California Vocational Agriculture Curriculum Guidelines Instructional Unit

ALTERNATE ENERGY
IN AGRICULTURE

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ALTERNATE ENERGY IN AGRICULTURE

Unit Goal

The goal of the unit is to acquaint the student with alternate energy sources and how the energy sources may be used in agriculture.

Unit Performance Objectives

Upon completion of this unit the student will be able to:

1. Identify the major energy sources.
2. Describe ways agriculture is using alternate energy.
3. Apply his/her knowledge of a particular energy source in a simple construction project.

Teaching Outline

I. Forms of Energy : Wind Energy

A. How wind has been used in the past

1. Wind sails in Persia

2. Windmills in 12th century England

3. Sailing ships

4. Windmills in the Midwest and West for pumping water and electricity generation

a. Decline in 1930's due to rural electrification programs
b. Poor storage systems

B. Present day wind machines

1. Small machines for individuals

2. Large machines for community power

3. Suitability in California is limited

a. Much of California is not windy enough: average wind velocity must be 8 m.p.h.
b. Windmills are inefficient: 59% of wind power may be extracted and gears or generator and pump also reduce efficiency
c. New windmills and generators are expensive on today's market in relation to output. Older models may be worth restoring.
d. Best use today: remote and unattended areas

C. Wind machine design factors

1. Study local wind (supply)

2. Capacity

a. Average number of days of wind
b. Average daily wind speed
c. Average daily electrical requirements
d. Amount of storage needed to cover windless periods

3. Three main factors determine power

a. Wind speed
b. Diameter of propeller
c. Propeller design
d. Wind passing through a propeller is 59% efficient

4. Basic components

a. Propeller geared to generator
b. Tower
c. Brake to stop unit
d. Speed controlling device to prevent damage in high wind
e. Batteries to store energy
f. Other utilization of wind power-pumping, air compressing

Suggested Learning Activities

A. 1. Locate old windmill.

2. Visit weather station or airport. Check wind speeds. Calculate average daily wind speed to determine whether windmills would be feasible in your area.

Suggested Resource Material

1. Producing Your Own Power, Rodale Press, Part I: Wind Power, Emmaus, Pa.

2. Local resources.

II. Solar energy

A. Introduction

1. Solar energy is most abundant form of energy

2. Radiation from sun is reduced as it travels from sun to strike the earth. Intensity is reduced by clouds, fog, air pollution.

3. Solar energy is dilute: therefore large collection areas are needed and installation costs are high.

B. Uses in agriculture

1. Plants harness sun's energy through photosynthesis

2. Drying fruit and other crops

3. Solar extractors (melting cappings and bees wax)

4. Greenhouses

5. Sun motors to power pumps (early 1900's)

6. Warming water for processing and other uses

C. A solar system will include:

1. Collection device

2. Storage units

3. Auxiliary units

4. Control device

D. Active systems: movement of energy

1. Flat plate collectors (TM - 1A, 1B)

2. Concentrating collectors

3. Solar cells

E. Passive systems: in place

1. Building orientation: allow for southerly exposure

2. Effects of latitude: place collector at latitude degrees plus 10°

3. Effects of roof overhang on building temperatures (TM - 2)

F. Construction projects

1. Simple water heater (breadbox) (TM - 3)

2. Solar oven (TM - 4)

3. Solar greenhouse (TM -5)

Suggested Learning Activities

II. 1. Class experiments:

a. Measure heat in a closed, parked car in sun as example of collector.

b. Demonstrate heat absorption in water. Using two dishpans, line the bottom of one with black plastic, the other unlined. Measure temperature differences after certain period of time.

c. Demonstrate solar energy storage -- Use two drums which will hold water. Fill one with gravel. Leave the other. Add water to both, let stand in sun. Measure temperature after 4 hours, after 16 hours for comparison of heat retention.

d. Determine the latitude of your locale and calculate best exposure for solar devices.

Suggested Resource Material

1. Solar Energy Experiments, Rodale Press, Emmaus, Pa.

III. Bio Fuels: Energy created from organic matter, usually waste

A. Aerobic conversion requires oxygen

1. Composting-organic matter ferments into carbon dioxide, ammonia, other gases and fertilizer residue

2. Does not require protection since aeration is essential to process

B. Anaerobic process creates combustible methane

1. Group of gases produced are called Biogas (70% methane, 29% carbon dioxide and 1% of sulfurated hydrogen and oxygen)

2. Undesirable products may be removed by processing gases through a water scrubber

3. Methane production in a digester (TM - 6)

a. Many containers may be used but each must be airtight for anaerobic digestion
b. Material put into digester may be manure or vegetable matter
c. Methane is safe. It ignites at 1320°C and is lighter than air. Therefore any that leaks out will disappear. When mixed with air and ignited it will explode.
d. Starting the digestion process
   1) Seed the material with sludge from another digester
   2) Keep digester warm and avoid drastic temperature changes (90-95°F or 32 - 35°C). Above ground--insulate with styrofoam.
e. Amount of gas depends upon temperature and type of slurry used
f. Each day add 1/10 of the volume of the digester as long as digestion is occurring
g. Slurry rises to top as digestion proceeds
h. Stirring of the slurry may be necessary
i. Do not add great quantities of straw or hay (remove what floats).
h. As gas rises it causes scum to form
i. Sludge must be removed from time to time
j. When digestion is working well PH is 8.0-8.5
k. Gas may have hydrogen sulfide which should be removed. Pass gas through copper sulfate
l. Carbon dioxide may be removed by passing it over hydrated lime
m. Storing gas
   1) In a water sealed gasometer (2 tanks: gas inside water tank)
   2) Rubber bags
   3) Cylinders which will take high pressures
o. Use of methane
   1) Burners (cooling, heating)
   2) Internal combustion engines

C. Other specific end products

1. Gasifier: uses crop residues (such as walnut shells and straw) to create gas for fuel (TM - 7)

a. Efficiency is 65-75%; burns with limited air
b. A substitute for natural gas when warm
c. Not practical for fueling farm vehicles but will do for stationary purposes

Suggested Learning Activities	Suggested Resource Material
III.1. Define terms and give examples: a. aerobic b. anaerobic c. digester d. sludge e. starter f. slurry	
2. Gather manure or organic matter. Add some water . Let digest in warm spot in closed container with balloon top. What happens to balloon?	
3. Build a digester from metal drums or rubber tire tubes (TM - 6A)	

IV. Fuel Alcohol distillation

A. Ethanol is made by fermentation of agricultural grains or by a synthetic process using fossil fuels (TM - 8)

1. A problem is producing an affordable product in a competitive market

2. Another problem with ethanol production at this point means continued use of gasoline for use in gasohol. Therefore some fossil fuel is still used.

B. Methanol is made from wood, agricultural waste, coal, or natural gas

1. Cheaper to produce than ethanol

2. Burns cleaner than gasoline

3. Lower BTU than gasoline or ethanol

C. Fuel alcohol uses and characteristics

V. Geothermal: using heat (steam) from the Earth for energy

A. Example: volcanic heat in Hawaii and California; Iceland heats 70% of its homes with geothermal steam

B. Geothermal energy may produce up to 10% of California's energy needs in the future

C. Production limited to geothermal areas of the state

D. Steam may be adulterated with sulfurous gases and needs to be purified

Suggested Learning Activities		Suggested Resource Material
IV. 1.	Convert one cylinder gas engine to operate on alcohol fuel or gasohol.	1. "Makin' it on the Farm," Nellis American Agri. News Pub., Iredell, Texas
2.	Demonstrate distillation by distilling water from salt water.	2. Pacific Gas and Electric Co.
V. 3.	Guest speaker on geothermal energy, its uses, and difficulties.	3. State Department of Energy;
4.	Locate geothermal areas of the state on a map.	4. California map

Student Evaluation

1. Name 5 sources of energy and one device for each to utilize the energy.

source	device
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

2. Describe three ways in which alternate energy sources can be used on the farm.

3. Name the four basic components of a solar system device.

   A. _____

   B. _____

   C. _____

   D. _____

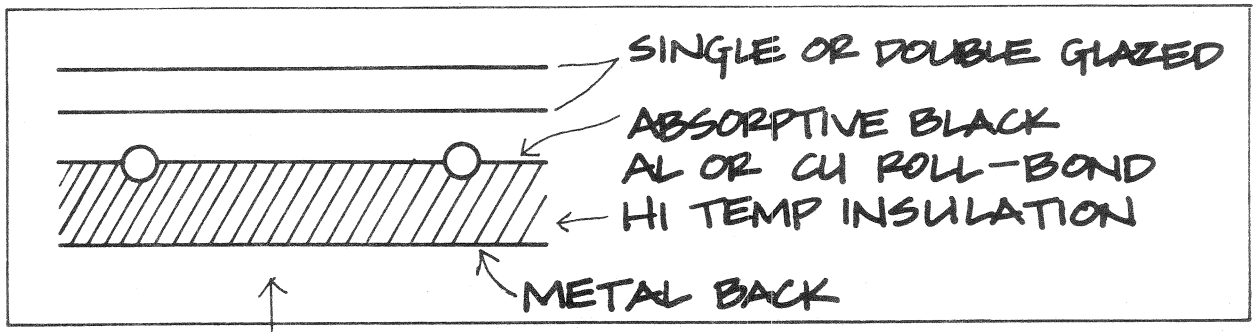
4. Name the products of each of these bio processors.

   A. compost pile _____

   B. digester _____

   C. gasifier _____

5. What is the source of geothermal energy.



CROSS SECTION OF COLLECTOR

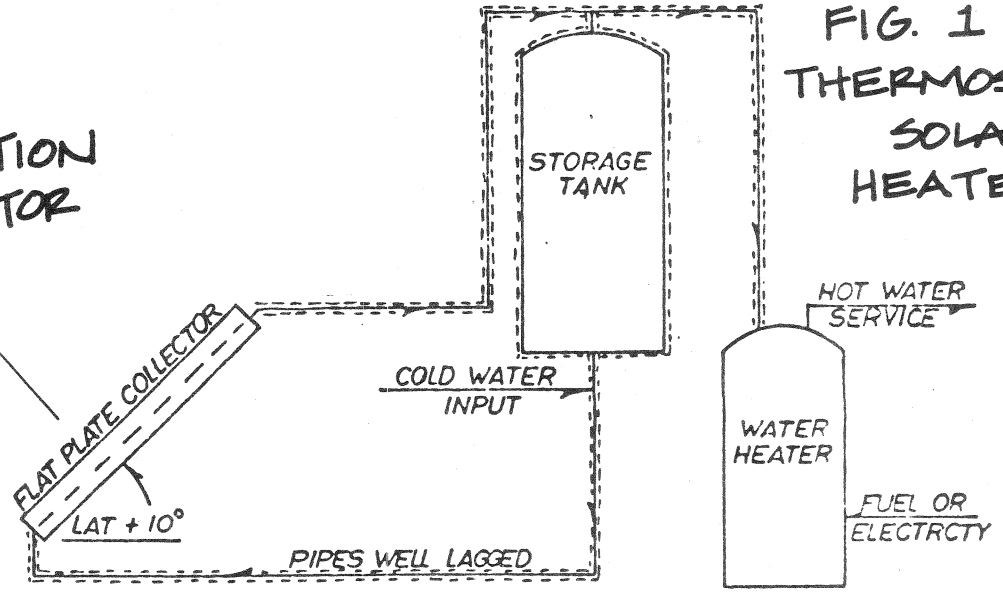


FIG. 1
THERMOSYPHON SOLAR HEATER

WATER HEATERS

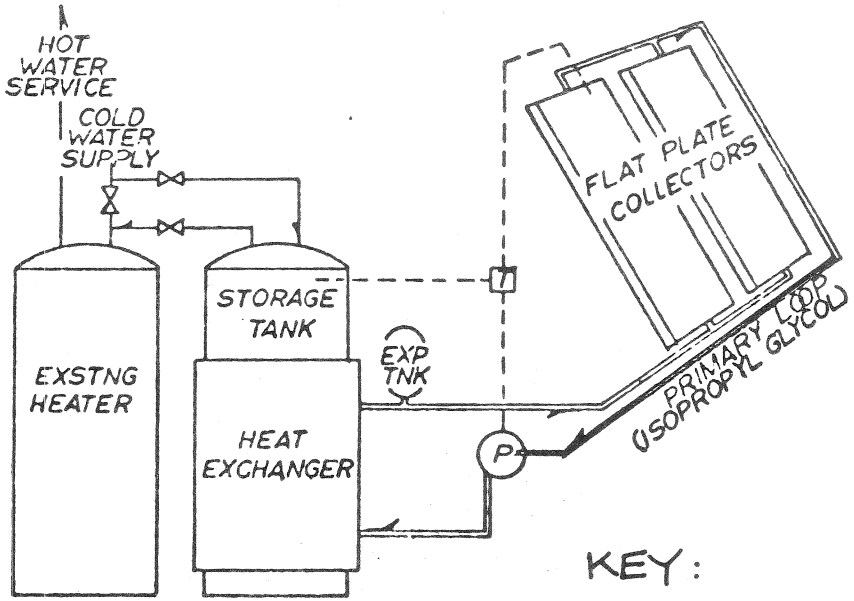


FIG. 3
HEAT EXCHANGER SYSTEM - USING ANTIFREEZE

KEY:

P = PUMP

= VALVE

= THERMO-SWITCH

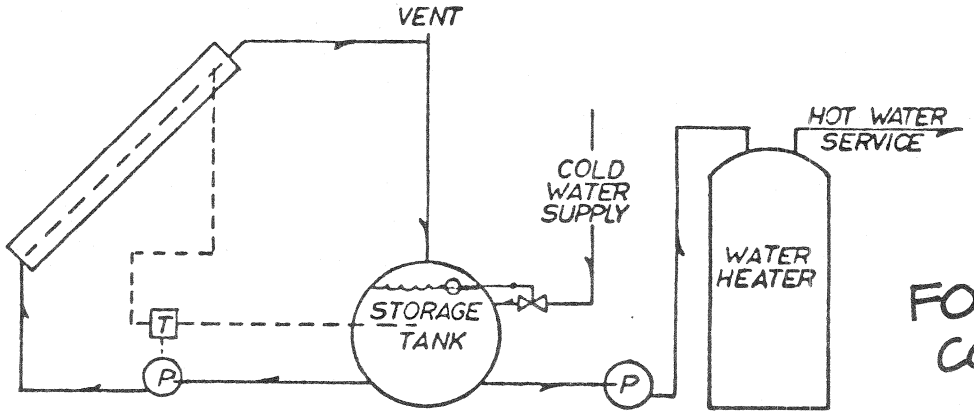
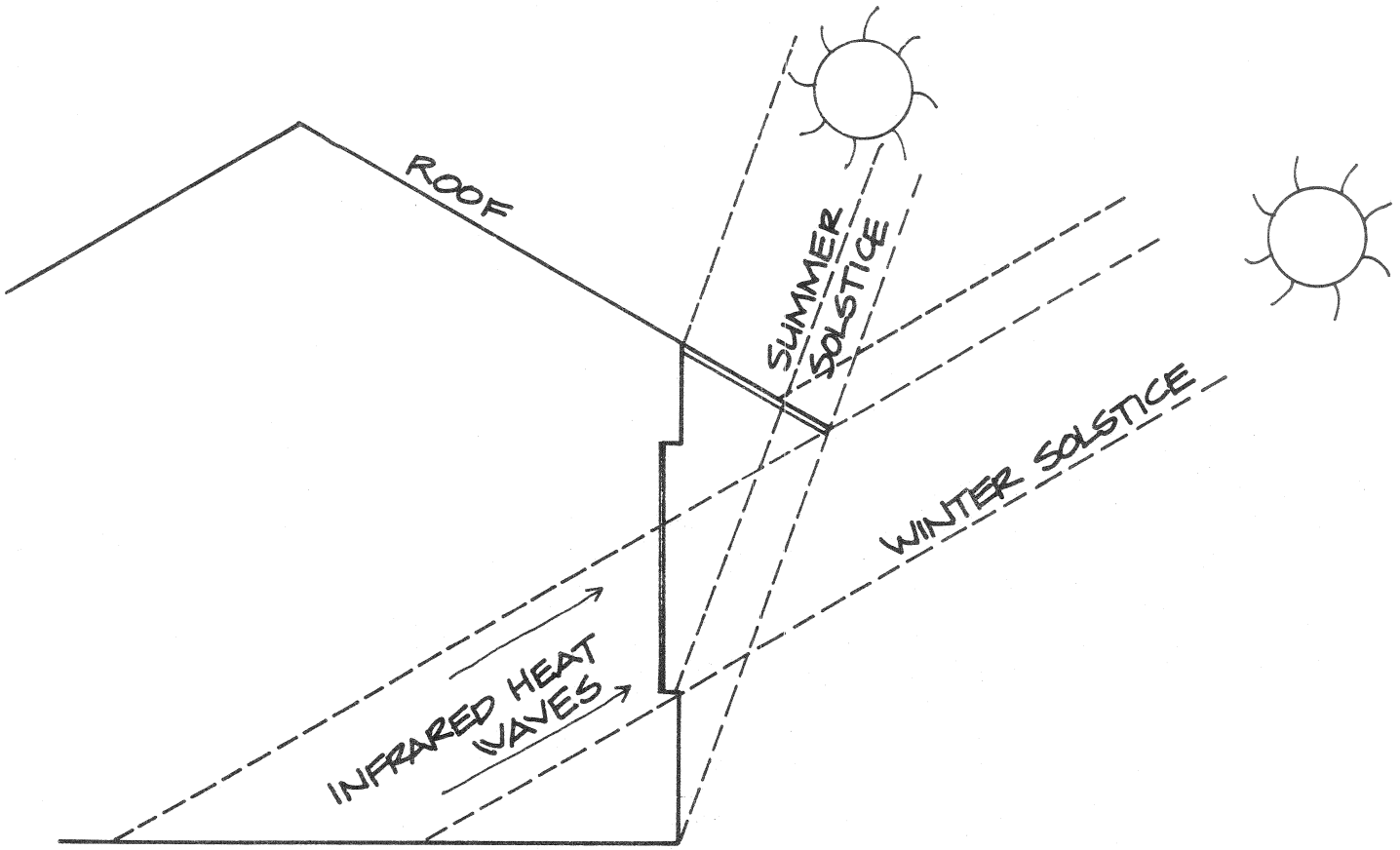
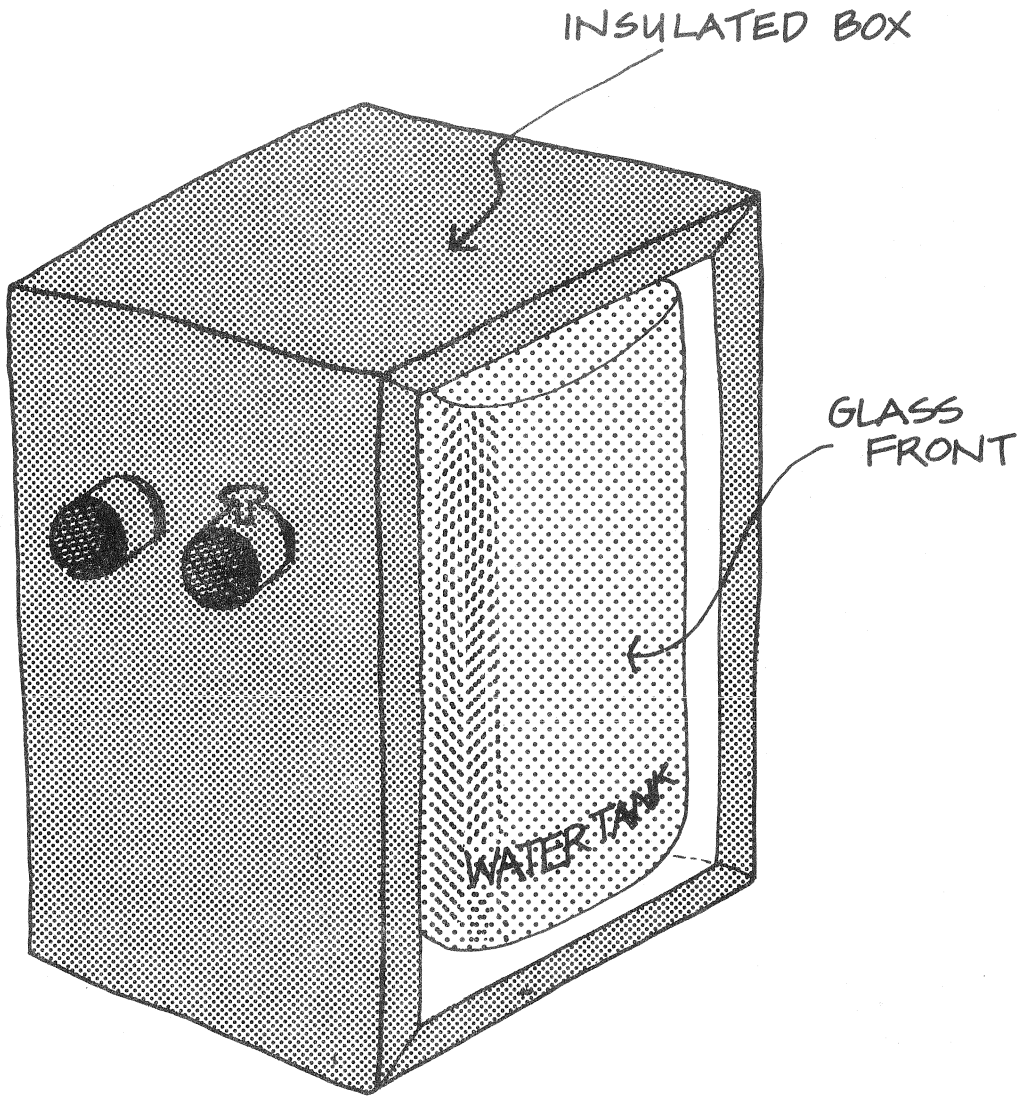


FIG. 2
FORCED CIRCULATION COLLECTOR SYSTEM (SELF-DRAINING)

WATER HEATERS



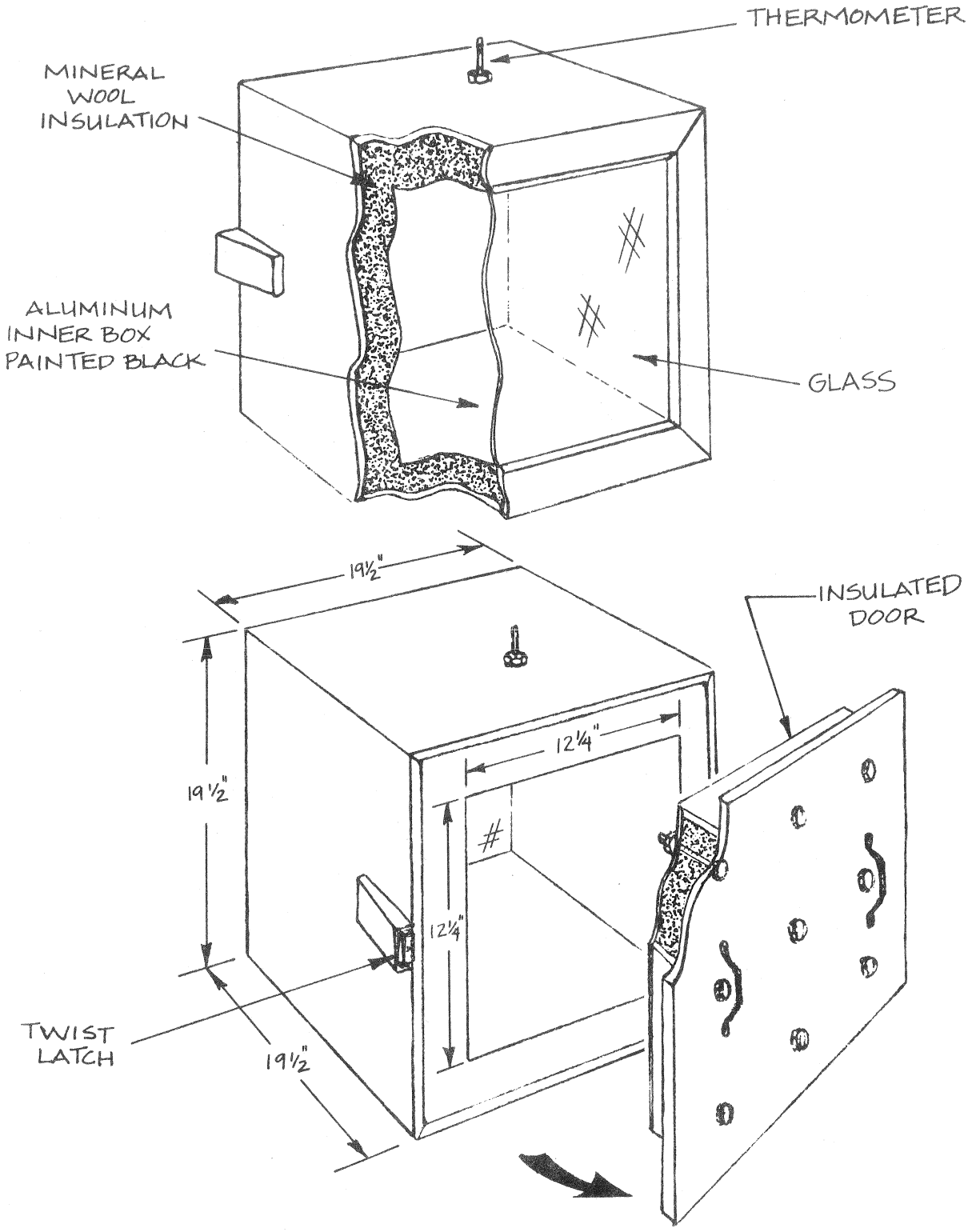
ROOF OVERHANG and THE GREENHOUSE EFFECT



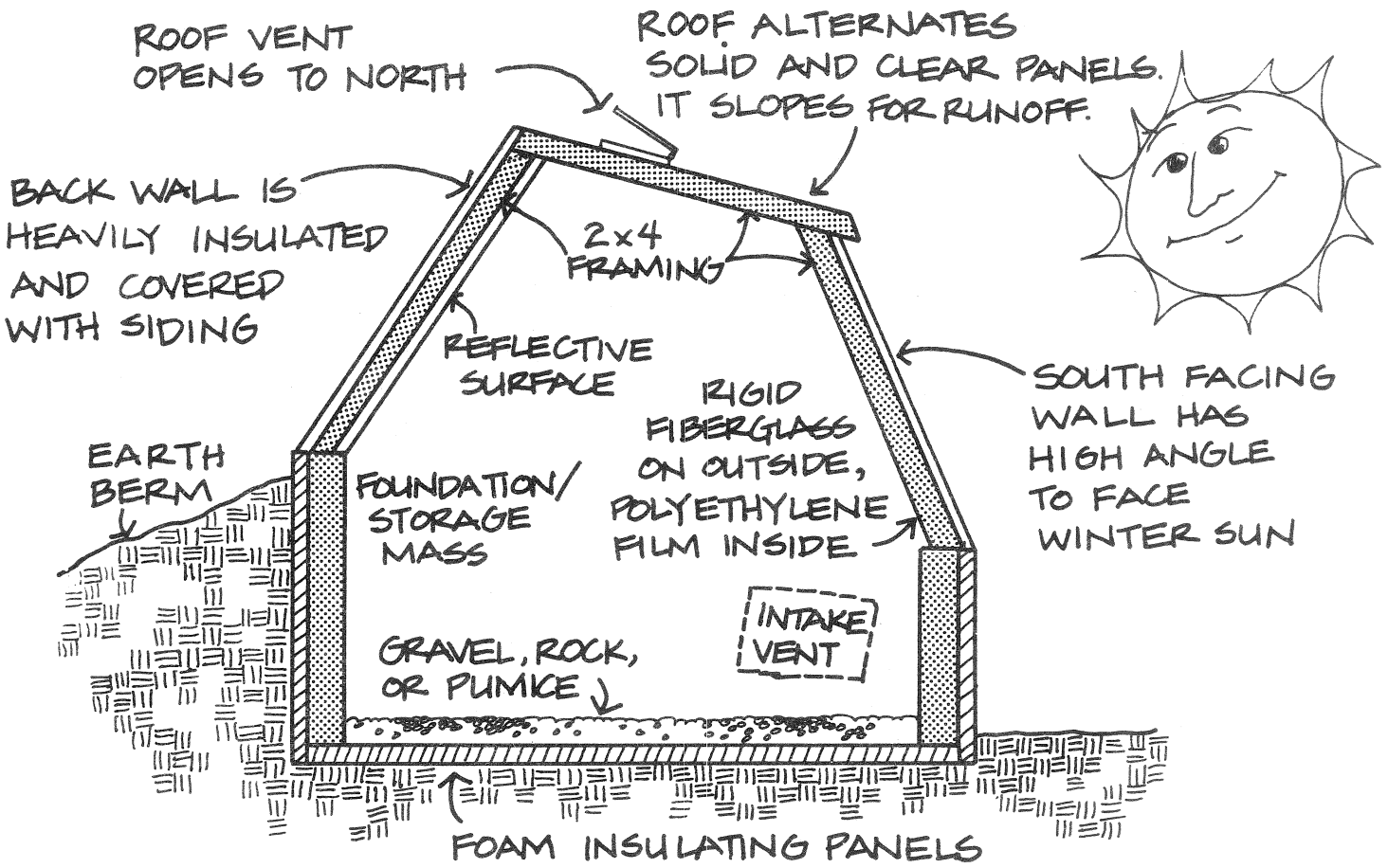
SIMPLE WATER HEATER
(BREADBOX)

SOLAR OVEN

TM-4



NOTE: DOUBLE WALL INSULATED SOLAR OVEN TO BE USED WITH A HELIOSTAT. CONSTRUCTED OF 3/4" PLYWOOD.

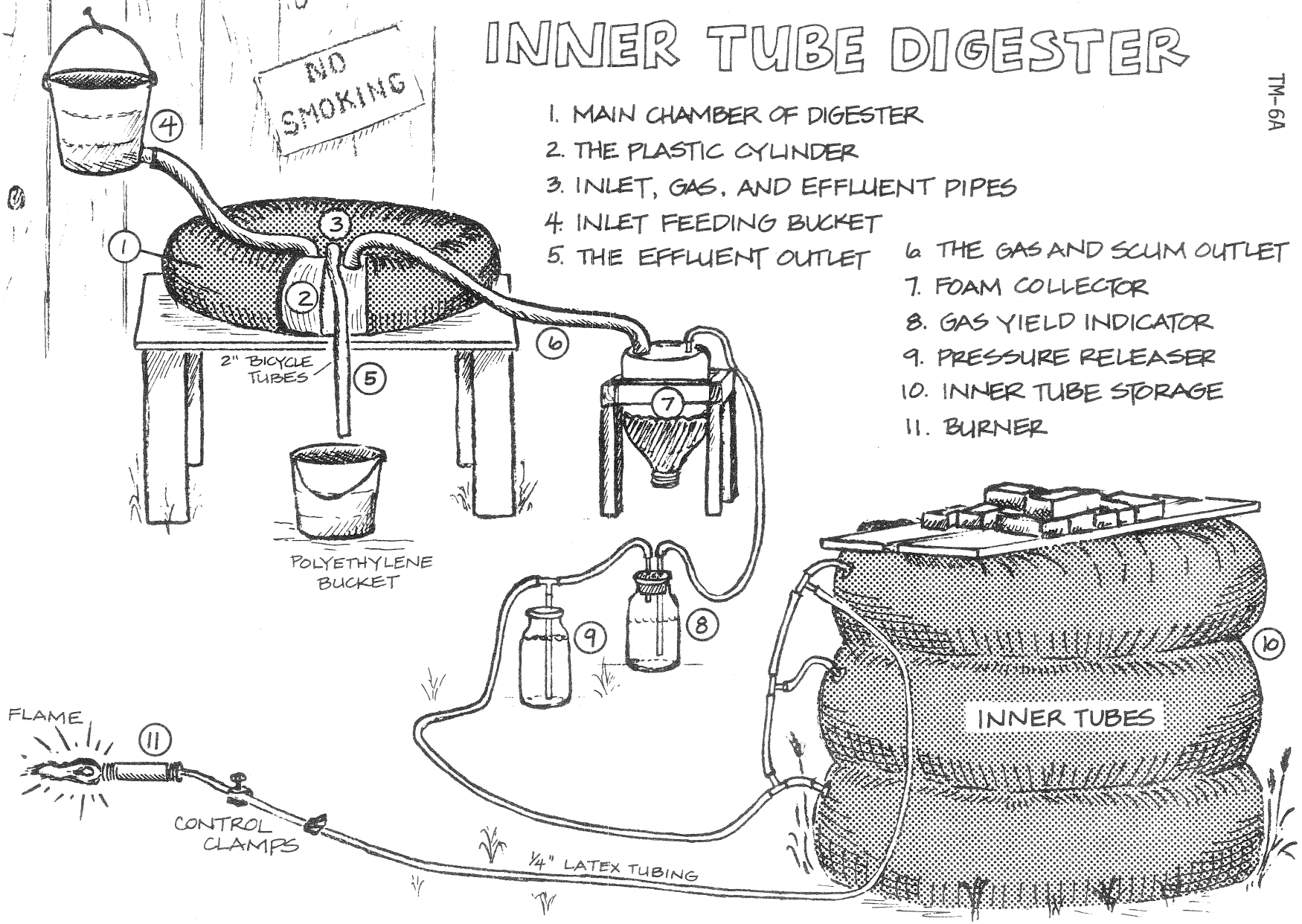


PRINCIPLES OF A SOLAR GREENHOUSE

INNER TUBE DIGESTER

TM-6A

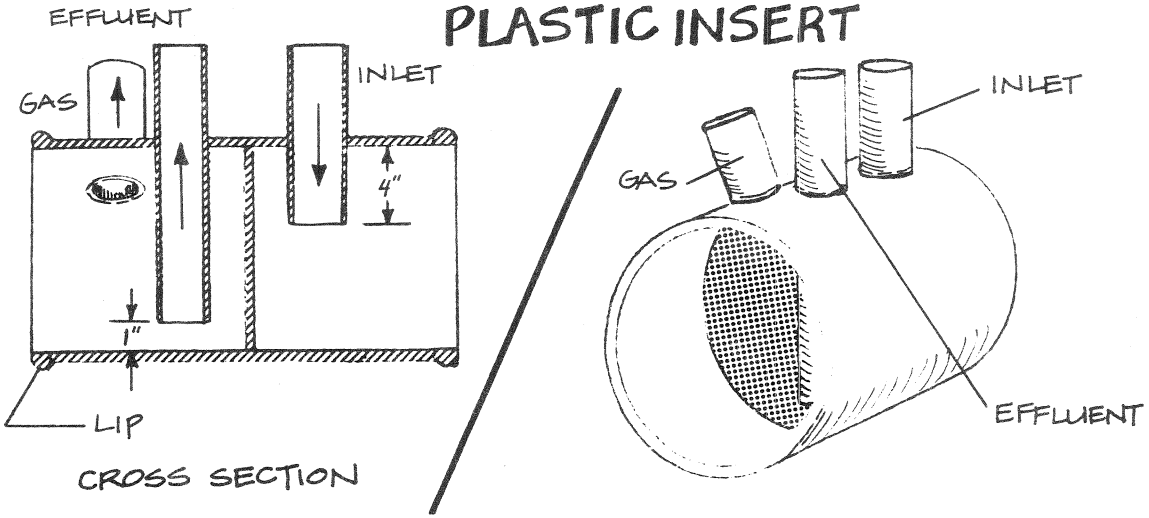
1. MAIN CHAMBER OF DIGESTER
2. THE PLASTIC CYLINDER
3. INLET, GAS, AND EFFLUENT PIPES
4. INLET FEEDING BUCKET
5. THE EFFLUENT OUTLET
6. THE GAS AND SCUM OUTLET
7. FOAM COLLECTOR
8. GAS YIELD INDICATOR
9. PRESSURE RELEASER
10. INNER TUBE STORAGE
11. BURNER



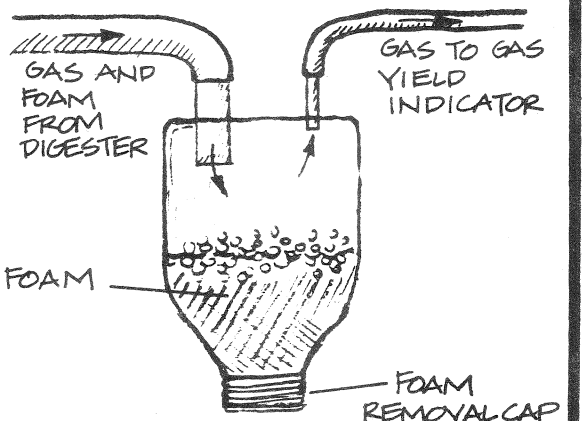
INNER TUBE DIGESTER - DETAILS

TM-6B

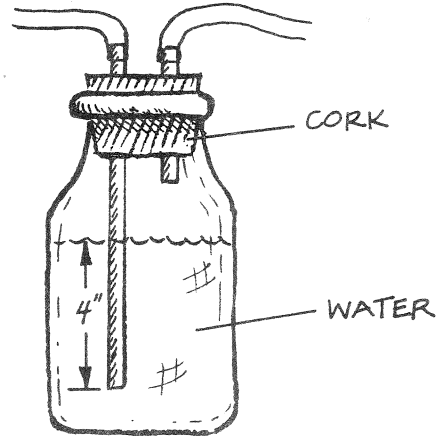
PLASTIC INSERT



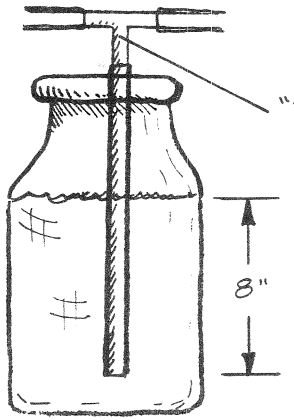
FOAM TRAP



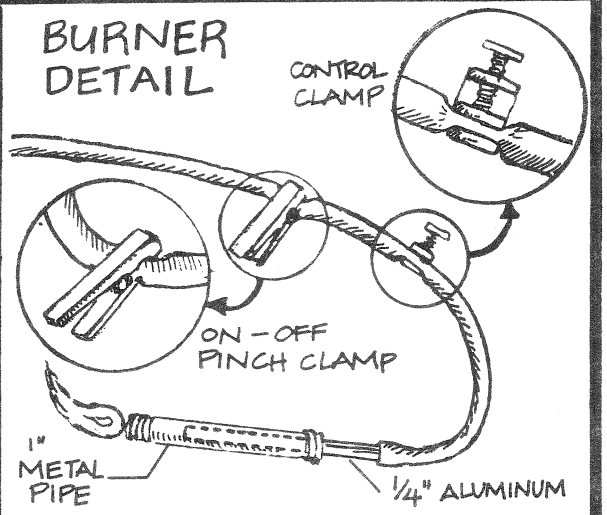
GAS YIELD INDICATOR

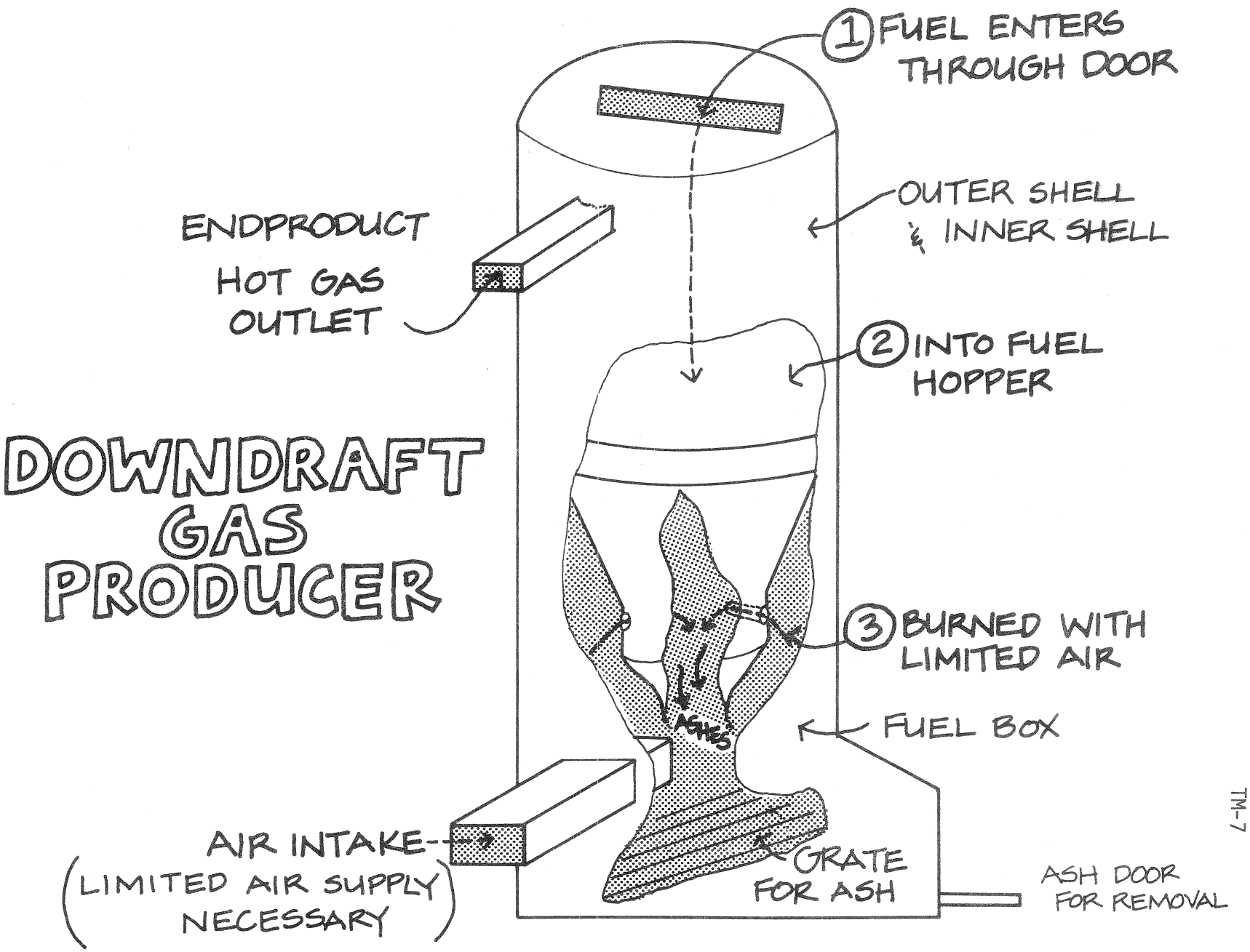


PRESSURE RELEASE BOTTLE

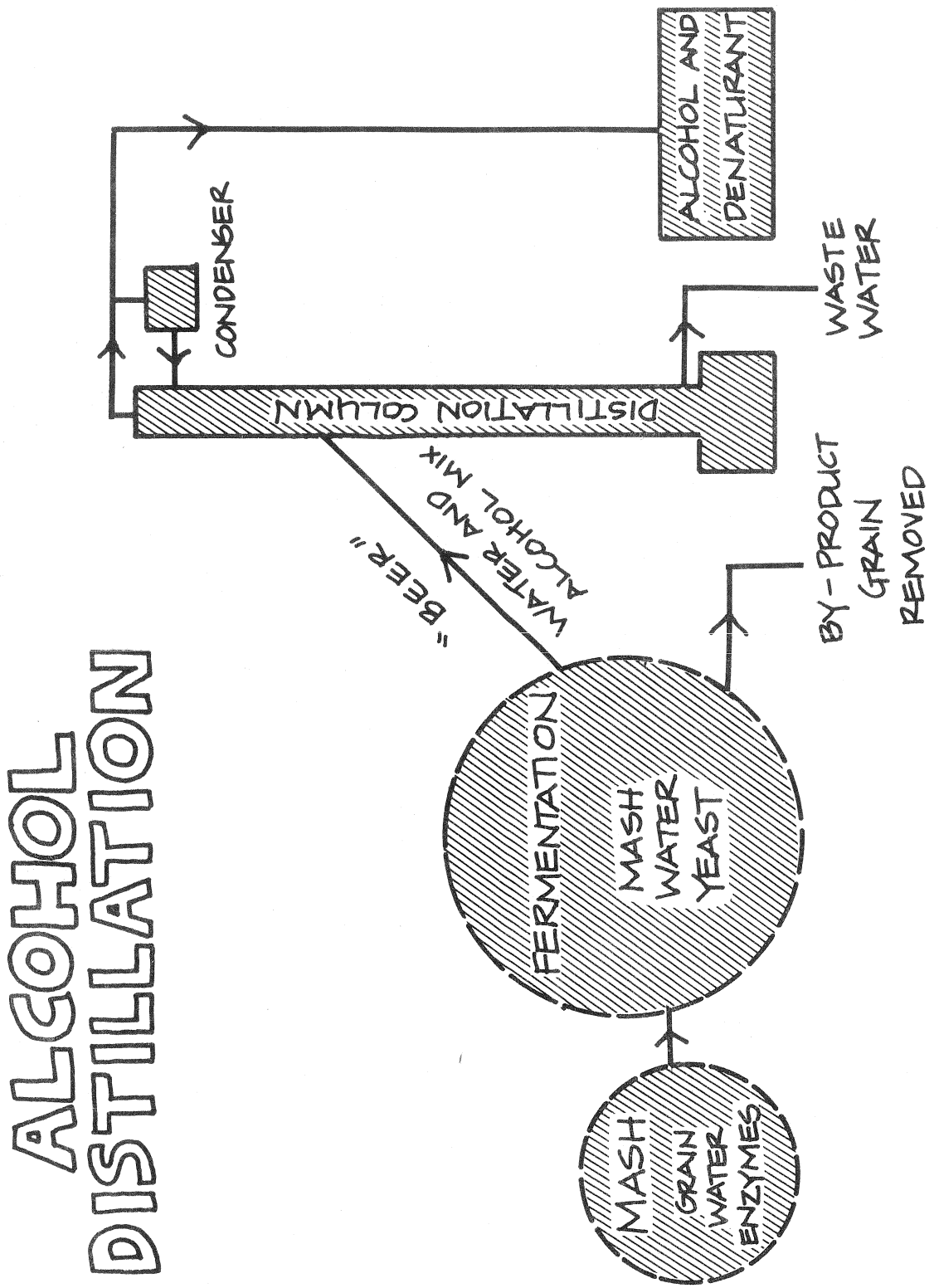


BURNER DETAIL




DOWNDRAFT GAS PRODUCER
1 FUEL ENTERS THROUGH DOOR
OUTER SHELL & INNER SHELL
ENDPRODUCT HOT GAS OUTLET
2 INTO FUEL HOPPER
3 BURNED WITH LIMITED AIR
ASHES
FUEL BOX
AIR INTAKE (LIMITED AIR SUPPLY NECESSARY)
GRATE FOR ASH
ASH DOOR FOR REMOVAL

TM-7


ALCOHOL DISTILLATION
MASH
GRAIN
WATER
ENZYMES
FERMENTATION
MASH
WATER
YEAST
"BEER"
WATER AND ALCOHOL MIX
BY-PRODUCT
GRAIN
REMOVED
DISTILLATION COLUMN
CONDENSER
ALCOHOL AND DENATURANT
WASTE WATER

References

1. Wind power: Producing Your Own Power. Rodale Press, Part I: Wind Power. Emmaus, Pa., 1977.

   Windmills and Wind Power, Cooperative Extension Bulletin 2386, University of California.

2. Solar energy:

Alternative Consumer Energy Soc.
c/o Public Education Services
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91103
(213) 354-2402

American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE)
Research and Technical Services
345 E. 47th St.
New York, NY 10017

California Solar Energy Industries Association (Cal SEIA)
926 J Street
Sacramento, CA 95814
(916) 443-1877

California Solar Energy Advocates (Cal SEA)
1107 Ninth St.
Sacramento, CA 95814

International Solar Energy Society (ISES)
c/o American Technological Univ.
P. O. Box 1416
Kileen, Texas 76541

National Association of Homebuilders (NAHB)
NAHB Research Foundation, Inc.
P.O. Box 1627
Rockville, MD. 20805

Northern California Solar Energy Association (NCSEA)
P.O. Box 1056
Mountain View, CA. 94042

Solar Energy Industries Association (SEIA)
101 Connecticut Ave., NW
Washington, D.C. 20036

Solar Utilization Now for Resources and Employment (SUNRAE)
1107 Ninth St.
Sacramento, CA. 95814
(916) 448-1198

Southern California Solar Energy Association (SCSEA)
City Administration Bldg., 11-B
202 C St.
San Diego, CA. 92101
(714) 232-3914

Collector Survey:

The Solar Survey, National Center for Appropriate Technology, 1979, 20 pp., $.75 from : NCAT, P.O. Box 3838, Butte, MT 59701. This is a survey of 19 low-cost do-it-yourself solar collectors designed primarily by grassroots organizations. Not detailed information, but the pamphlet gives enough of an idea of the system's construction and operation to determine whether follow-up communication is desirable. The booklet includes system description, schematic drawings, costs and comments by the designers from RAIN

The Solar Energy Research Institute (SERI) published in January 1979 the National Solar Energy Education Directory, 1st ed. With this voluminous production, are the listings of solar courses taught within Community/Junior Colleges and also Universities by each State in the Union. California lists 50 JC/CC. Also listed are curriculums, faculty contacts, etc. Some 26 courses of our Projct Sunrise participants are included in their listings. Copies may be obtained from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; Stock #061-000-00210-3; Price: Microfiche $3.00, Book $11.00

References (continued)

Films/Slides/Videotapes

The National Solar Heating and Cooling Information Center, P.O. Box 1607, Rockville, MD, 20850; 800/523-2929; has an excellent listing of fifty media resources available on solar topics. The recent material we have reviewed has been improving steadily in its value for use in instructional programming. Some of their slide tape presentations in specific areas such as passive design are very good. It is free for the asking.

3. Alcohol:

Iowa Dept. of Agriculture - Publications on alcohol production
Wallace Building
Des Moines, Iowa 50319

Construction Blueprints:
Solstice Publication
Domestic Technology Institute
P. O. Box 2043
Evergreen, CO 80439

Makin' it on the Farm-Nellis
American Agri. News Pub.
P.O. Box 100
Iredell, Texas 76649

4. Methane:

Producing Your Own Power. Rodale Press, Part IV: Methane Power. Emmanus, Pa., 1977.

David Hillis and W. Fairbank. "Methane Generation from Agricultural Wastes," U. C. Davis, Department of Agricultural Engineering, January 1979.

Pharaoh, D. M. Manure Digesters and Methane Gas Production. Lesmore, Great Britain.

General References

California Energy Commissions Publications Catalog, 1111 Howe Avenue, Sacramento, CA, 95825, toll free number: 800/852-7516.

James Ruhle Catalog on Energy and Environmental Developments (free), P. O. Box 4301, Fullerton, CA 92631.

Pacific Gas and Electric Co.