each line and marking two intersecting arcs. A line was drawn through the intersection perpendicular to the base. A ruler, kept parallel to the base, was placed a little above the intersection of the arcs until it touched the arc ½″ on each side of the perpendicular line. At that point a line 1″ long was drawn parallel to the base line, and the ends of the two parallel lines were connected. A strip ⅜″ wide was added on all sides for seams and hems.

In preparation for cutting, one long side of each pattern piece was placed on the lengthwise straight of the material and the corners marked in pencil on the material. The connecting lines were drawn on the organdy with the aid of a ruler. The pieces were then carefully

cut and sewed along the pencil lines. The pieces of each funnel were sewn together with nlyon thread so that each seam was composed of one margin on the straight of the material. It may be better to place the center length of each piece on the straight of the material with the front and rear margins on the true crosswise. This has not been tried. When installing the cloth funnels, strings were run through the hems at the rear margins, then through holes in the shell, as indicated in Figures 11 and 12, and tied to the reinforcing frame. The front margins of the funnels were pulled taut and fastened at the middle to the aluminum partitions with a patch of adhesive tape. The whole front margin of the partitions was then overlaid with 7" and 9" strips of 2" wide adhesive tape extending one inch on either side of the partition and over the adjacent funnel.

Twelve small funnels made of mylar sheeting .003" thick were attached to the strings and fitted over the rear ends of the cloth funnels. These funnels extended into the lips of the entrance tubes when the conducting unit was attached. Each side of the mylar funnel was identical. In the pattern shown in Figure 14 the solid lines indicate cuts, the dotted lines creases. The pattern for one side was drawn in the same manner as described for the cloth funnels, with the base or front margin 1⅝" wide, the side (radius) 2½", and the rear margin 7/16". The string holes were 1½" from the rear margin as measured along the "radius."

This pattern was then placed on a piece of paper and a pin hole made at each corner and at the location of the string hole. The pattern was removed and the pin holes connected by lines. Then the pattern was placed adjacent to the one already drawn with the pin holes on one side coinciding. This process was repeated until all four sides were drawn. Then a ¼" overlap seam was added on the fifth side. This one complete pattern was transferred to the mylar by using pinhole markings at the corners and stringholes. Then connecting lines were scratched on the mylar with the point of a compass. After the funnels were cut, the string holes were punched with a belt punch, the mylar creased, and the ¼" overlap was glued with Duco household cement to the outer surface of the first side. The crease across the width of each side, half way between the front and the string holes, gives crosswise rigidity to the sides, and keeps the funnel on the strings.

The six sleeves and rear stops that hold the three beams of the conducting unit in the rear of the collecting unit were cut from 1/32" aluminum, according to the pattern in Figure 15, then bent and bolted to the plywood shell as indicated in Figure 12. The sleeve strips are 6¼" x 2" and the rear stops 2¼" x 2".

The three beams holding the entrance tubes shown in Figure 5, were 1⅝" x 2¼" x 36", and each contained four 1" holes positioned to correspond to the string holes indicated in Figure 11.

Metal collars with inch square sides having ½" feet welded to two sides were screwed to the beams at the holes as shown in Figure 5. The inside perimeter of these collars was slightly larger than the circumference of the tubes to keep the tubes square and straight at the end and to prevent slipping. If the collars are not quite snug, adhesive tape can be wrapped around the tubing until the collars fit.

The entrance tubes were cut from a 50-foot piece of transparent Dynalon food tubing ¾" ID and 1" OD, after the trap was mounted on the vehicle. The rear ends of the tubes were inserted in the head block of the concentrating funnel as shown on the left in Figure 6. The tubes protruded ¼" inside the head block and were wrapped with adhesive tape inside and outside to prevent slipping.

Although the head block was made of three pieces of wood bolted together, a single block, 1½" x 5" x 10", with a battery of twelve 1" holes in the center (as indicated in Figure 18) might be preferable. Two bolts instead of six, as shown

in Figure 6, may hold this single block to the top of the board supporting the concentrating funnel.

The board supporting the concentrating funnel was made of ⅜" plywood 8½" x 60", with a hole 4¼" x 5⅝" centrally located 2⅛" from one end, as indicated in Figures 6 and 17. A series of bolt holes permitted adjustable attachment to the base frame, although only four bolts were used at a time.

The metal part of the concentrating funnel was bolted to the underside of the board around the hole. The funnel was cut from 1/32" aluminum. The finished dimensions (dotted lines on Figure 16) were 6⅜" x 7⅞" at the entrance margin, 3¼" x 3¼" at the exit margin and 8¾" along each of the four creases. A half-inch strip was added on the fifth side for the overlap seam, a 1" flange at the large end for attachment to the board, and a ⅝" flange at the small end for attachment of the tail block. Figure 7 shows an oblique view of the concentrating funnel opened at the bottom, with the tail block (shown at the left) removed.

A nylon organdy funnel was suspended inside the metal funnel, as seen in Figures 6 and 7. Its finished dimensions were 4½" x 5⅝" at the top margin, 1⅛" x 1⅛" at the bottom margin and 8⅝" along each seam. An additional ⅜" was allowed for seams and hems. The center length of each piece was placed on the lengthwise straight of the material. Strings run through the hem on the top margin held the funnel in place, (but adhesive tape might be substituted here as it was on the front margin of the organdy funnels in the collecting unit). The small end of this nylon funnel was suspended on strings through the hem that extended through holes in the sides of the metal funnel, as indicated on the pattern, Figure 16.

A mylar funnel attached to the strings was fitted over the end of the cloth funnel and extended into the lip of the exit tube. Each side of this mylar funnel was 1⅝" wide at the base (front margin), 1 13/16" along the "radius," and ⅝" wide at the rear margin. A ¼" overlap seam was provided on the fifth side and the string holes were punched on the "radius" 1 1/16" from the rear end. As seen in Figure 7, the mylar funnel was reinforced with strips of adhesive tape ¼" from the end to provide more rigidity, but this is not necessary if care is taken, when assembling the concentrating funnel, to make sure the end of the mylar funnel extends into the lip of the exit tube. This can be accomplished by carefully attaching the tail block first, then the head block.

The tail block, as shown in Figure 7, contained the mouth of the exit tube in the center hole, and eight ¾" round holes (wind vents), four of which were plugged with corks. The block was made of two pieces of ½" plywood sandwiched together. The outside piece has a 1¼" round hole in the center. The inside piece has a square hole, 1 1/32" x 1 1/32", as shown in Figure 19; otherwise the two were identical.

The exit tube consisted of a six-foot length of transparent Dynalon food tubing, 1¼" OD and 1" ID.

The upper part of the flat metal holder supporting the exit tube was made from a strip of iron 17" x 1" x 3/16". This strip was heated and bent to a rounded right angle; the vertical arm was twisted slightly so the exit tube would be parallel with the side of the car as it passed through the aluminum strip attached to this holder. Bolt holes ¾" apart toward the end of the horizontal arm permitted adjustable attachment to the base frame. Bolt holes ¼" apart at the end of the vertical arm permitted adjustable attachment of the 10" aluminum band that wrapped around the exit tube, as shown in Figures 1, 2 and 3.

At the end of the exit tube, as shown in Figure 8, is the cage holder, consisting of a block of wood 1¼" thick x 2¼" x 3" with a square hole 1 1/32" x 1 1/32" in the center. A piece of aluminum, 7" x 2¼", with an identical square center hole, had a right-angle-bend 1 inch from each end. There was a ½" slot in the center

of these upturned ends through which the ribbon elastic was threaded. The aluminum piece was nailed to the block. Figure 9 shows a cage in the cage holder. The end of the exit tube fits into the base of the mylar funnel in the cage floor.

The overall dimensions of the cage were 5″ x 5″ x 5″ and the frame was made of wood ½″ thick. The floor was cut from a discarded fibreglass lamp shade. Figure 10 shows the mylar funnel taped to the cage floor on the outside and extending in through the 1¼″ x 1¼″ hole in the center. Each side of this mylar funnel was 1½″ wide at the base (front margin), 2″ along the "radius" and ½″ wide at the rear margin. A ¼″ overlap seam was provided on the fifth side. The crease was slit open ½″ up from the base to form a flange for taping to the cage floor. The sides of the cage were made of nylon mesh from discarded but runfree stockings. As indicated in Figure 10, a stocking sleeve formed one side of the cage. This sleeve determined the size of the cage side, which was limited to 5″ x 5″ since 20 inches was about the maximum circumference the cut-off stocking top would stretch. To prevent runs from forming when the sleeve was cut and stretched, the stocking was laid on a piece of plastic sheeting and a swath of rubber cement about a half-inch wide was brushed across it where the cut was to be made,—about 8 inches from the end. Before the rubber cement was completely dry, the stocking top was cut off and the two edges pulled apart and allowed to dry, then stretched to fit against the cage side and tacked in place. The tacking was then supplemented with household cement. Pieces of nylon mesh cut from stockings were fastened to the remaining four sides of the frame simply by laying a piece over the frame, holding it smoothly in place with a rubber band, and lightly applying household cement to the nylon and smearing it through to the frame. When the cement was dry the excess nylon was neatly trimmed off. The nylon mesh affords excellent visibility as indicated in Figures 9 and 10.

The cages can be washed under the faucet but should not be immersed or soaked. About once a month the head block and tail block were removed from the concentrating funnel and water from the garden hose squirted through the tubing to wash out the dust. At the beginning of each trapping season, both the nylon and mylar funnels were removed from the trap, washed carefully, then restrung and retaped in place.

A needle was made to run the string through the funnel hems and through the string holes in the metal and wooden parts of the trap. A 6″ piece of copper wire about 1/50″ thick was looped double and twisted to within a half-inch of the loop end, which formed the eye. A smooth rounded tip was made by dipping the opposite end in household cement and letting it dry.

The trap, as described, worked very well. Perhaps the main factors contributing to the good condition of the insect catch were: the steep sides of the cloth funnels (76 and 78 degree angles); the smooth flexible Dynalon food tubing; the gentle breeze that enters the conducting unit, controlled in part by the size of the base of the mylar funnels, and the open wind vents at the bottom of the concentrating funnel; the slippery and flexible nature of the nylon cloth funnels and mesh sides of the cages; the dark, damp holding cartons; and the ease with which the cages could be emptied through the stocking sleeve.

We are indebted to the staff of the Florida State Board of Health Entomological Research Center at Vero Beach, Florida for information on the construction and performance of a single-funnel truck-top trap developed there. Our thanks are also extended to Kenneth Austerman of the Arctic Health Research Center for the photographs.