

## VII. GAS GENERATORS

The apparatus used in the production of gases has been placed in two sections, one of which contains the complete apparatus for gas generation while the second section contains two devices useful in collecting gases.

### A. GAS GENERATORS

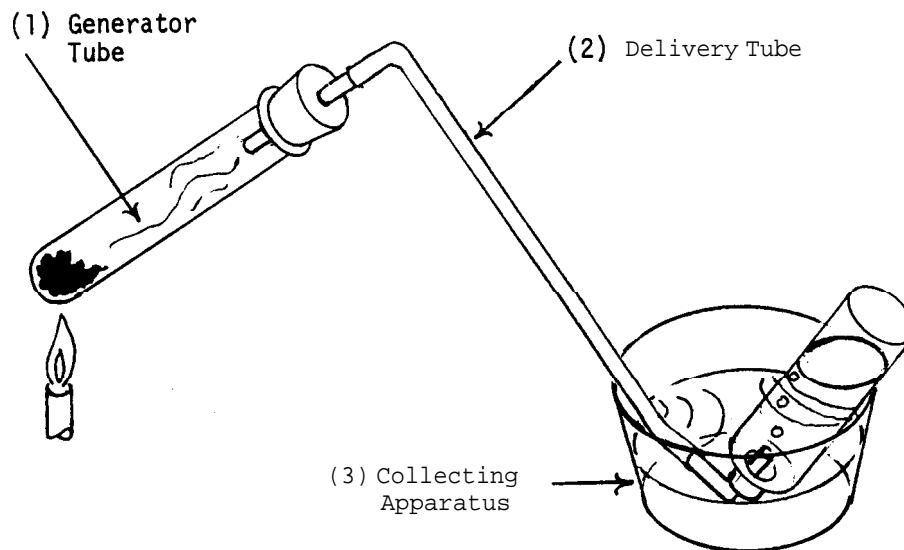
Three types of generators will be given: simple devices for which no special equipment is required; and an inexpensive version of Kipp's gas generator.

### B. ACCESSORIES

Included here are the beehive shelf and metal sheet shelf.

A. GAS GENERATORS

Al. Simple Gas Generator and Collecting Apparatus



a. Materials Required

<u>Components</u>	<u>Qu</u>	<u>Items Required</u>	<u>Dimensions</u>
(1) Generator Tube	1	Test Tube or Flask (A)	Capacity at least 50 ml
	1	1-Hole Rubber Stopper (B)	To fit generator tube (A)
(2) Delivery Tube	1	Glass Tubing (C)	0.5 cm diameter, 5-10 cm long
	1	Rubber or Plastic Tubing (D)	To fit glass tubing (C and E), 30 cm long
	1	Glass Tubing (E)	0.5 cm diameter, 15-25 cm long
(3) Collecting Apparatus	1	Test Tube, Flask, or Bottle (F)	Capacity at least 50 ml
	1	Bowl or Pan (G)	250 ml or greater capacity

b. Construction

(1) Generator Tube

For the generator tube, use a hard-glass test tube or flask suitable for heating (A). Secure test tube in a slanted position with an appropriate clamp or support (IV/B5 or B6).

(2) Delivery Tube

Fit the generator tube with a one-hole rubber stopper (B).

Insert the shorter glass tube (C) through the one-hole rubber stopper. Connect the rubber or plastic tubing (D) to the free end of the glass tube (C). Bend the longer glass tube (E) at a 90° angle or less, and connect it to the flexible tubing (D).

(3) Collecting Apparatus

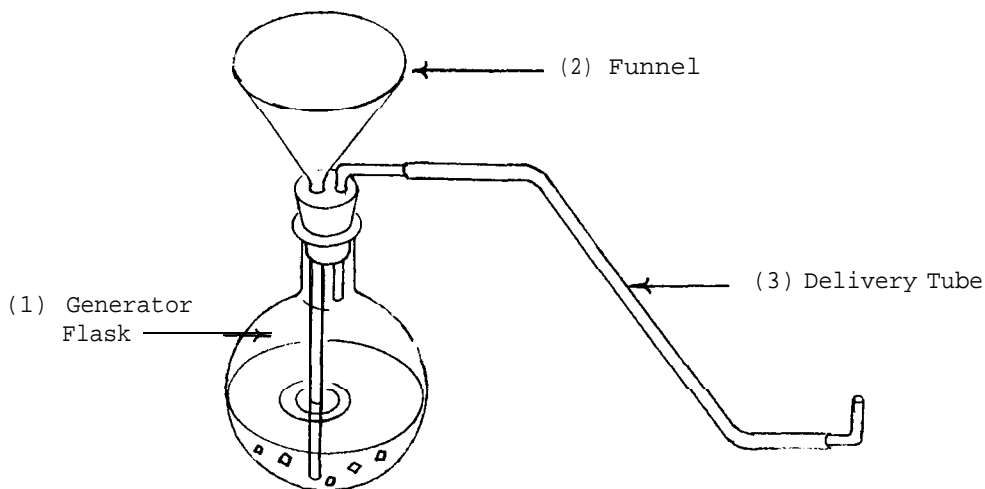
Select a large test tube, flask, or bottle (F). Fill with water, cover the opening, and invert in a bowl or pan of water (G) so that the water is held in the bottle (F). Uncover the opening and place the free end of glass tubing (E) into the mouth of the collecting tube.

C. Notes

(i) This apparatus is suitable for student use in generating small amounts of gases which are insoluble or only slightly soluble in water.

(ii) Small amounts of reactants are placed in the generator tube and carefully heated (if heating is required). The gas generated passes through the delivery tube, and is collected by displacing the water in the collecting tube.

A2. Flask Generator



a. Materials Required

<u>Components</u>	<u>Qu</u>	<u>Items Required</u>	<u>Dimensions</u>
(1) Generator Flask	1	Flask or Bottle (A)	250 ml capacity or larger
	1	2-Hole Rubber Stopper (B)	To fit flask (A)
(2) Funnel	1	Long-necked Funnel (C)	Approximately 10 cm diameter (large end)
(3) Delivery Tube	2	Glass Tubing (D)	0.5 cm diameter, 15-25 cm long
	1	Plastic or Rubber Tubing (E)	To fit glass tubing, approximately 30 cm long

b. Construction

(1) Generator Flask

Support the flask or bottle (A), if necessary, in a suitable support. Fit the flask with a two-hole rubber stopper (B).

(2) Funnel

Select a funnel (C) with a sufficiently long neck to reach nearly to the bottom of the flask (A). Carefully push the funnel neck through one of the holes in the stopper (B).

(3) Delivery Tube

Make a 90° bend in each piece of glass tubing (D). Connect

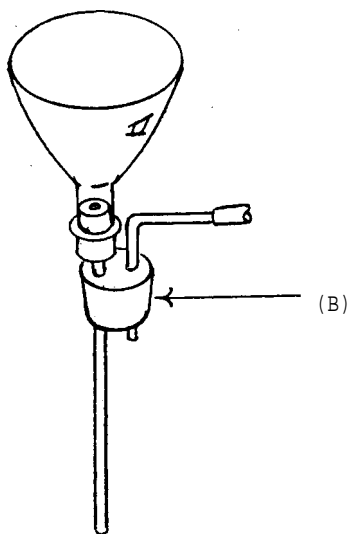
these with flexible tubing (E).  
Insert one of the glass tubes  
into the second hole of the  
rubber stopper (B).

c. Notes

(i) This apparatus is used in conjunction with the collecting apparatus just as described in the previous section (VII/A1).

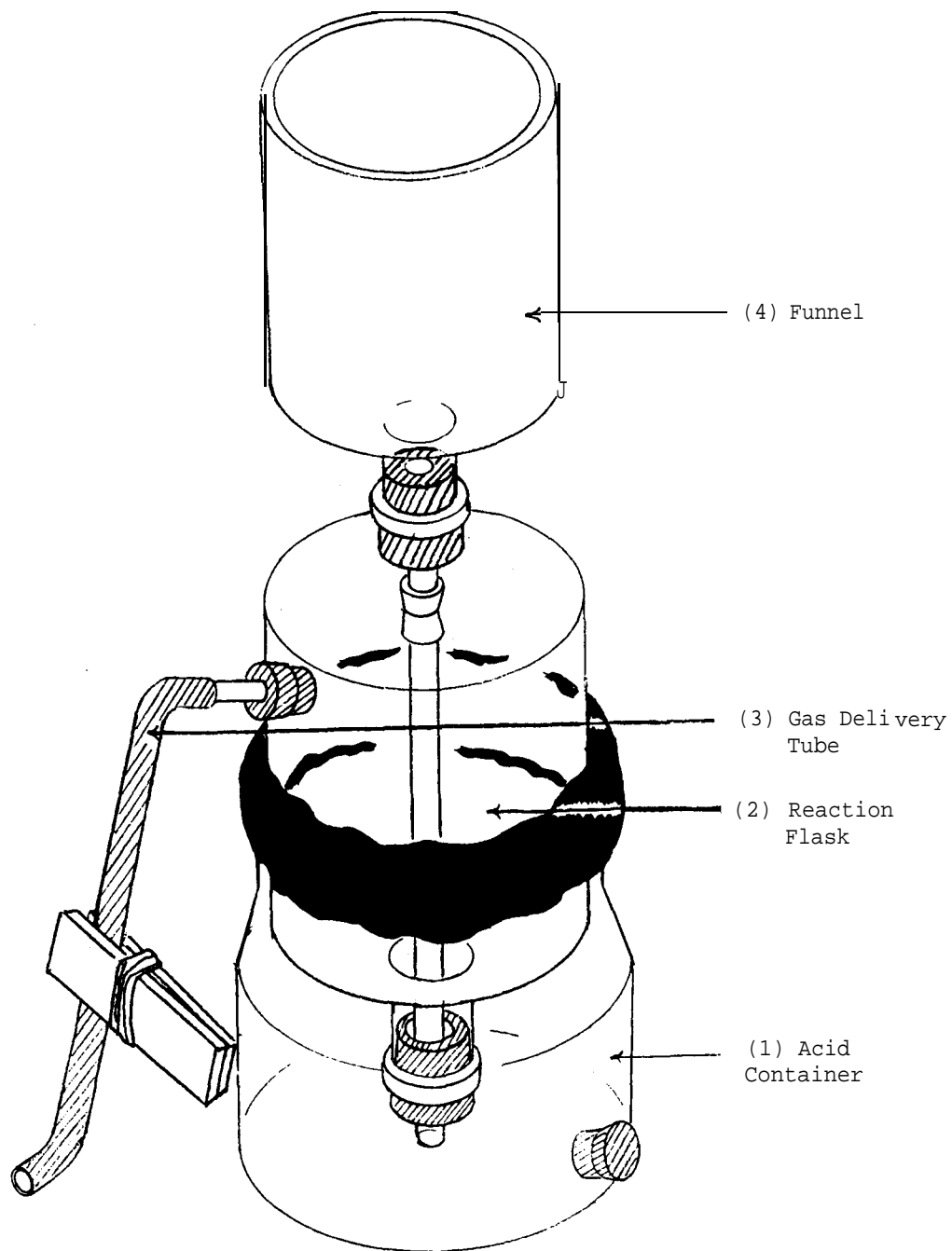
(ii) This device is generally chosen when the gas generating reaction involves a solid (such as zinc) and a liquid (such as dilute sulfuric or hydrochloric acid). The solid is placed in the bottom of the generator flask, then the rest of the apparatus is placed in position. When the collecting bottle is in place, the liquid reagent is added through the funnel. Thus, the reaction does not begin until the apparatus is sealed. Additional liquid can be added to the flask without dismantling the apparatus.

(iii) If a funnel made from a cut-down bottle is used (V/A3), it will be necessary



to adapt the construction of this item slightly. Connect such a funnel to the flask (A) with a long piece of glass tubing running through the stopper (B) and a one-hole stopper fitted into the funnel.

A3. Kipp's Generator \*



\*Adapted from C S. Rao (Editor), Science Teachers' Handbook, (Hyderabad, India: American Peace Corps, 1968), pp 174-175.

a. Materials Required

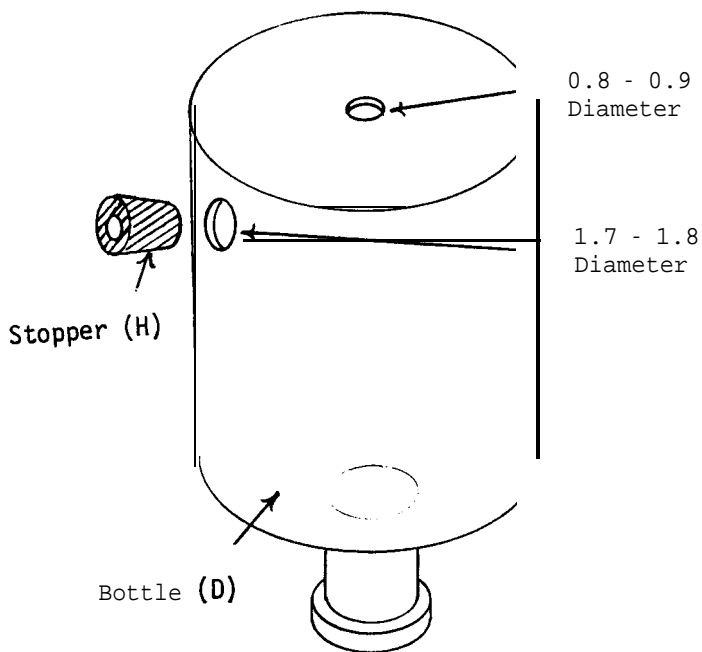
<u>Components</u>	<u>Qu</u>	<u>Items Required</u>	<u>Dimensions</u>
(1) Acid Container	1	Glass Jar (A)	Capacity approximately 500 ml
	1	Rubber Stopper (B)	Approximately 2.0 cm diameter (large end)
	--	Plasticine (Modeling Clay) or Pitch (C)	4 cm x 4 cm x 4 cm
(2) Reaction Flask	1	Glass Bottle (D)	Capacity approximately 500 ml
	1	1 or 2-Hole Rubber Stopper (E)	To fit bottle (D)
	1	Glass Tubing (F)	Approximately 0.7 cm diameter, 30 cm long
	1	Rubber Tubing (G)	1.0 cm diameter, 3 cm long
	1	1-Hole Rubber Stopper (H)	Approximately 2.0 cm diameter (large end)
(3) <b>Gas Delivery Tube</b>	1	Glass Tubing (I)	0.7 cm diameter, 5 cm long
	1	Rubber Tubing (J)	1.0 cm diameter, 30 cm long
	1	Pinch Clamp (K)	(IV/A4)
(4) Funnel	1	Glass Bottle (L)	<b>Capacity</b> approximately 1 liter
	1	1-Hole Rubber Stopper (M)	To fit bottle (L)

b. Construction

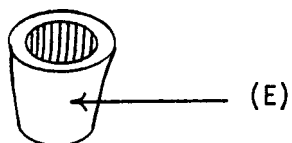
(1) Acid Container

Select a low, wide-mouth jar with a capacity of about 500 ml (A). Drill a hole in the side of the jar, just above the bottom, (I/E2). Enlarge the hole, by filing with a round file, to a diameter of 1.7 - 1.8 cm. Seal this hole with a **solid** rubber stopper (B).

(2) Reaction Flask

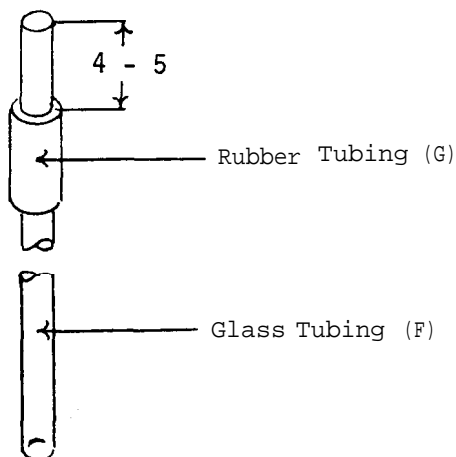


For the reaction flask, choose a narrow-necked bottle (D) that will just fit into the neck of the acid container (A). Drill a hole in the center of the bottom of the bottle (D), and enlarge the hole to a diameter of 0.8 - 0.9 cm. Drill a second hole in the side near the bottom. Enlarge this hole to a diameter of 1.7 - 1.8 cm. Fit a one-hole rubber stopper (H) into the side hole.

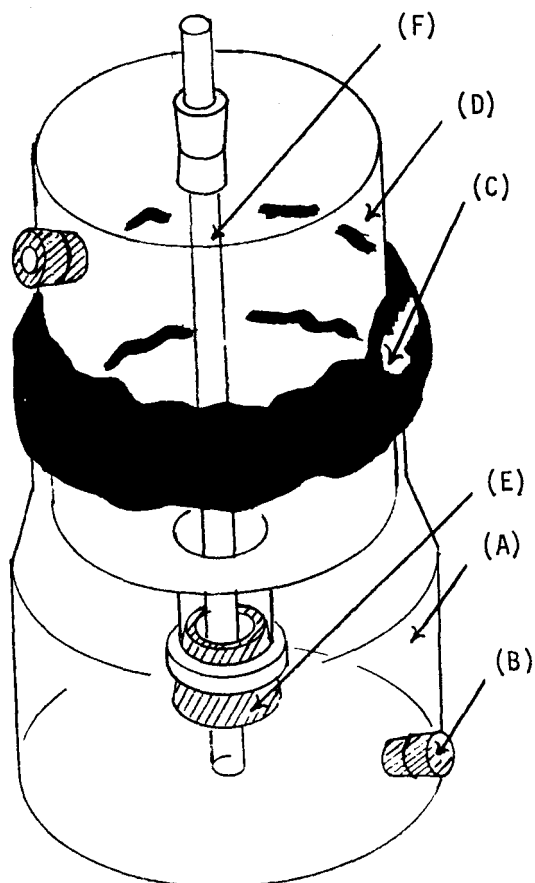


Select a stopper (E) that fits the neck of the bottle (D). If it is a one-hole stopper with a round file, enlarge the hole in the stopper to about two to three times its normal diameter. Fit this stopper into the neck of the bottle. **If a two-hole stopper is available, make no alterations, and fit the stopper into the neck of the bottle (D).**





Fire polish (I/D4) both ends of the glass tubing (F). Insert one end into the short length of rubber tubing (G). Allow 4 - 5 cm of glass tubing (F) to protrude beyond the rubber tubing (G).



Insert the long end of the glass tubing (F) into the bottle (D), from the bottom. Fit the end through the enlarged hole of the stopper (E), and carefully push and twist until the rubber tubing (G) around the glass tightly seals the hole in the bottom of the bottle (D).

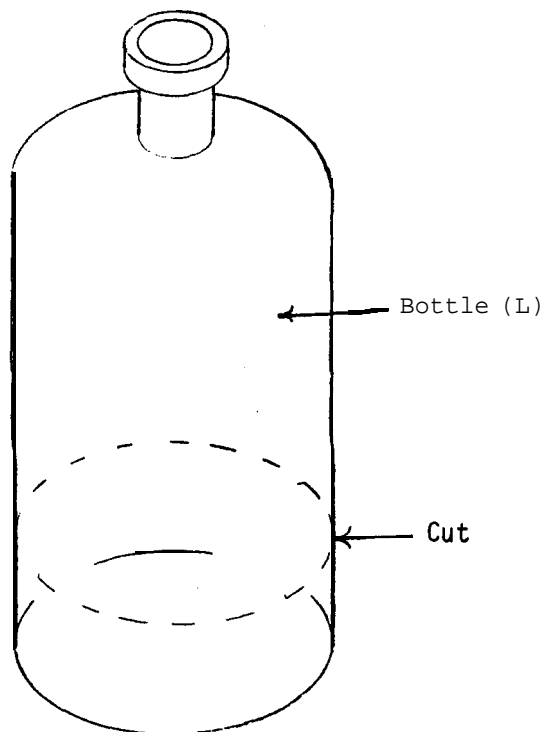
Set the reaction flask (D), neck down, into the neck of the acid container (A). Adjust and cut the glass tubing (F), if necessary, so its lower end is about 0.5 cm from the bottom of the acid container (A).

Roll the modeling clay (plasticine) (C) into a long cylinder and wrap it around the seam between reaction flask (D) and acid container (A). Press the clay firmly in place to make an airtight seal.

(3) Gas Delivery Tube

Insert a short piece of glass tubing (I) into the stopper in the side of the reaction flask. Attach rubber tubing (J) to the other end of the glass tube. Use a wooden pinch clamp (K) (IV/A4) or other suitable clamp to close the rubber tubing.

(4) Funnel



Construct a large funnel with a capacity equal to that of the acid container by cutting off the bottom third of a narrow-necked bottle (L) (I/F2). Smooth the rough cut edge of the funnel with emery cloth. Select a one-hole rubber stopper (M) to fit the funnel neck. Insert the glass tube (F) from the reaction flask (D) into the stopper (M).

Invert the funnel (L) and fit its neck tightly over the stopper (M).

Support the funnel in a ring stand (IV/B5) or other suitable holder.

C. Notes

(i) To complete the gas generating apparatus, the gas delivery tube of the Kipp's Generator must be connected to a suitable collection device such as that described in VII/A4 or the aspirator described in V/A8.

(ii) The solid reactant, such as zinc chips is added to the reaction flask (D) through the hole in the side. The solid will sit, for the most part, on the stopper (E) in the neck of the flask. The stopper (H) and gas delivery tube are then securely replaced in the reaction flask, and all connections and seals are checked to insure that they are gastight. Then the liquid reagent, such as 6M hydrochloric acid, is poured into the funnel (L).

When the pinch clamp (K) is removed from the gas delivery tube, the acid will flow into the acid container (A). As the acid level rises above the neck

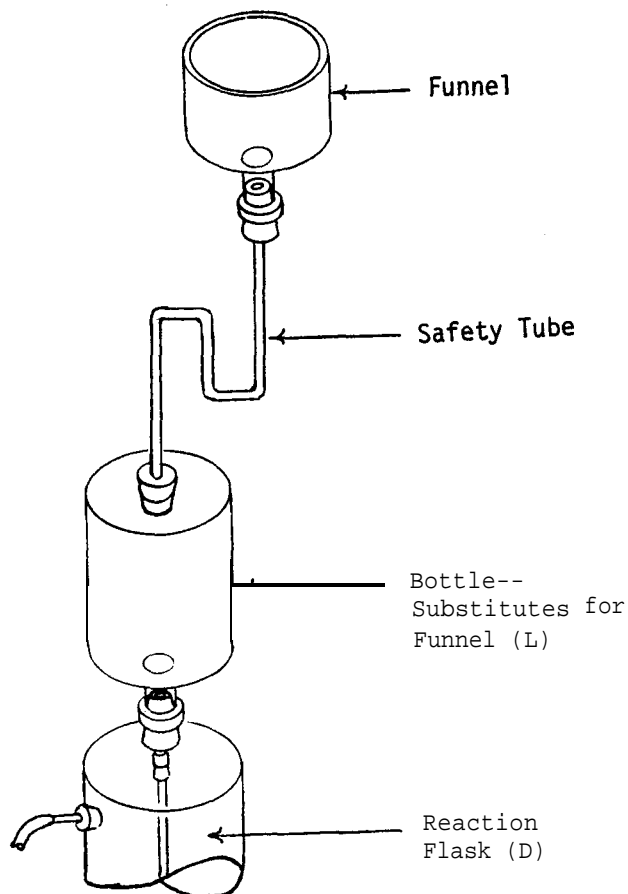
of the reaction flask (K), it will flow into the reaction flask through the enlarged or second hole of the stopper (E) and will react with the solid to produce a gas (hydrogen, in this example). The gas will pass through the delivery tube to the collecting vessel.

(iii) The reaction can be stopped without removing any of the reactants or dismantling the equipment. When the gas delivery tube is closed with the pinch clamp, the pressure of the gas accumulating in the reaction flask will force the acid out of the reaction flask and back into the acid container until it is no longer in contact with the solid. Some of the acid will also be forced back up the glass tube and into the funnel. The funnel must therefore be large enough to safely contain a large volume of acid that might be backed up.

To restart the reaction, the delivery tube is opened, and acid again flows into the acid container and reaction flask to evolve more gas.

(iv) This device is suitable for evolving large quantities of a gas for class use, or as a demonstration. It should be possible to build a larger model, but experimentation with the size relationships between the funnel, reaction flask, and acid container will be necessary.

(v) If the Kipp's Generator is to be employed for continuous classroom use, a

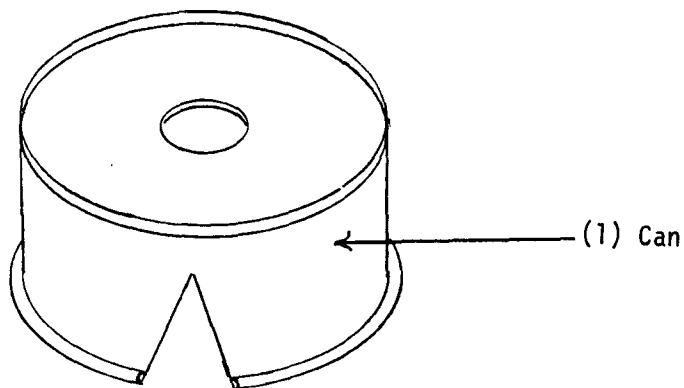


safety tube and funnel may be substituted for the large funnel to prevent the escape of unpleasant or undesirable acid fumes. A piece of glass tubing, approximately 0.7 cm diameter and 35 - 40 cm long, is bent as shown. This is connected, by means of a rubber stopper at the upper end, to a funnel. A bottle with a hole drilled in the bottom is substituted for the large funnel (L), and the lower end of the safety tube is connected to this bottle with a one-hole rubber stopper or short piece of rubber tubing.

The whole apparatus must be supported in a stand or frame of some kind.

B. ACCESSORIES

B1. Beehive Shelf



a. Materials Required

<u>Components</u>	<u>Qu</u>	<u>Items Required</u>	<u>Dimensions</u>
(1) Can	1	Tin Can (A)	9 cm diameter x 5 cm high

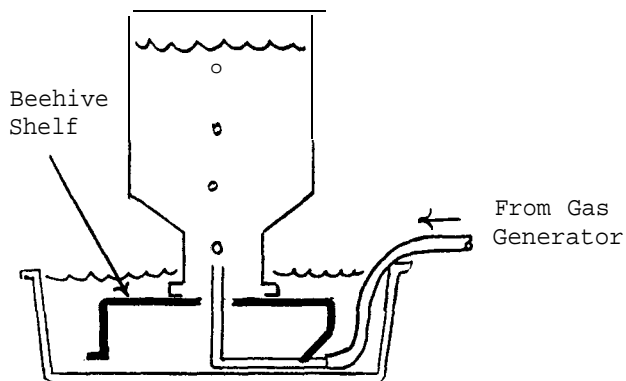
b. Construction

(1) Tin Can Shelf

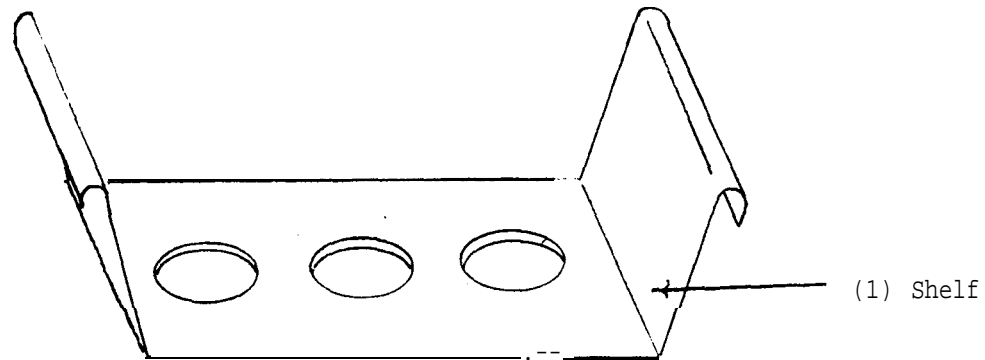
Select a short tin can with one end removed (A). Cut a V-shaped notch about 1 cm high in the side of the can. Drill a hole 1.5 cm in diameter in the center of the end of the can. Varnish the can.

c. Notes

(i) The beehive shelf is placed in the bottom of a pan of water. A gas collecting tube or jar, filled with water as described in VII/A1, is inverted on the shelf, with the mouth of the jar over the hole in the shelf. The gas delivery tube is then inserted through the notch of the shelf, up through the hole, and into the neck of the collecting jar.



B2. Metal Sheet Shelf



a. Materials Required

Components

(1) Shelf

Qu Items Required

1 Metal Sheet (A)

Dimensions

Approximately 0.05 cm thick, 8 cm x 30 cm

b. Construction

(1) Metal Sheet Shelf

Cut the metal sheet from heavy aluminum sheeting or a tin can. Cut three holes, 1.5 cm in diameter, in the sheet (A) as shown. Bend the edges up as shown. Finally, make curved bends approximately 1 cm from each end.

c. Notes

(i) This shelf may be hung from the sides of a rectangular pan measuring from 12 to 20 cm wide. The shelf must be covered with water. Collecting bottles, filled with water, are inverted over the holes and set on the shelf.