PN-ABJ-174

PARTICIPATORY
LOW-COST HOUSING

S&T/FENR Agro-forestation
Series #36
Rm. 515-E, SA-18
Agency for International
Development
Washington, DC 20523-1812
March 30, 1990

PARTICIPATORY

LOW-COST HOUSING

S&T/FENR Agro-forestation
SERIES #36
March 30, 1990

Written by Michael D. Benge, Agroforestry Officer, Bureau for Science and Technology, Office of Forestry, Environment, and Natural Resources, Agency for International Development, Washington, D.C. 20523

TABLE OF CONTENTS

PARTICIPATORY LOW-COST HOUSING

In many developing countries where there is much unemployment or underemployment, such as Panama and Nicaragua, there is also a dire need to construct low-cost housing. Also, there is a need to train people in manual skills such as carpentry and bricklaying. This can be done through a well planned, military-assisted civic action program in cooperation with the United States Agency for International Development (USAID). Houses can be simply constructed from Civna-Ram Earth Blocks, with wood and tile or metal roofs (see attached).

The military component can be either indigenous forces or U.S. military forces trained in civic action. Some U.S. military forces, such as Special Forces reserve units, are well trained in civic action. If indigenous forces have not been trained in civic action, U.S. forces could be used to train them. The indigenous forces in turn will train unemployed and underemployed people in manual skills so they can construct their own housing. Those already receiving training will in turn train others. (This is referred to as the multiplier effect.) In the case of Nicaragua, Contra units could be used in place of the indigenous forces. This would provide gainful employment to these former soldiers and at the same time help integrate them back into the society. During the training and construction phase of the participatory low-cost housing program, military civic-action units could also provide health care, especially setting up nascent clinics and vaccination programs for the local population. These clinics could also be built under the participatory low cost housing program, and if well planned, could be staffed and run by government health care workers once the civic action units pulled out.

A participatory low-cost housing project would have to be logistically well planned so that not only are adequately trained and equipped civic action personnel available to train the trainers, but adequate tools, building materials and food are in place to complement the training program so construction can begin immediately.

A number of the commodities needed to make a participatory low-cost housing project successful could be provided by USAID through one of its programs. PL-480 commodities, such as cooking oil, rice and beans could be provided as payment for work-in-kind to maintain families during the time they are building their own houses. The walls of the houses can be built out of Cinva-Ram Earth Blocks fabricated by the home builders. Cement, for the Earth Blocks, mortar for the blocks, for floors and steps could be also be provided by USAID. The Cinva-Ram Earth Block machines would have to be made locally, but they are easily fabricated in a local machine shop.

USAID could also provide wood for the doors, shutters, door and window frames, and rafters of the houses through one of its developmental assistance programs. USAID has provided wood as an emergency relief commodity to countries such as El Salvador and Jamaica. Through programs run by the United States Department of Agriculture, wood products have also been provided under the PL480-Title 1 Program to Jamaica and Costa Rica, and under the work for progress program to Panama. Wood could also be purchased under A.I.D.'s Commercial Import Program. The logistics of bringing the lumber into the country must be well planned so that it is there when the house building program in initiated. Additionally, it must be ensured that the lumber be treated against rot and termites or it will deteriorate rapidly in tropical countries.

It is best if tiles are used for the roofs of the houses if they are made locally, for they are more durable and less likely to be damaged by winds during hurricanes or typhoons. If tile is not available, aluminum or corrugated iron can be used as the roofing material, but it is important that it be affixed to the rafters in such a way that it won't be torn off during storms. Aluminum roofing is cooler than corrugated iron, since it reflects more heat, but in either case a ceiling can be installed simply made of flattened/woven strips of bamboo to reduce heat in the house.

Civic action teams can begin the project to train trainers in cinva-ram block making, brick laying and carpentry. They can also train trainers in well drilling and construction of community washing facilities and hermetically sealed toilets. It is important that the trainers to be trained by the civic action groups be chosen from among those needing housing, and trained, first to build their own houses. They in turn will train and assist others in the project to build their own houses, etc. Participatory training and self-help create tremendous pride in the homeowners, and maintenence is enhanced.

Such a participatory low-cost housing project would have a number of benefits including:

-- provide housing and employment to those who need it.

-- train a large number of people in manual skills, such as carpentry and masonery, which would benefit the economy of the country.

-- instill tremendous pride in the indigent and unskilled sector of the population, who are not only able to build and own their own houses, but will have a well constructed house that they could probably never afford otherwise.

V

-- provide food for work-in-kind to the needy in a non-degrading way.

-- result in excellent public relations between the host-country government and the indigent population of their country; between U.S. forces and indigenous military forces or between U.S. forces and the indigenous civilian population; and between indigenous forces and the civilian population. It would also diffuse a base of dissent that insurgency forces have been able to capitalize on among the poor urban populations of these countries.

-- keep peacetime forces busy and out of trouble and divert their energies in a constructive way. Such a program could also be geared to absorb and provide gainful employment to disbanded forces, such as the Contras in Nicaragua.

Other ingredients for a successful participatory low-cost housing project include:

-- Families must be given title to the land on which they build the houses.

-- The plot of land on which the houses are to be built must be adequately drained.

-- The locations of the houses must be well laid out, and roads or paths built to give access.

-- Adequate amounts of potable water for drinking, clothes washing and bathing must be provided to the housing area, through either pipes to individual houses or community wells. In some countries, low maintenence windmills have been installed on the wells to pump the water not only for drinking, for bathing and clothes washing, but also for irrigating garden plots or tree nurseries. This could be especially effective to complement gardens and tree nurseries at local schools.

It is important that areas where bathing and washing take place are well drained or they will become breeding grounds for mosquitoes, rats, etc. Wells that are dug must be topographically uphill and adequately distanced from toilet facilities, garbage dumps and sewage facilities to prevent pollution of the wells.

If wells are dug and pumps installed, the community must be organized in order to have adequate facilities for a specified number of families. Responsibility must be determined for the repair of the pumps and wells, either through government public works or community self-help.

-- Other sanitation facilities must be provided such as garbage disposal and pickup, and hermetically sealed public toilets. Again, an adequate number of facilities must be built for a specific number of families, and care and responsibilities for care and maintenence must be determined.

-- Since in the developing countries, most families burn either wood or charcoal for cooking, a low-cost housing project could include the installation of more energy efficient cooking stoves, built or provided as an added feature of the house (see enclosed). In some developing countries, a sizable amount of the family income is spent just on the purchase of wood or charcoal for cooking the family meal.

A number of publications and training manuels available that cover the wide variety of subjects covered in this paper, such as Cinva-Ram Earth Blocks making and well drilling. The Whole ICE Catalog, Information Collection & Exchange (RE001), 1990, published by the United States Peace Corps, Information Collection & Exchange, 1990 K Street, N.W. - 8th Floor, Washington, DC 20526, lists a number publications covering these subjects (see enclosed Table of Contents). The Remote Areas Development Manual, published by the Community Development Counselling Service, Inc, 1964, Arlington, VA, is also an excellent resource book; unfortunately, it is out of print and the company is out of business. Another is The Almanac of Rural Living, published by Western Media Printing, Tacoma, WA. Also, the Agency for International Development published in the 1960s two different volumes of a Village Technology Handbook that may be available on microfiche through the A.I.D. Resources Library, Agency for International Development, Washington, DC 20523. Volunteers in Technical Information (VITA), 1815 N. Lynn Street, Suite 200, Arlington, VA 22209 also has a number of publications covering these subjects. IT Power, Ltd., Mortimer Hill, Mortimer, Reading, Berks., RG7 3PG, United Kingdom has designed a low-cost and low-maintenance windmill and storage system.

MBenge, S&T/FENR, Rm.515-E, SA-18, Agency for International Development, Washington, DC 20523-2812, (703)875-4063, 5/29/90, 2201z/VOL1/pp1-4.

#3a

REMOTE AREAS DEVELOPMENT MANUAL

Dedicated to Improved Living Standards
and Economic Growth of
Remote Areas Populations Throughout the World

Compiled by Field Personnel

of

COMMUNITY DEVELOPMENT COUNSELLING SERVICE, INC.

(CDCS)

1815 North Fort Myer Drive
Arlington, Virginia, USA

.4
15

AIDED SELF-HELP HOUSING ABROAD

For the most of human history, shelter has been provided by the self-help method. Within recent years many governments and peoples have found that when included as a part of the process of economic development, aided self-help methods will contribute greatly to shelter improvement. They are particularly useful in countries where economic development is in its early stages, providing an opportunity for the people to make significant improvements with regard to housing within available resources by using the greatest resource of all, the manpower of the families themselves.

Thus, aided self-help in housing is a method to utilize the many man hours available in the form of heretofore unused leisure time - often enforced leisure because of seasonal unemployment, used in conjunction with some practical form of aid from the state, or others, enabling man to improve his shelter through his own efforts using profitably his spare time to an extent that he never could - alone and unaided.

Perhaps the most important consideration is that this formula permits many governments to not wait for economic development but to proceed now within available resources and to both improve living conditions and also actually contribute to economic development.

The production of better shelter by the aided self-help housing method involves certain responsibilities both on the part of the sponsor of aid and on the part of the families or groups of families who are engaged in the effort to obtain better housing. The sponsor often assists with technical advice in design and construction. Sometimes he arranges for the provision of limited amounts of hard-to-get building materials which may greatly improve the end product. Long term building loans at low interest rates are often necessary. At times the sponsor must assist in arranging for secure land tenure through title or long term lease. Often a combination of some or all of these forms of aid make up an aided self-help housing program. In any event, the sponsor must be organized and equipped to promptly furnish such aid as is deemed necessary and advisable.

The family or group to be aided must assume the responsibility for contributing its labor to the joint effort. Frequently the family gathers together all of the local materials which will be necessary. Usually it repays the cost or a portion of the cost of the aid.

The aided self-help method of improved housing and shelter encourages private ownership of property. It provides constructive opportunity for the use of spare time. It gives the family an opportunity to improve its economic position and its social status in the community. It gives each participating family a stronger interest in the economic and political stability of the country. It adds hope for a better future for many, even though their government has comparatively few resources.

The programs reported in this brochure are only a few of those which are well under way in many places. Each program can learn from the other programs, particularly new ones. This can be done through film and documents, but by far the best way is to call in people who have experience, especially those who have shown imagination and ingenuity in initiating new programs in new places. Technical cooperation in this field is developing rapidly through agreements between individual governments (bilateral); and agreements between international organizations with individual governments (multilateral) and, also, through private contracts.

EXAMPLE OF AIDED SELF-HELP HOUSING

After World War II, while most of Europe was rebuilding, Greece was still fighting against a Communist inspired revolutionary army. When the Communists were defeated late in 1949, immediate reestablishment of Greece's agricultural economy was necessary. Ninety thousand war damaged houses in over 2100 farm villages had to be rebuilt. Funds, labor, materials and transportation were in short supply. At this point, Greece turned to aided self-help housing, as a technique to rebuild for most of the homeless families.

In conference with village leaders and others, the Ministry of Housing and Reconstruction developed a plan so that returning farmers could quickly rebuild their own homes with aid from the Government. The State provided technical advice and the organization to make possible the huge building program. It furnished the scarce (often imported) materials and it delivered these materials to local points of distribution. In addition, the State supplied small amounts of cash, so that the returning farmers could purchase materials which were produced locally, and could employ a limited amount of skilled labor to show them how to rebuild and to assist them in the most difficult phases. Periodic release of aid was on the basis of eligibility and the progress which the family made in reconstruction. Living areas were limited to 300 square feet per family, with provision for future expansion.

The families accepted the responsibility for organizing the reconstruction of their homes. They gathered together the local materials which were available near the site, such as stone, adobe earth and sometimes timber, and purchased locally manufactured products such as lime. They transported the hard-to-get materials supplied by the State from the nearest distribution center to their home site. Then, with the entire family working, they rebuilt their own homes with the advice and sometimes the assistance of the limited supply of skilled labor and government technicians which were available.

SELF-HELP HOUSING MATERIAL

PRESSED EARTH BLOCKS (10% Cement or Lime Mix)

The Dampened Earth Mixture is Placed in a Machine to Form Building Blocks Under Pressure.

Compression of the Stabilized Earth Occurs. Some Authorities Suggest Sinking the Machine in a Small Pit About 18" Deep for Easier Filling and Compressing.

The Block is Removed from the Machine Ready for a Short Period of Drying Before Use.

STONE AND CEMENT SELF-HELP HOMES

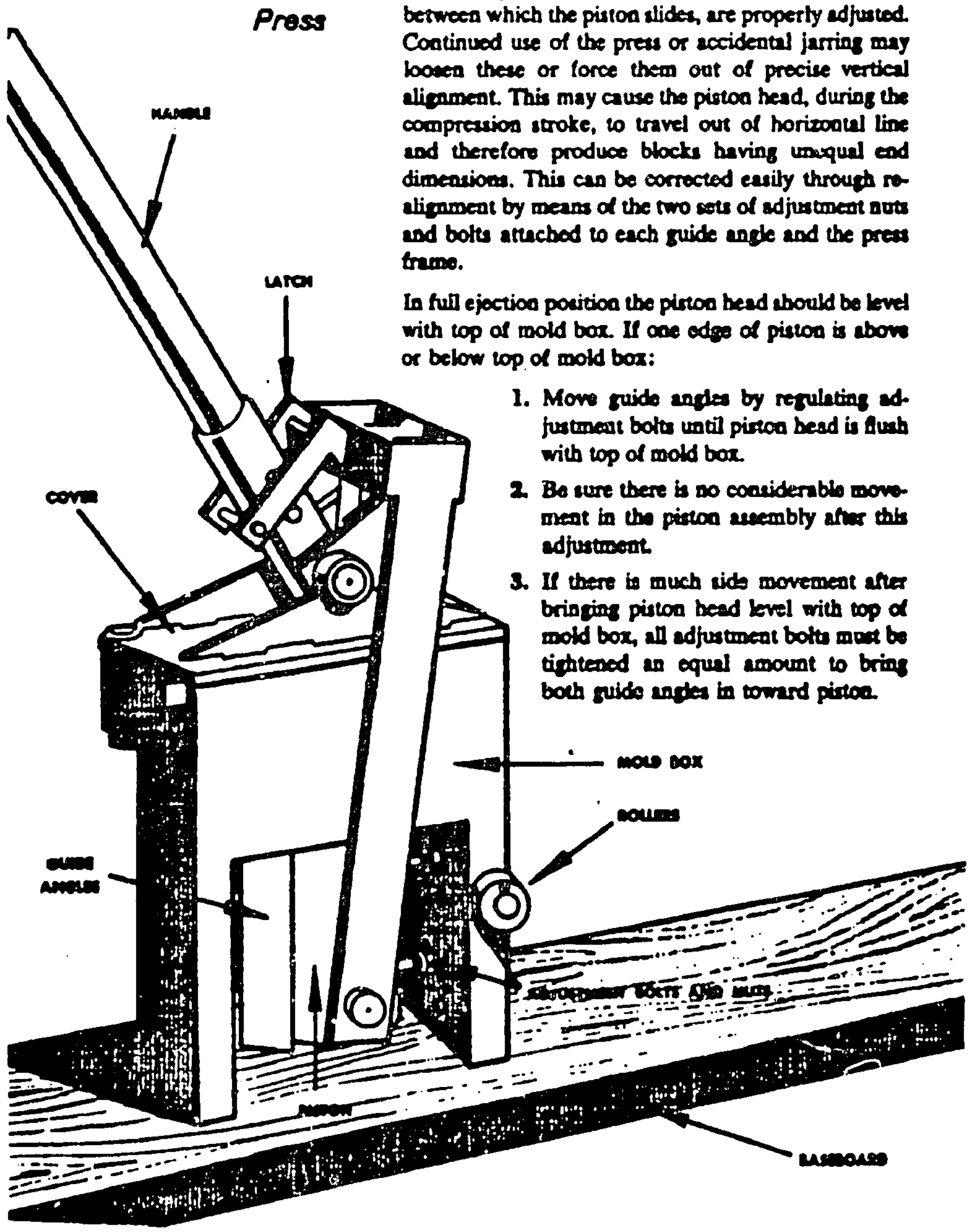
Life Begins Again for the Seventy Thousand Greek War Refugee Families who Rebuilt Their Own Homes Under the Aided Self-Help Housing Program.

EARTH BLOCK PRESS

Building blocks and tiles for small houses, farm buildings, walls, floors, patios, and walks can be made from a simple, portable, low-cost, hand-operated machine using common earth and cement or lime. The all-steel machine, tough and durable, is constructed for long and hard use. Oiling and ordinary care to keep it rust-free are the only maintenance requirements. In many areas earth blocks, if made by the user, cost only about 1/20 as much as conventional building blocks.

Earth blocks are used in the same way as other masonry building materials. In laying them up, apply the same mortar you would normally use. Blocks of heavier densities need no surface protection. They may be painted.

The Cinva-Ram Block Press



ADJUSTING THE PISTON

When the press leaves the factory the two guide angles, between which the piston slides, are properly adjusted. Continued use of the press or accidental jarring may loosen these or force them out of precise vertical alignment. This may cause the piston head, during the compression stroke, to travel out of horizontal line and therefore produce blocks having unequal end dimensions. This can be corrected easily through re-alignment by means of the two sets of adjustment nuts and bolts attached to each guide angle and the press frame.

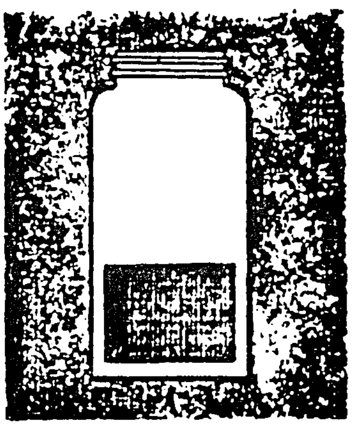
In full ejection position the piston head should be level with top of mold box. If one edge of piston is above or below top of mold box:

1. Move guide angles by regulating adjustment bolts until piston head is flush with top of mold box.
2. Be sure there is no considerable movement in the piston assembly after this adjustment.
3. If there is much side movement after bringing piston head level with top of mold box, all adjustment bolts must be tightened an equal amount to bring both guide angles in toward piston.

SELECTING THE EARTH

Most earth, when reasonably free from vegetable matter, will make good compressed earth blocks and tiles. Select earth on your property which requires the least amount of digging to meet this specification. The earth from foundation or basement excavations will usually be suitable.

STEPS IN TESTING YOUR EARTH

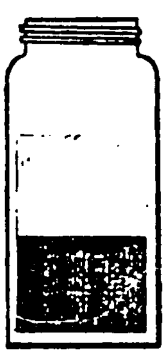


1

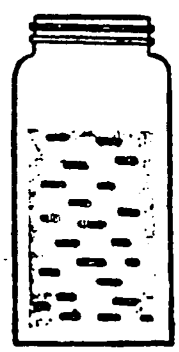
1. Fill a straight-sided glass jar about one-third full of earth.
2. Add water to fill jar about two-thirds full.
3. Cover jar and shake vigorously until all of the earth is in suspension.
4. Allow earth to settle until you can see the various particle-size divisions. (About 30 minutes.)

Although any earth will make a suitable block, one should attempt to use earth which will make the best block. This is made from earth having particle-sizes from very fine to fairly coarse. The coarse particles should not be less than one-third, nor more than two-thirds of the earth in the jar. The only earth which is not suitable is earth having only one particle-size. However, it is often possible to add sand to make fine-particle earth suitable.

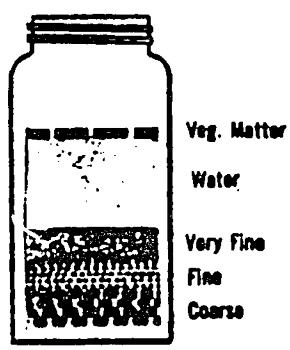
2

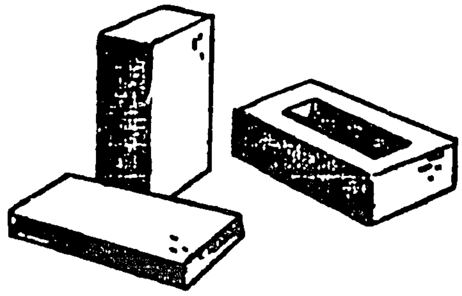


3

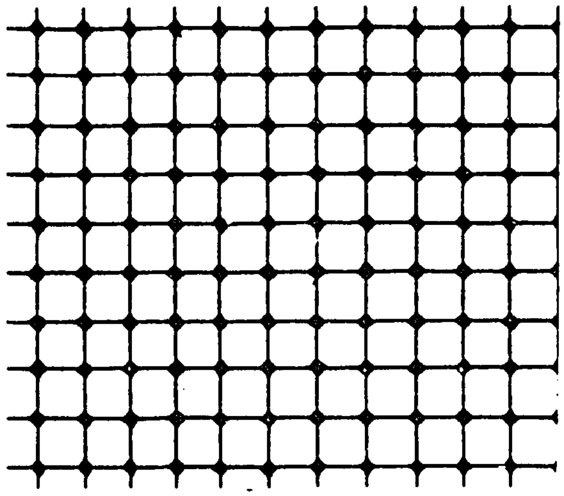


4





Blocks and Floor Tiles



¼" mesh: actual size —

PREPARING THE EARTH

Only the simplest of implements are required to properly prepare the selected earth.

SCREENING THE EARTH

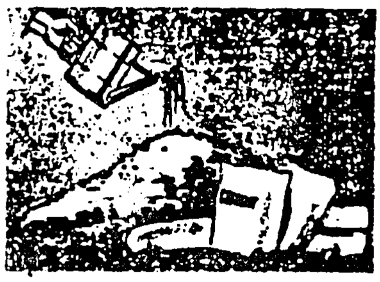
The selected earth must be screened through mesh having openings of about ¼" square.

Screening the soil

ADDING THE CEMENT

Depending upon the intended use of the blocks and the climatic conditions, excellent results can be obtained with 5 to 10 percent cement. After screening the earth, sprinkle the measured amount of cement evenly and mix thoroughly. Generally, a higher percentage of cement will result in a block having greater resistance to erosion, absorption, and abrasion.

Moistening the soil

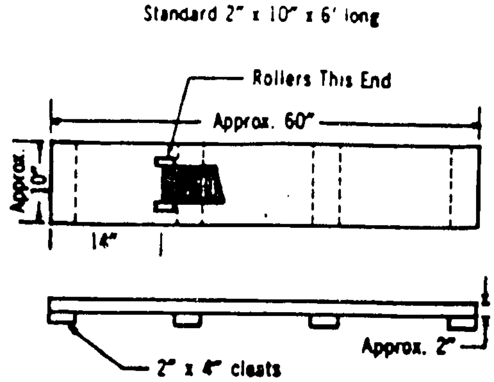


NOTE: Lime may be substituted for Cement, but in doing so, double the quantity of Lime used and also Double the Curing Time of the Blocks or Tiles.

MOISTURE CONTENT

The amount of moisture in the earth mixture is one of the *most important requirements*. A simple test to determine the correct amount of moisture in the mix is to squeeze a ball of the soil mix in your hand. If the ball can be broken in two without crumbling and without leaving any moisture on your hand, the moisture content is correct. Should the mix be too dry, sprinkle small amounts of water evenly and mix thoroughly until it is of the right consistency.

determining the dampness



MOUNTING THE PRESS

The press must be attached to a wooden baseboard for necessary stability.

OPERATING THE PRESS

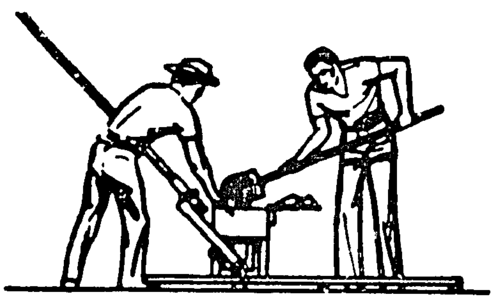
In order to make good compressed earth blocks and tiles, enough earth mix must be loaded into the mold box to require a *hard pull* on the handle. Make a few test blocks and tiles to determine the quantity of your earth mix which must be loaded into the press to give you this adequate, hard pull.

There are three basic operations in making the compressed earth blocks or tiles:

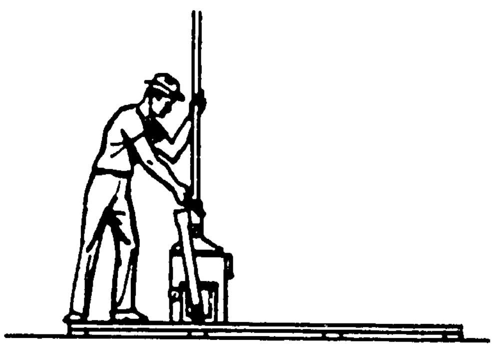
1. Loading the mold box.
2. Compressing the mix.
3. Ejecting the finished product.

Detailed Movements

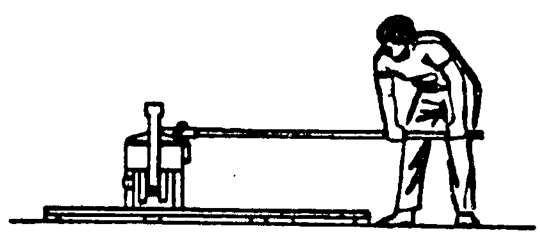
1. Place the handle in the rest position and open the mold box by swinging the cover horizontally until its stop is reached; then fill the mold box with the prepared earth.
2. Close the mold box, skimming off excess earth, and bring the handle to the vertical position; then release the latch.
3. Pull down the handle until it is parallel with the ground. This applies the necessary pressure to form the block. If the mold box is properly filled, this should require a *"hard pull"*.



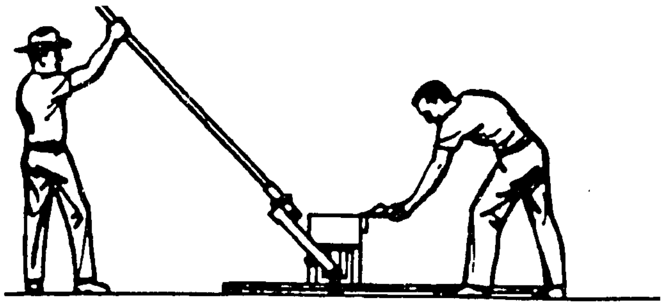
1.



2.



3.

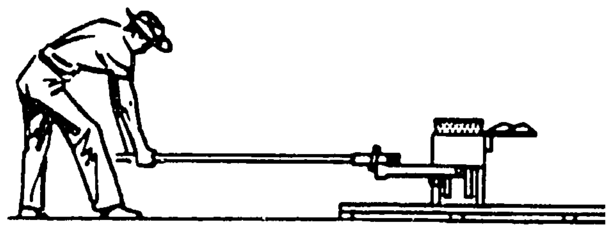


4. Return the handle to the original rest position, swing cover back and open the mold box.
5. Pull down on the handle in the opposite direction until it is parallel with the ground. This ejects the block.

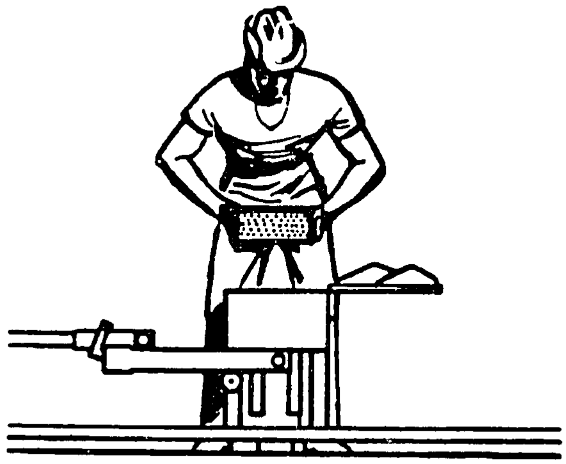
6a *Removing blocks from the press:* Place hands flat at the ends of the block, being careful not to damage the corners or edges and then gently lift the block from the mold box. Place on edge at the curing site.

6b *Removing tiles from the press:* Place one flat hand on top of the tile. Keeping the tile and wooden insert together, slide both off the mold box until the other hand can be placed beneath the insert. Place both on edge at the curing site and then gently separate the insert from the tile.

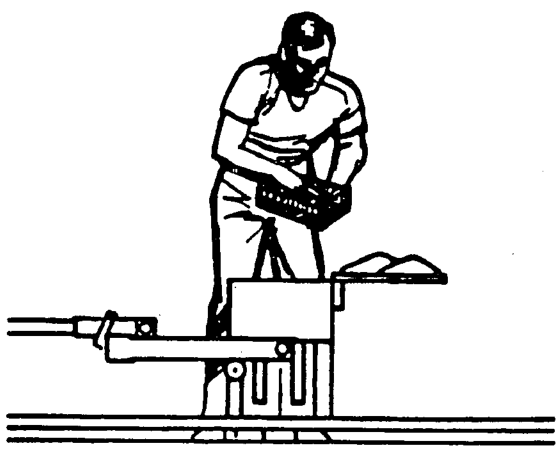
***NOTE:** One of the greatest advantages of a compressed earth block or tile is that it can be removed immediately from the press without the use of a pallet.*



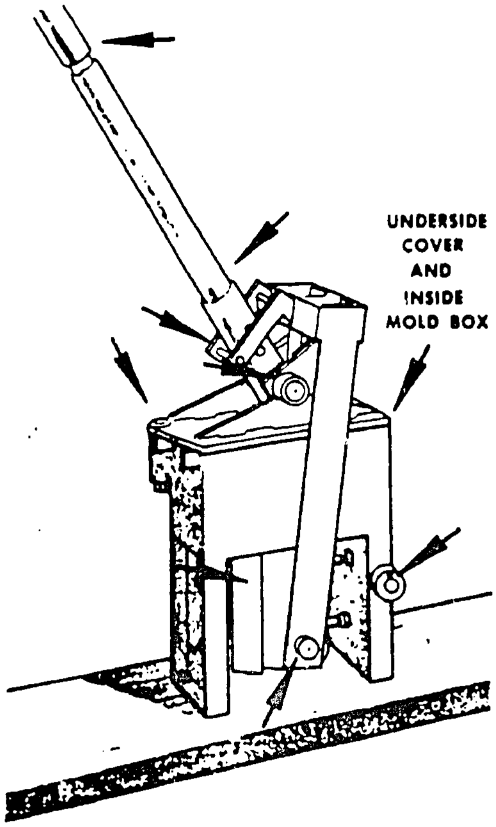
5.



6a



6b



LUBRICATION POINTS

LUBRICATING THE PRESS AND ACCESSORIES

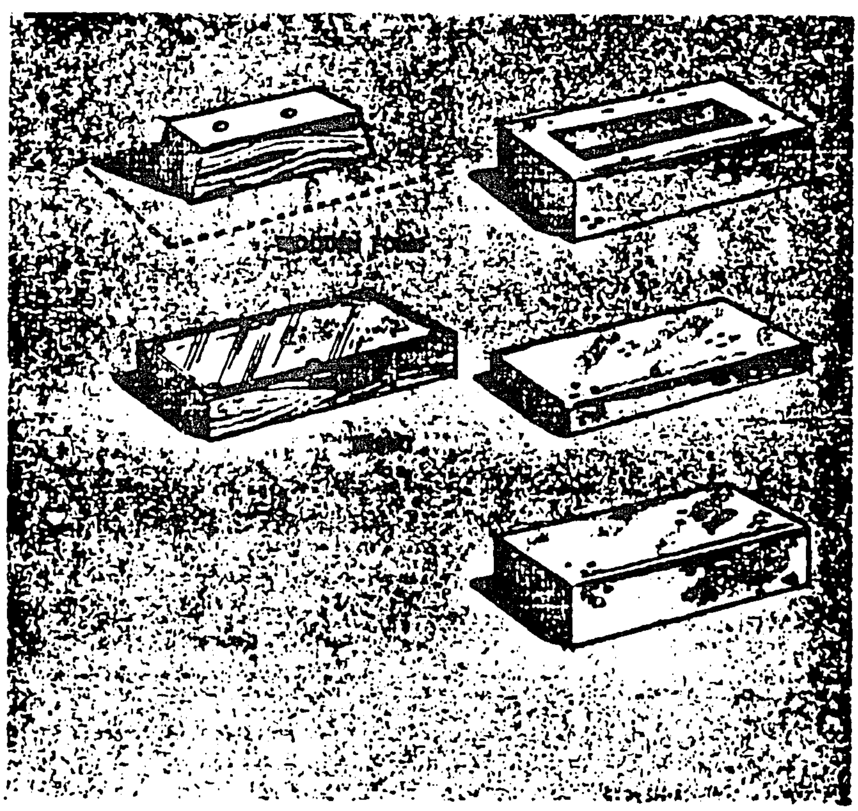
Before and during operation, oil all moving and wearing parts; especially the underside of the steel cover, the inside of the mold box, the metal face of the insert. and the wooden form. FREQUENT oiling of the form and insert DURING OPERATION will prevent finished blocks and tiles from sticking when removing them from the press. A light coating of oil over the entire press after operation or during storage for long periods of time will keep it free from rust.

MAKING BLOCKS AND TILES

To make a solid block, do not use the wooden form or the insert. Remove both from the mold box. If the wooden form is attached to the piston head, it can be released by removing the two screws at the top of the wooden form.

To make a semi-hollow block, attach only the wooden form to the piston head by means of the two screws supplied.

To make a tile, place only the insert at the bottom of the mold box, *Metal face up.*



NOTE: Each Cinva-Ram comes equipped with 5 inserts to fabricate blocks for field drains, grilles, lintels, shelf-supports, conduits and pipes, as well as semi-hollow, tile, and half blocks.

CURING THE BLOCKS AND TILES

The instructions for curing Cinva-Ram blocks and tiles should be followed carefully. In general, they are cured similarly to cement blocks or concrete. The moisture in Cinva-Ram blocks must be eliminated slowly, under cover and protected from sun and rain. They should not be stacked upon each other during the first three or four days after making. They should be separated, in single rows away from direct contact with the ground. For the first three or four days they must be sprinkled lightly with water twice a day. On the eighth day blocks may be laid-up in a wall where they continue to cure and gain full strength in about 30 days.

Tiles should not be laid-up until they have fully cured (about 25 days).

NOTE: If Lime is used in making the Blocks or Tiles, Remember to Double the Curing Time.

15
271

DEEP DUG WELL

Abstract

Simple, light equipment and untrained workers can safely make a deep, sanitary well if good supervision is provided. This paper outlines the basic method.

Tools and Materials

- Shovels, mattocks
- Buckets
- Rope...deep wells require wire rope
- Forms...steel, welded and bolted together
- Tower with winch and pulley
- Cement
- Reinforcing rod
- Sand
- Aggregate
- Oil

Details

The hand dug well is the most widespread of any kind of well. Unfortunately, most of these wells were dug by uninformed people and now are infected by parasitic and bacterial disease. By using modern methods and materials, dug wells can safely be made 60 meters (196.8 feet) deep and will give a permanent source of pure water.

Experience has shown that for one man, the average width of a round well for best digging speed is 1 meter (3¼ feet). However 1.3 meters (4¼ feet) is best for two men digging together and they dig more than twice as fast as one man. Thus, two men in the larger hole is usually best.

Dug wells always need a permanent lining (except in solid rock and here the best method is usually to drill a tubewell).

The lining prevents collapse of the hole, supports the pump platform, stops entrance of contaminated surface water, and supports the well intake which is the part of the well through which water enters. It is usually best to build the lining while digging, since this avoids temporary supports and reduces danger of cave-ins. Dug wells are lined in two ways; where the hole is dug and the lining is built in its permanent place and where sections of lining are added to the top and the whole lining moves down as earth is removed from beneath it. This is called caissoning. Often a combination of both is best, as shown in Figure 1.

If possible, use concrete as it is strong, permanent, made mostly of local materials, and can be handled by unskilled workers with good speed and results. Masonry and brickwork are widely used in many countries and can be very satisfactory if conditions are right. In bad ground, however, unequal pressures can make them bulge or collapse. Building with these materials is slow and a greater thickness of wall is required than with concrete. There is also always the danger of movement during construction in loose sands or swelling shale before the cement has set firmly between the bricks or stones. This danger is prevented with concrete by leaving the form in place to support the lining, until the concrete is hard. Also, skilled masons, suitable stone or well-fired bricks may not be readily available, while it is easy to train unskilled workers to place concrete, and sand and gravel can usually be found within reasonable distance of the wellsite. Wood and steel are not good as wood requires bracing, tends to rot and hold insects, as well as sometimes making the water taste badly. Worst of all, it will not make the well watertight against contamination. Steel is seldom used because it is expensive, rusts quickly, and usually is subject to bulging and bending.

The general steps in finishing the first fifteen feet are:

- set up a tripod winch over cleared, level ground and reference points for plumbing and measuring the depth of the well.
- two men dig the well while another raises and unloads the dirt until the well is exactly 15 feet deep.
- the hole is accurately trimmed to size using a special jig mounted on the reference points.
- the forms are carefully placed and filled one by one with tamped concrete.

After this is done, dig to 30 feet, trim and line this part also with concrete. A five inch gap between the first and second of these sections is filled with pre-cut concrete which is grouted in place. Each lining is self-supporting as it has a curb. The top of the first section of lining is thicker than the second section and extends above the ground to make a good foundation for the pump housing and to make a safe seal against ground water.

This method is used until the water-bearing layer is reached where an extra-deep curb is constructed. From this point on, caissoning is used.

Caissons are concrete cylinders fitted with bolts for attaching them together. They are cast and cured on the surface in special molds, prior to use. Several caissons are lowered into the well and assembled together. Then a workman digs and the caissons drop lower as earth is removed from beneath them. The concrete lining guides the caissons.

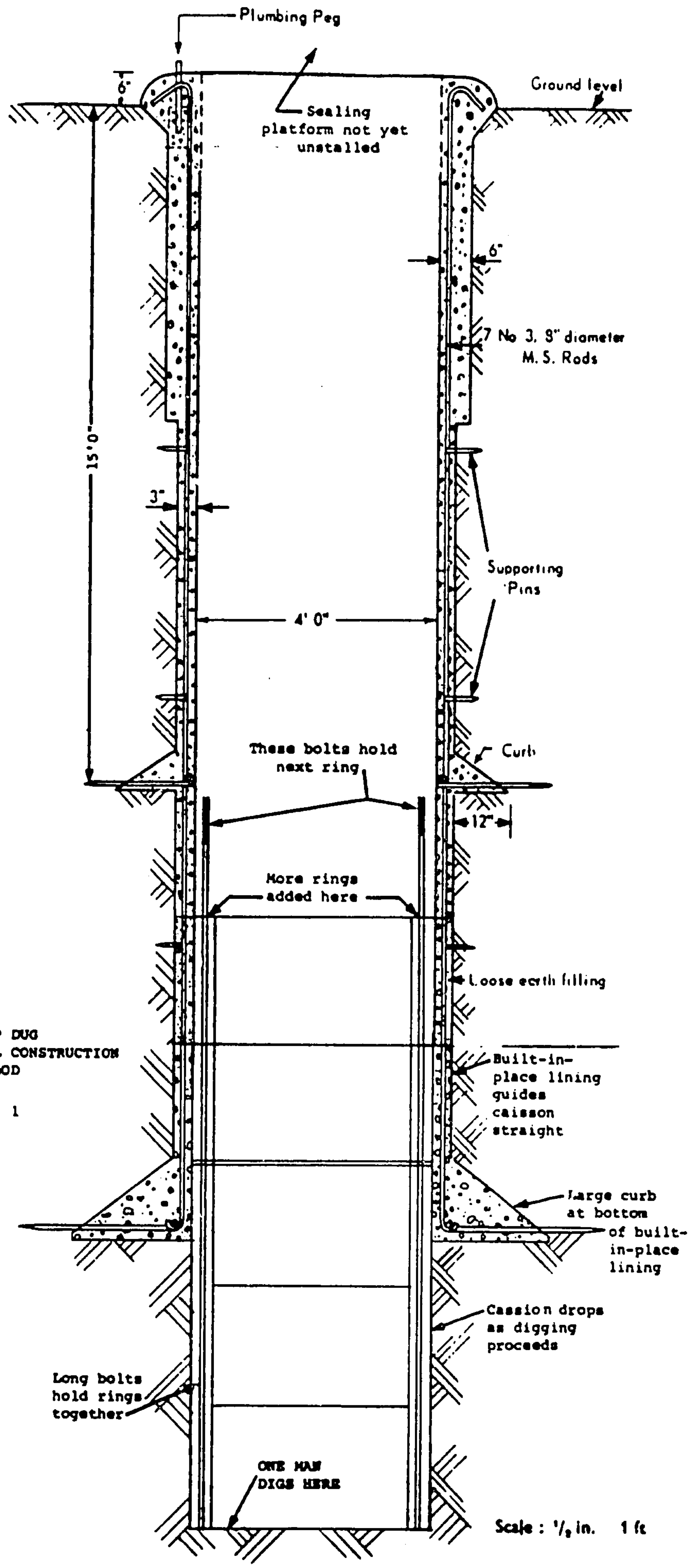
If the water table is high when the well is dug, extra caissons are bolted in place so that the well can be finished by a small amount of digging and without concrete work, during the dry season.

Evaluation

Detailed plans and equipment for this process are found in WHO Monograph #42. The method has been widely used in Nigeria.

Material from...WHO Monograph #42
Water supply for rural
areas and small communi-
ties...E.G. Wagner and
J.N Lanoix (1959)

33 18



DEEP DUG
WELL CONSTRUCTION
METHOD

FIG. 1

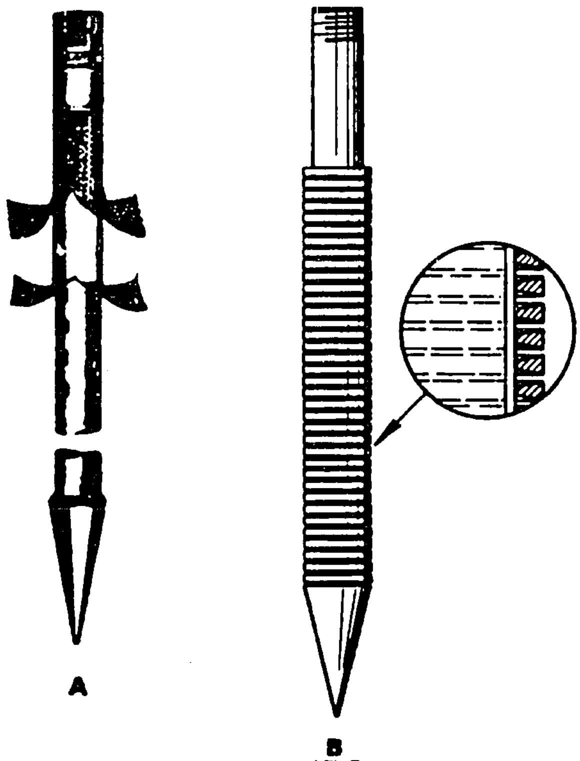
DRIVEN WELL

Abstract

A pointed strainer called a well point, properly used, can quickly and cheaply drive a sanitary well, usually less than 25 feet deep.

Tools and Materials

Well point and driving cap...usually obtainable from the U. S. for about $10, through mail order houses
Pipe...3 cm (1 inch) diameter
Heavy hammer and wrenches
Pipe compound
Special pipe couplings and driving arrangements are desirable but not necessary



A – Common type of screen for well point. It is reasonable in cost and, in a good water-bearing formation, it can give good results. Over-pumping is apt to plug up the screen.

B – An effective type of well point. It will not plug easily but is more expensive than common screens. With proper development, large quantities of water can be obtained through such well points.

Details

Driven wells are highly successful in coarse sand where there are not too many rocks and the water table is within 7 meters (23 feet) of the surface. They are usually used as shallow wells where the pump cylinder is at ground level. If conditions for driving are very good, 10 cm (4 inches) diameter points and casings that can accept the cylinder of a deep well, can be driven to depths of 10 to 15 meters (33 to 49 feet).

Before starting be sure the driving cap is tight, butted against the end of the pipe. Check to see that the pipe is vertical with a plumb bob. Test it occasionally and keep it straight by pushing on the pipe while driving. Hit the drive cap squarely each time or you may damage the equipment.

There are several methods that help avoid damage to the pipe. Least destructive is to drive with a steel bar that is dropped inside the pipe and strikes against the inside of the steel well point. It is retrieved with a cable of rope. Once water enters the well, this method does not work.

Another way is to use a driver pipe, which insures hitting the drive cap squarely. A guiderod can be mounted on top of the pipe and a weight dropped over it, or the pipe itself used to guide a falling weight which strikes a special drive-clamp. See Figure 2.

Figure 3 is a table which will help identify the formations being penetrated. Experience is needed...but this may help you to understand what is happening.

When you feel that the water-bearing layer has been reached, stop driving and attach a handpump to try the well. Usually this is shown by easier driving, especially in coarse sand. If the amount of water pumped is not enough, try driving a few feet more. If the flow decreases, pull the point back until the point of greatest flow is found. The point can be raised by using a lever arrangement like a fence-post jack, or, if a drive-monkey is used, by pounding the pipe back up.

Sometimes sand and silt plug up the point and the well must be 'developed' to clear this out and improve the flow. First try hard, continuous pumping at a rate faster than expected. Mud and fine sand come up with the water, but this should clear in about an hour. It may help to allow the water in the pipe to drop back down, reversing the flow periodically. With most pitcher pumps this is easily accomplished by lifting the handle very high, which opens the check valve, allowing air to enter and the water rushes back down the well.

If this does not clear up the flow, there may be silt inside the point. This can be removed by putting a 3/4 inch pipe into the well and pumping on it. Use the pitcher pump or else quickly and repeatedly raise and lower the 3/4 inch pipe. By holding your thumb over the top of the pipe on the upstroke, a jet of muddy water will result on each downstroke. After getting most of the material out, return to direct pumping. Clean the sand from the valve and cylinder of pump after developing the well. If you have chosen too fine a screen, it may not be possible to develop the well successfully. A properly chosen screen allows the fine material to be pumped out, leaving a bed of coarse gravel and sand that provides a highly porous and permeable water-gathering area.

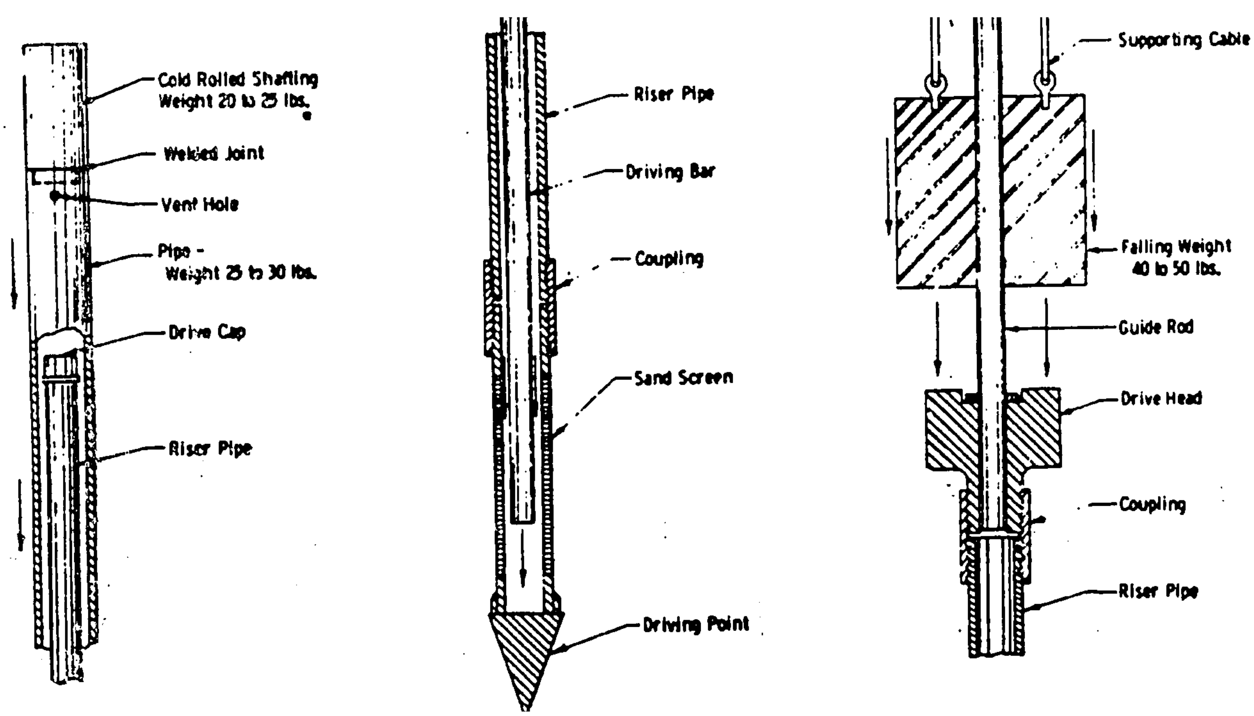
Well points usually are of two types...

- a slotted steel pipe with no covering screen, which allows more water to enter but is less rugged

- a pipe with holes covered by a screen and a brass jacket with holes. For general use, a #10 slot or 60 mesh is recommended. Fine sand requires a finer screen, perhaps 90 mesh or a #6 slot

Before starting to drive the point, make a hole at the site with handtools. In heavy soils, particularly clay, an earth auger is faster than driving. The hole should be plumb and have a diameter slightly larger than the well point.

The joints must be carefully made to prevent thread breakage and assure airtight operation. Clean and oil the threads carefully and use joint compound and special drive couplings when available. To insure that joints stay tight, give the pipe a fraction of a turn after each blow, until the top joint is permanently set. Do not twist the whole string and do not twist and pound at the same time. The latter may help get past stones, but soon will break the threads and make leaky joints.



DRIVING METHODS.

The final step is to fill in the starting borehole with puddled clay or, if clay is not available, with well-tamped earth. Make a solid, waterproof pump platform (concrete is best) and provide a place for spilled water to drain away.

Evaluation

In soils where the driven well is suitable, it is often the fastest and most economical way to dig a sanitary well.

Material from...WHO Monograph #42, Water Supply for Rural Areas and Small Communities.

Figure 3 Identification of Formation Being Penetrated

Type of formation	Driving conditions	Rate of descent	Sound of blow	Rebound	Resistance to rotation
Soft moist clay	Easy driving	Rapid	Dull	None	Slight but continuous
Tough hardened clay	Difficult driving	Slow but steady	None	Frequent rebounding	Considerable
Fine sand	Difficult driving	Varied	None	Frequent rebounding	Slight
Coarse sand	Easy driving (especially when saturated with water).	Unsteady irregular penetration for successive blows	Dull	None	Rotation is easy and accompanied by a gritty sound
Gravel	Easy driving	Unsteady irregular penetration for successive blows	Dull	None	Rotation is irregular and accompanied by a gritty sound
Boulder and rock	Almost impossible	Little or none	Loud	Sometimes of both hammer and pipe	Dependent on type of formation previously passed through by pipe

from: Wells, TM5-297/AFM 85-23, 1957
Army Technical Manual, P. 24

Fig. 32. IMPROVEMENT OF EXISTING WELLS (I)

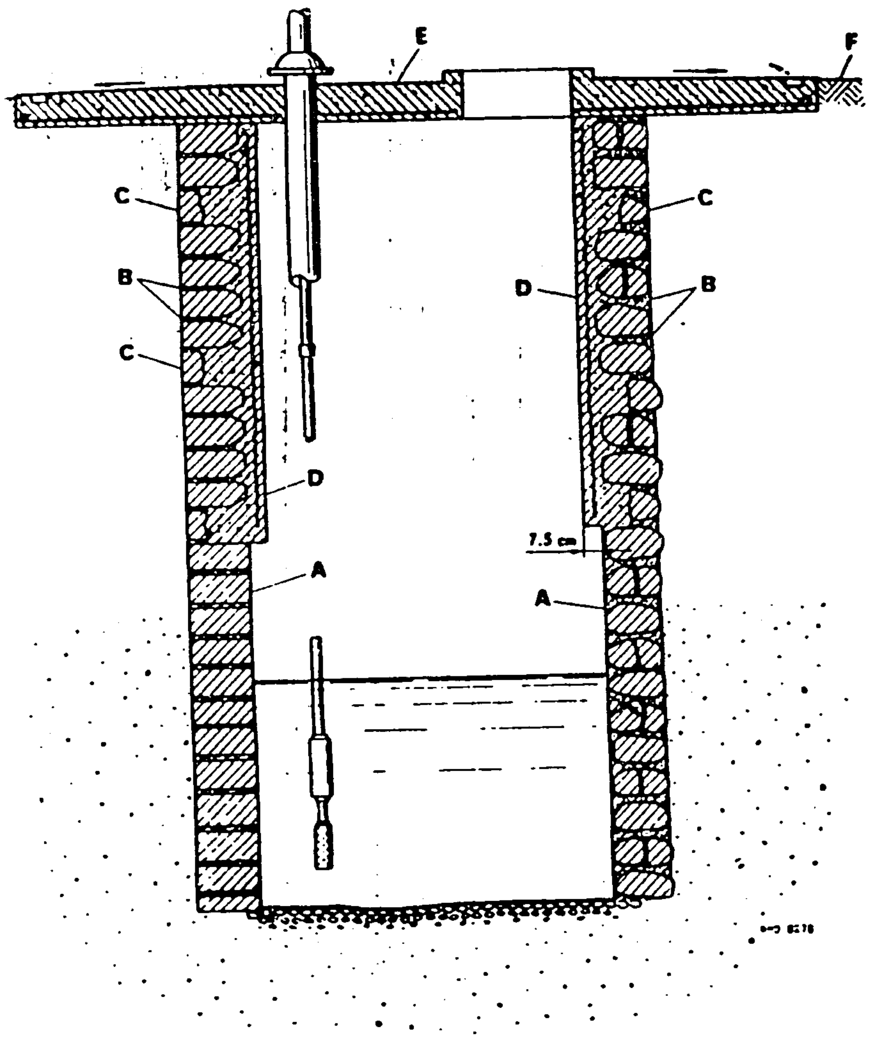
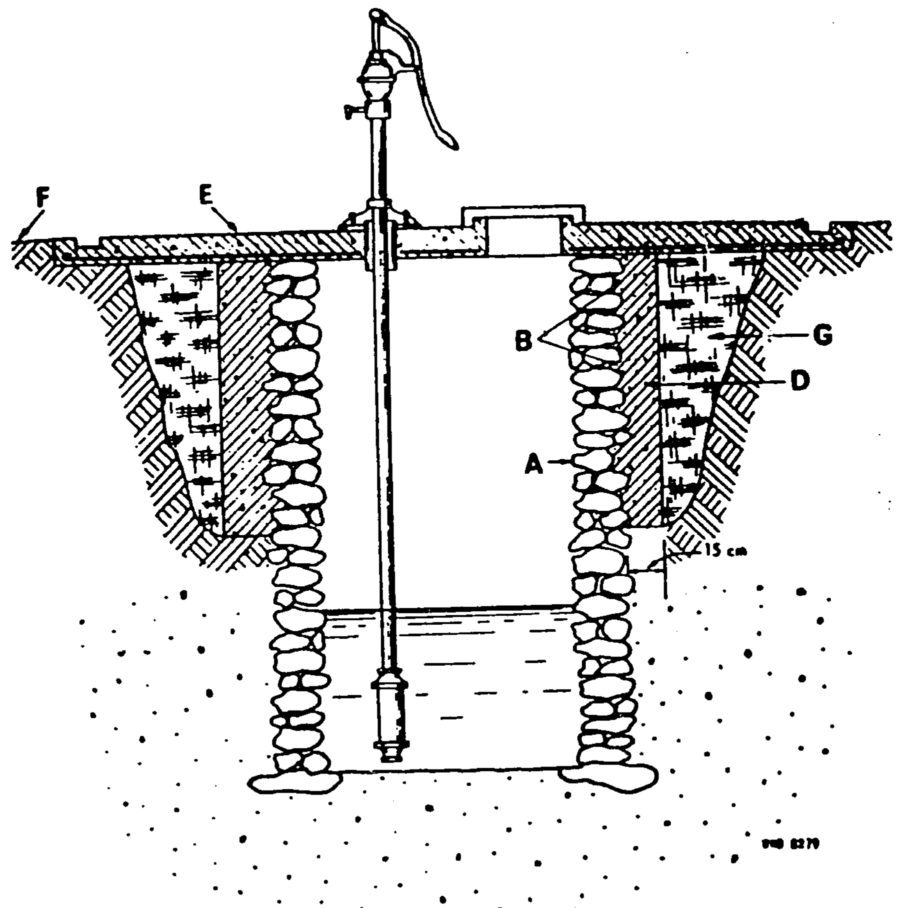


Fig. 32 (*continued*). IMPROVEMENT OF EXISTING WELLS (II)



A = Existing masonry or brick walls with cracked mortar joints
B = Old mortar removed with chisel as far back as possible
C = Stone or bricks dug out to provide key for new concrete lining
D = New concrete lining, built to a depth of at least 3 m (10 ft) below outside ground level, or to low water level in well. For concrete, use pea-sized gravel and wire-mesh for temperature reinforcement.
E = New concrete well top, incorporating sanitary features (manhole with raised edges, slope for proper drainage, proper pump installation, etc.).
F = Outside ground level (adequate drainage being provided for excess water or surface run-off)
G = Backfill with clay, well tamped in layers 15 cm (6 in.) thick

Fig. 32. IMPROVEMENT OF EXISTING WELLS (i)

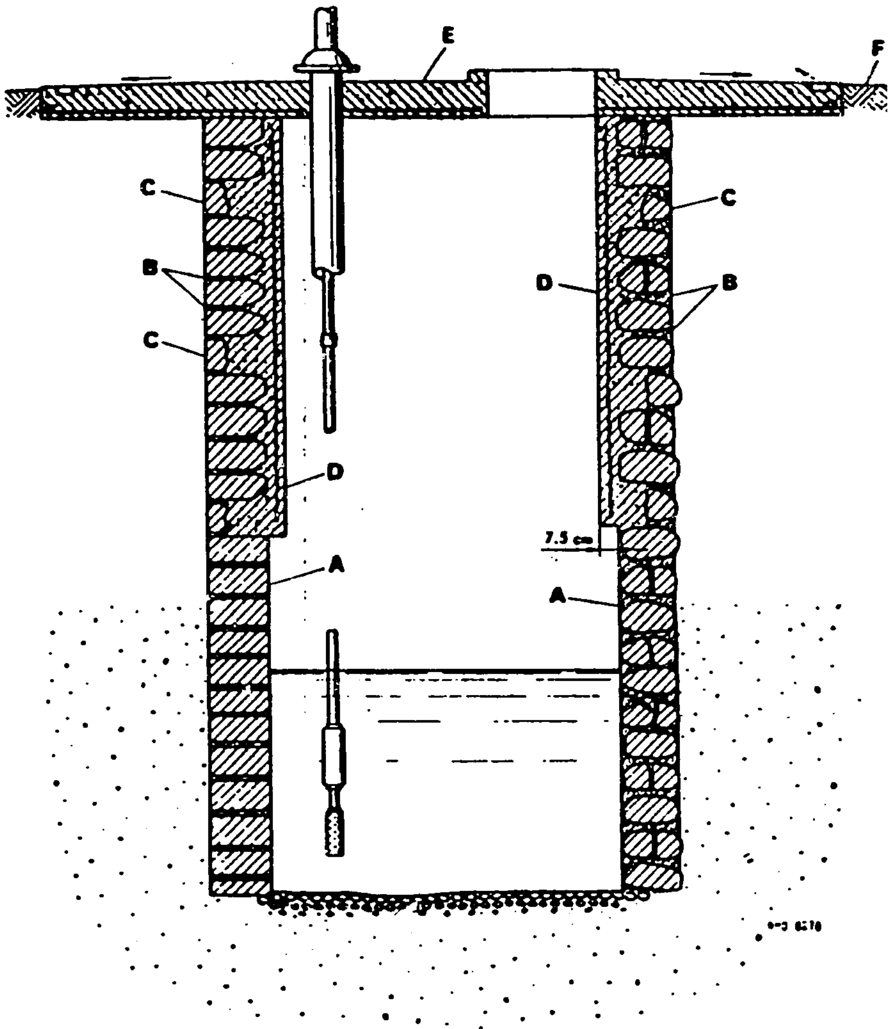
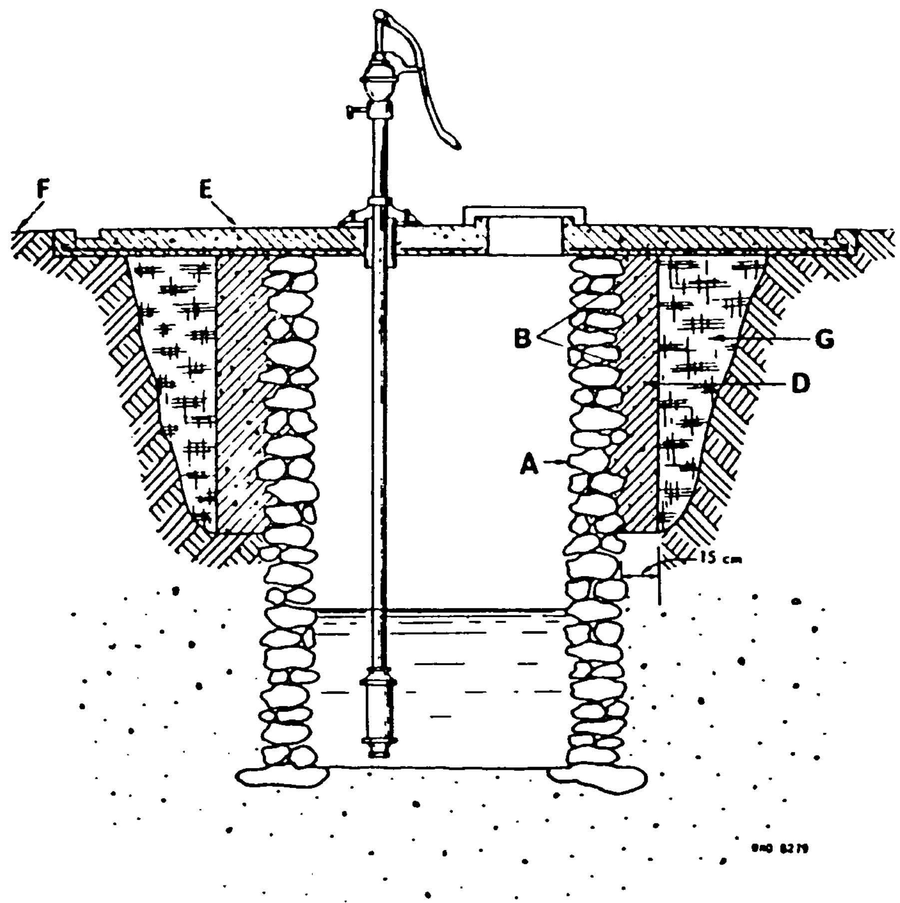


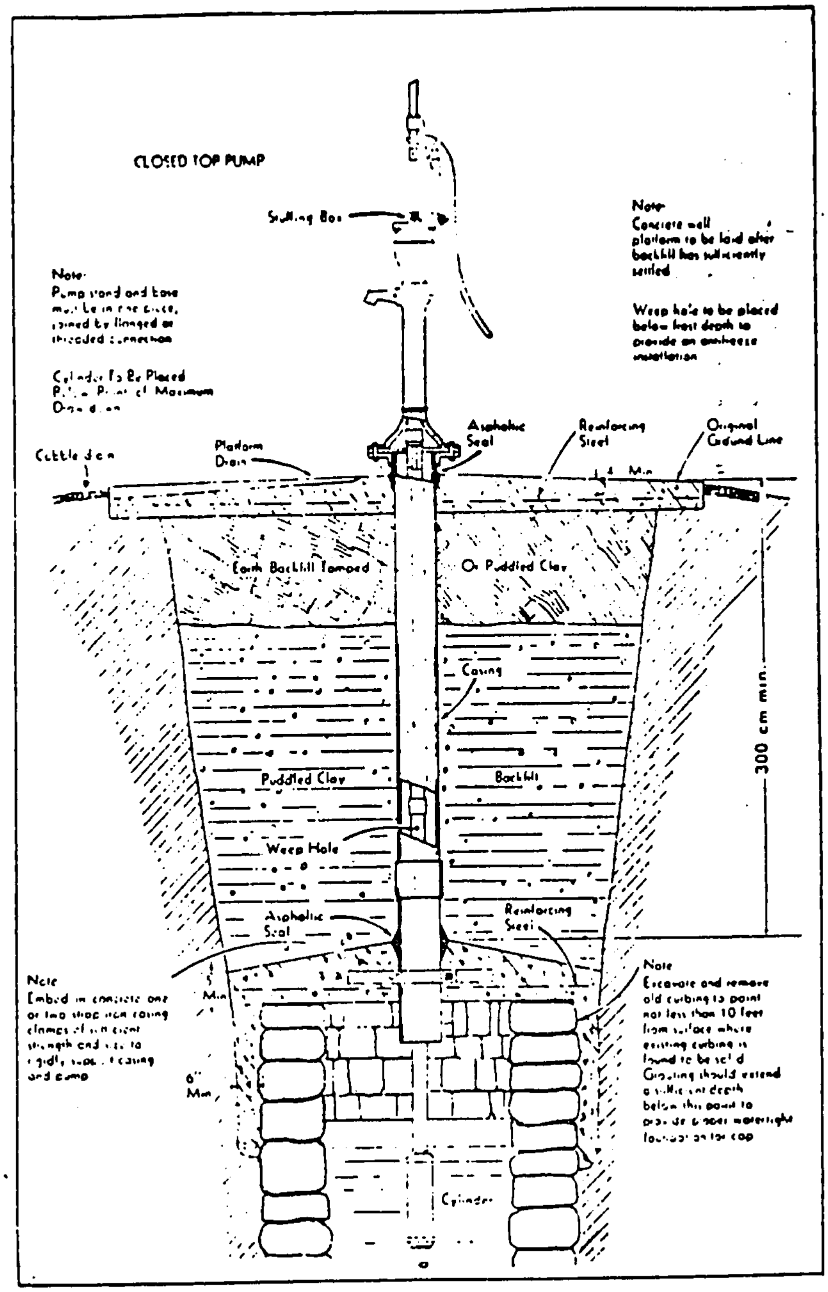
Fig. 32 (*continued*). IMPROVEMENT OF EXISTING WELLS (ii)



A = Existing masonry or brick walls with cracked mortar joints
B = Old mortar removed with chisel as far back as possible
C = Stone or bricks dug out to provide key for new concrete lining
D = New concrete lining, built to a depth of at least 3 m (10 ft) below outside ground level, or to low water level in well. For concrete, use pea-sized gravel and wire-mesh for temperature reinforcement.
E = New concrete well top, incorporating sanitary features (manhole with raised edges, slope for proper drainage proper pump installation, etc.).
F = Outside ground level (adequate drainage being provided for excess water or surface run-off)
G = Backfill with clay, well tamped in layers 15 cm (6 in.) thick

slope for proper drainage, proper pump installation
F = Outside ground level (adequate drainage being provided for excess water or surface run-off)
G = Back...

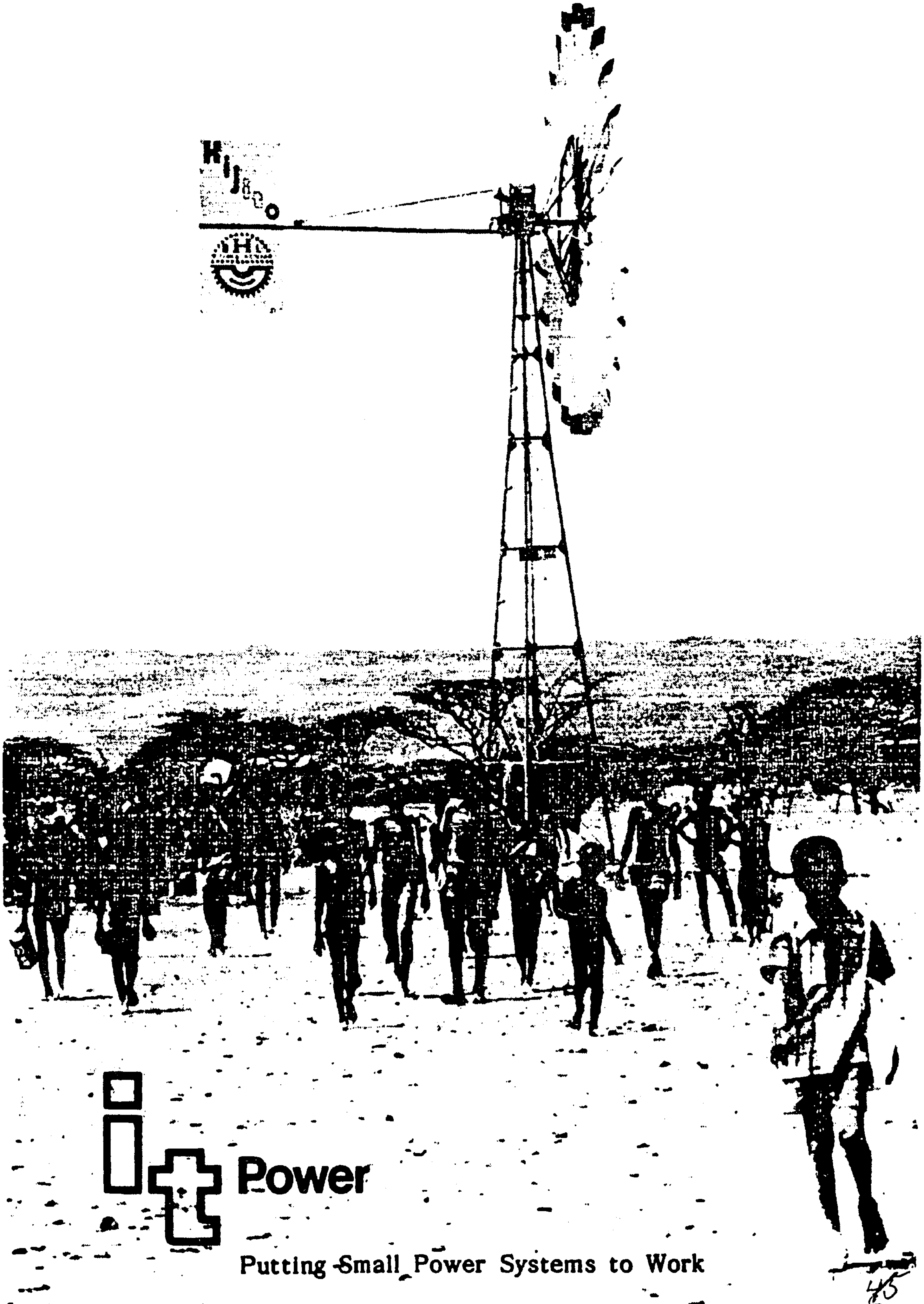
Fig. 15. RECONSTRUCTED DUG WELL WITH BURIED SLAB



Material from...WHO Monograph #42, Water Supply for Rural Areas and Small Communities, E.G. Wagner, J.N. Lanoix (1959)

Manual of Individual Water Supply Systems, U. S. Department of Health, Education and Welfare, Public Health Service Publication No. 24

SA



Power

Putting Small Power Systems to Work

POWER FOR PROGRESS

SCOPE OF OPERATION

I T Power specialises in evaluation, development, testing and installation of small-scale new and renewable energy technologies of all kinds, including solar, wind, micro-hydro and biomass, particularly for applications in developing countries. Our knowledge and experience covers the whole field of small power systems. We are committed to identifying appropriate and optimum solutions, be they conventional or unconventional, rather than to pushing particular technologies.

I T Power is primarily a catalytic organization which bridges gaps between the users, suppliers and financiers of these technologies. Clients have included - international aid agencies and donors with bilateral aid programs - governments and investment banks - commercial manufacturers.

CAPABILITY

I T Power has offices in the UK and the USA, and employs professional engineers, scientists and economists who can draw on the support of a group of eminent specialist associates from the universities and industry to assist with specialised tasks

I T Power has completed projects in over 30 countries world-wide

I T Power operates in the three principal fields of:

- technology development and evaluation
- technology transfer and training
- investment planning and project management

I T Power has a subsidiary company, **Global Renewable Energy Services Ltd** (GRES), jointly owned with with **Sir William Halcrow & Partners Ltd** (consulting engineers), for undertaking specialised testing and training in relation to solar photovoltaic systems

I T Power and its principals have provided services for the following international agencies:

United Nations Development Programme (UNDP)
United Nations Department for Technical Cooperation (UNDTCD)
United Nations Capital Development Fund (UNCDF)
World Bank (IBRD)
Food and Agriculture Organization of the UN (FAO)
World Health Organization (WHO)
Commission of the European Community (CEC)
International Reference Centre for Water Supply (IRC)
European Space Agency (ESA)
Inter-American Development Bank (IADB)

plus government agencies or ministries from the Republic of Cape Verde, Peoples Republic of China, Dominican Republic, Egypt, the Gambia, German FR, Lao PDR, Mali, the Netherlands, Philippines, Romania, the Seychelles, Sudan, United Arab Emirates, UK, USA, and Zaire

plus numerous private sector and non-government clients ranging from small voluntary aid agencies to some of the largest international corporations

EXPERIENCE

I T Power is active in the entire small-scale renewable energy field, having worked in over thirty countries on applications ranging from water pumping and purification to telecommunications and vaccine refrigeration. The following examples indicate the variety and breadth of our experience

- **technology design and development**: windpump development (for UK ODA and private industry) in UK, Kenya, Botswana, Egypt, Oman, Pakistan and India; windpump development (for USAID) in Mali; windgenerator development in association with commercial manufacturer (systems tested in UK, Kenya and Botswana); development of solar PV water purifier for commercial manufacturer for trials in Nigeria and India; river current turbine for irrigation (testing and development in UK and Sudan) for ITDG/Netherlands Government; micro-hydro electronic control systems (in association with Evans Engineering, GP Electronics and ITDG) - systems in use in Nepal, Thailand, Sri Lanka, China and Colombia; stirling engine development (GTZ and Shell International)

- **testing and practical evaluation of technologies**: small scale solar pumping systems (in association with Sir William Halcrow & Partners for UNDP/World Bank) in Egypt, Mali, Philippines and Sudan and also (just ITP) in the Gambia (for UNDTCD); solar pump testing in Mali (for USAID); windpump testing in Kenya (for ODA); solar vaccine refrigerator evaluation (for WHO) and in Zaire (for the CEC); diesel engine tests (for ODA and USAID) in Kenya

- **renewable energy resource evaluation**: for agencies of the governments of the Seychelles, the Gambia, United Arab Emirates, Cape Verde, Romania, (under contract to the UN) and further similar studies for various commercial clients

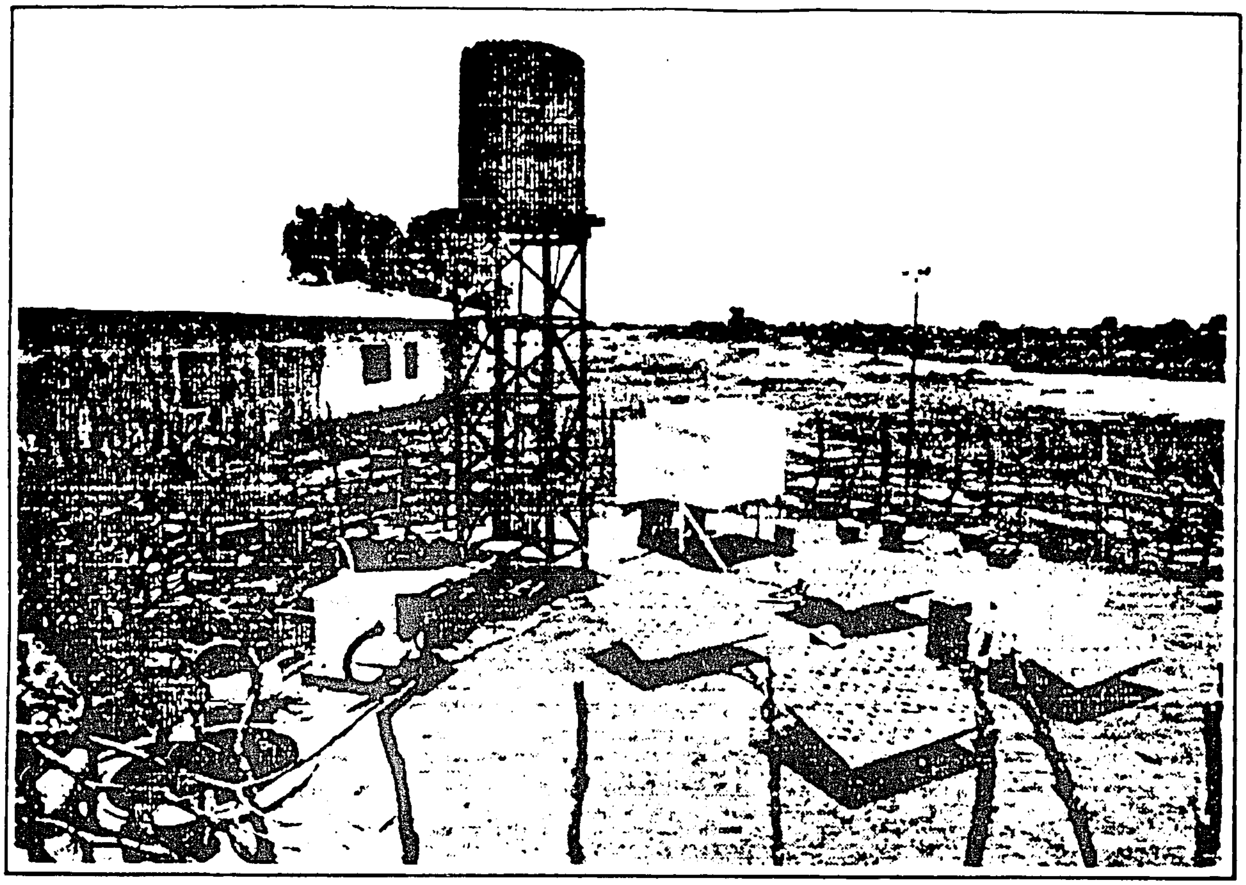
- **renewable energy technology market evaluation**: study of prospects for selected technologies in developing countries (for CEC) plus similar studies for various manufacturers

- **project pre-investment studies**: recommendations on procurement, manufacture or use of: solar PV power systems for the rural health and telecommunications sectors of the Gambia, (for World Bank/UNDP); wind and solar powered pumps (for the government of the Gambia and UN); hydraulic ram pumps in Laos (for UNCDF); hydraulic ram pumps and simple turbines in northern Pakistan (for FAO); wind/solar powered system to irrigate 800ha in Egyptian desert (UN)

- **techno-economic evaluations**: comparative economics of small scale solar pumps (World Bank); power sources for satellite ground stations for telephone communications in Africa (for ESA); Wind Technology Assessment Study (for the World Bank); system specification and feasibility study of wind powered 3 tonne/day ice production unit for fisheries in Egypt (for UN); pre-feasibility study for wind/solar powered irrigation in Egypt (for UN); industrial drying system options for paper pulp products (for commercial client); economic evaluation of the Humphrey Pump (for GTZ); power transmission systems for wind-pumping systems (for ITDG); comparison between small windpumps and solar pumps for water supply in Nigeria (commercial company); vaccine refrigerators (WHO)

- **project management and evaluation**: project to introduce renewable energy technologies in Dominican Republic in association with Sir William Halcrow & Partners (for Inter-American Development Bank); installation of 100 vaccine refrigerators and 750 solar lighting units in Zaire (CEC); evaluation of renewable energy projects in Sri Lanka and Indonesia (for government of the Netherlands)

- **publications and training**: training courses on solar photovoltaic systems and on windpumps have been regularly organized for engineers from several countries; I T Power staff have produced numerous books and publications on aspects of renewable energy, including "The Solar Pumping Handbook" (World Bank and IT Publications), "The Power Guide" (IT Publications), "Food from Windmills" (IT Publications), " "Prime-movers and Pumps for Small-Scale Lift Irrigation" (FAO and IT Publications)



I T Power has unique experience in the practical and cost-effective application of small-scale renewable energy systems, using solar, wind, micro-hydro or biomass technologies as appropriate

I T Power provides professional advice and technical assistance in the specification, design, marketing, manufacture, installation, evaluation and testing of small-scale power systems for remote and rural areas in both developing and industrial countries

I T Power works for international aid agencies, investment banks, governments and private industry and has completed projects in over thirty countries world-wide

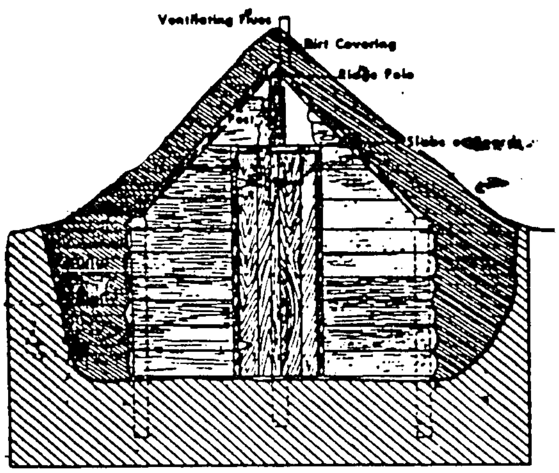
it Power Ltd
Mortimer Hill, Mortimer
Reading, Berks., RG7 3PG,
UK

tel (0734) 333231
tlx 849289 HELIX G

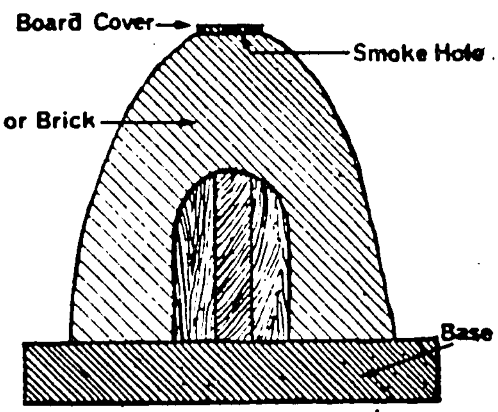
it Power Inc
1015 Eighteenth St NW
Suite 801
Washington DC 20036, USA

tel (202) 775 8777
tlx 262550 POWER UR

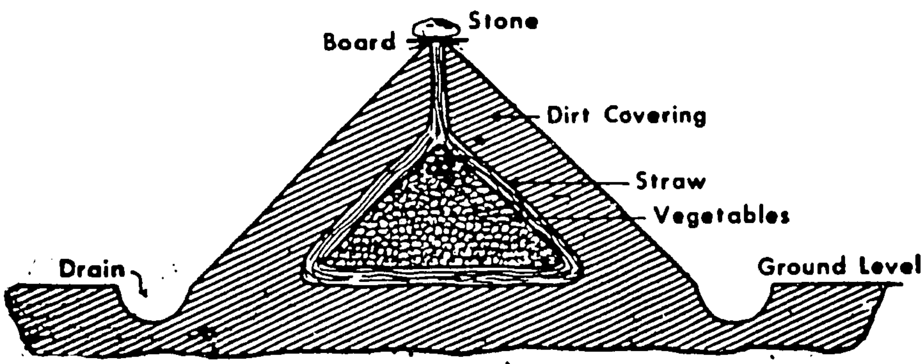
VILLAGE TECHNOLOGY HANDBOOK



Outdoor Storage Celler



Outdoor Oven



Outdoor Storage Pits

DEPARTMENT OF STATE • AGENCY FOR INTERNATIONAL DEVELOPMENT
COMMUNICATIONS RESOURCES DIVISION
Washington, D. C. 20523

WATER PRIVY

This system uses a watertight tank for initial decomposition. The tank is connected by sewer pipe to an underground drain area or seepage pit.

Details

The digesting tank is usually made of watertight concrete. A drop-pipe is attached to the squatting plate or seat and hangs down 10 cm (4 inches) below the liquid surface in the digesting tank. This forms a water seal that prevents bad odors from entering the privy shelter. Because of the digestion process, a sludge forms in the tank and must be bailed out before it is half full. A manhole, often outside the shelter, is made for this job. The amount of sludge is only one-fourth of the total nightsoil deposited in the pit because some of the solid matter breaks down into pieces, liquid and gas. The pieces of nightsoil and liquid run out the overflow pipe to the drain field and the gas escapes from an outside vent pipe. The pieces of nightsoil are very small as they leave the pipe.

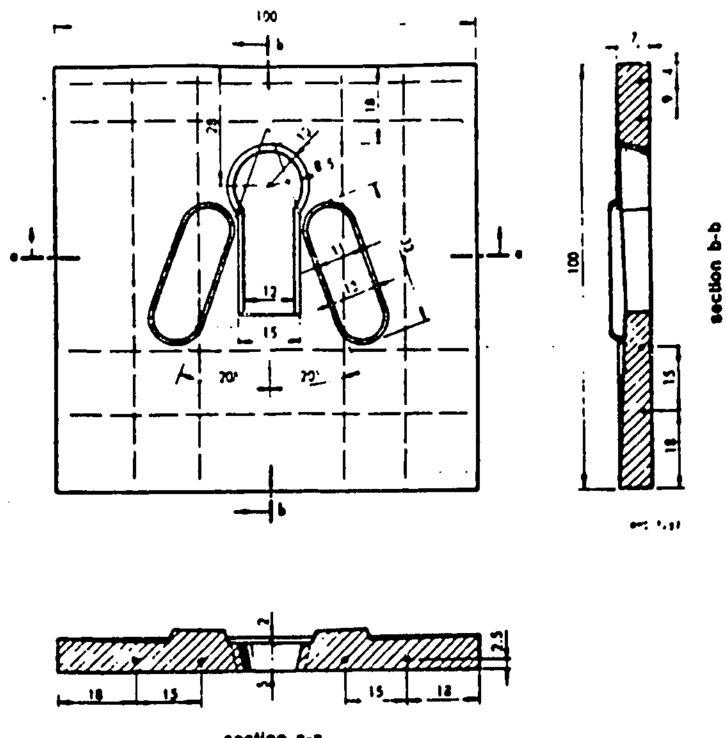
Notice in figure 1 that the tank floor slopes toward the manhole for easier cleaning. Both the vent and drain are easily reached. The drain has a T section which helps to stop the hard surface scum from entering and plugging the drain and also allows for easy cleaning.

The 10 cm diameter drop pipe, with the end 10 cm below the surface, prevents water from splashing and improves flushing. Nightsoil may stick in the pipe from time to time and must be flushed or poked down to stop odors and flies from breeding. The pipe may be up to 20 cm (8 inches) in diameter and reach 20 cm below the surface of the water in the pit, which will prevent sticking, but this makes more odors and splashing and the pipe may crust over.

The tank must be watertight. If the tank leaks, the liquid level will fall below the drop pipe, odors will form, flies and mosquitos breed, and pollustion of the soil and ground water will occur. Tanks with bricks or stone and mortar must be faced with a coat of rich cement plaster to insure water tightness.

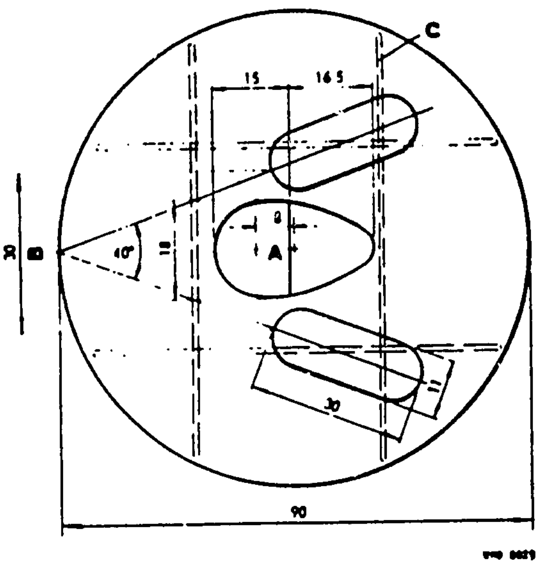
Use the chart in PIT PRIVIES, under wet-pit, to estimate the time before bailing of the pit will be necessary. Bury the sludge in shallow 40 cm (16 inch) trenches.

SQUARE CONCRETE SLAB FOR PIT AND BORED-HOLE LATRINE



Measurements shown are in centimetres.

CIRCULAR SLAB FOR BORED-HOLE LATRINE*



Measurements shown are in centimetres.

* Built in East Pakistan. See also Fig. 52.

A — Centre open hole 2.5 cm (1 in.) back of centre if slab is 80 cm (31 in.) in diameter; centre open hole 8.0 cm (3 in.) back of centre if slab is 90 cm (35 in.) in diameter

B — Between back centre foot-rests

C — Reinforcement

Notes on construction of slab

Concrete for slabs should be not weaker than 1 part cement to 6 parts aggregate, with a minimum of water.

Slab is reinforced with strips of bamboo of timber quality. Reinforcing strips are about 2.5 cm (1 in.) wide, have had inner, weaker fibres stripped away, and have been soaked in water overnight before use.

Slabs are cast upside down in one operation. Base of form is of wood with indentations for foot-rests. Base of form is encircled by sheet metal strip which makes outer wall of form. Side walls of hole form and foot-rests are made with slight slope so as to come out easily. Form for open hole is removed when concrete has taken initial set. Slabs are removed from form in about 40 hours and stored under water, preferably for 10 days or more. Since these slabs are round, they may be rolled some distance when conveyance is difficult.

33

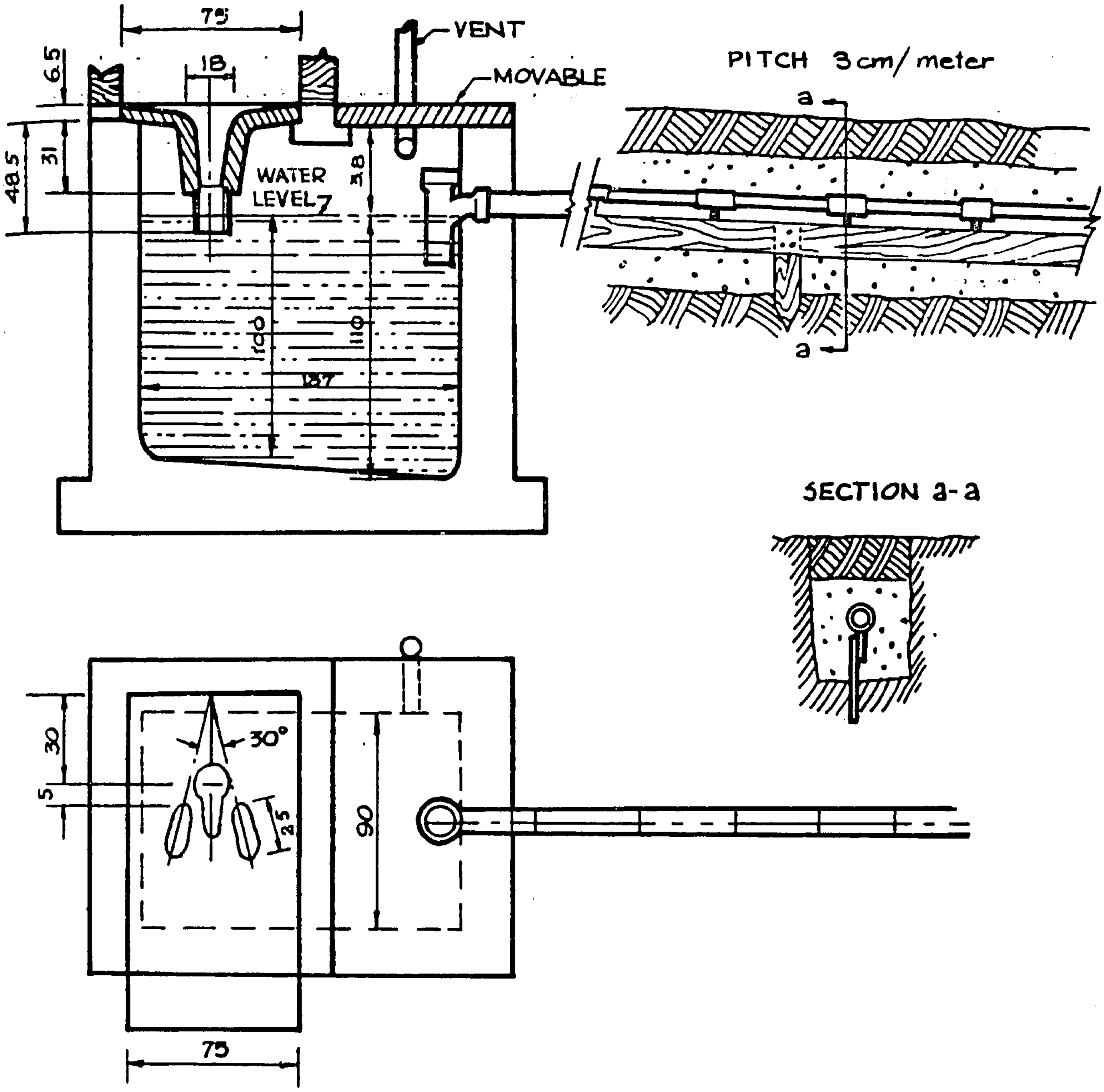
The tank can be made of plain concrete sewer pipes 90 or 120 cm (36 to 47 inches) in diameter and sealed at the bottom with concrete. Family-sized units should not be less than 1 cubic meter (35 cubic feet), which will usually allow 6 years or more between cleanings. Thus the family water privy need not be too deep, which is an advantage in rocky ground where the water table is high.

Disposal of effluent from a family unit is usually done in seepage pits or by below ground irrigation. The amount of effluent is equal to the amount of nightsoil and water put into the digesting pit. This averages 4.5 liters a person each day. The drainage system should be designed to handle 9 liters a person each day. When a water tap is inside the privy, the effluent disposal system must be much larger. Too much water causes poor digestion of sludge. The area of the bottom of below ground irrigation ditches or seepage pits needed for a family of five will be from 1.4 square meters (10.7 square feet) in very light soil to 5 square meters (53 square feet) in soils that are hard to penetrate. These methods are not practical in regions where the water table rises to within 1 meter from the ground surface, or in clay soils or swampy land. Here some type of sand filter may help, but this requires help and approval from local health experts and continued maintenance.

Evaluation

This is a sanitary and permanent installation when properly built and given daily use and proper maintenance. It can be placed near a building. The first cost of a water privy is high, but it is not expensive in the long run since it will be used for many years. It needs some water and cannot be used in cold climates. The water privy may not be successful in rural areas where there are no organized sanitation and health education services.

Material from...WHO Monograph #39
Excreta Disposal for Rural
Areas and Small Communities,
by E. G. Wagner and J. N.
Lanoix



all dimensions in cm.

FIG. I

75

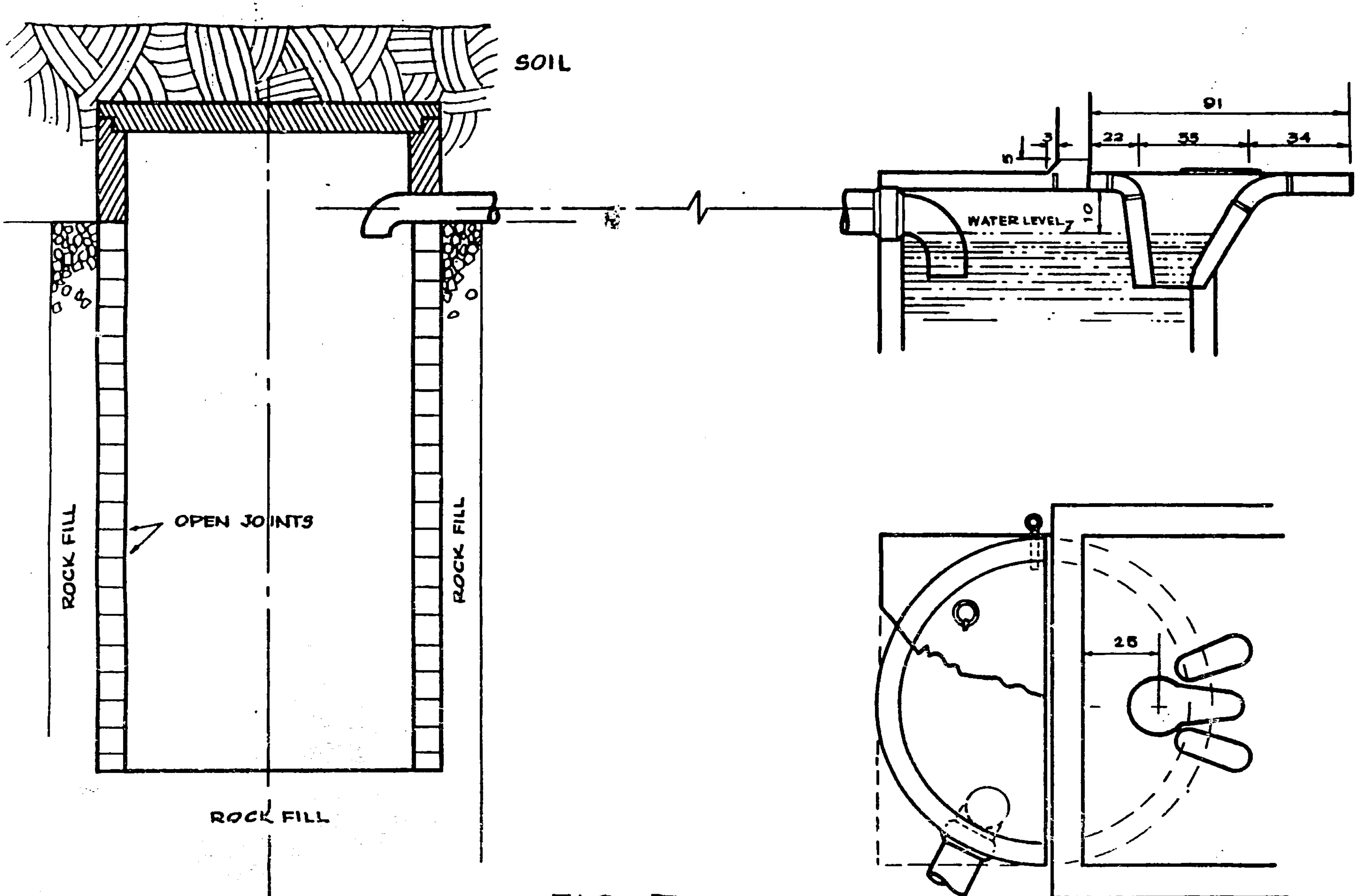


FIG II

Not in Scale
Dimensions in cm.

PHILIPPINE WATER SEAL LATRINE

Abstract

This easily-made mold is used to make water seal bowls for latrines. It has been made and used in successful sanitary latrine programs in the Philippines.

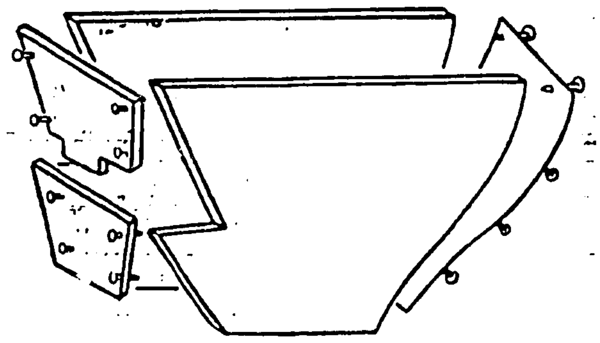


FIG 1

Tools and Materials

Wood, 3/4 inch thick by 12½ inches
by five feet, as needed.
Galvanized iron, 1/32 inch by 12½
inches by 16 inches. Metal from a
five inch kerosene can is all right.
18 large nails.
Clean, sharp sand; cement; spade and bucket to mix concrete.
Spoon, to dig out interior.
Galvanized wire, 3/16 inch, 1 foot long to make interior
mold handle.
Bamboo pole or iron rod, 1 foot long, to position interior
mold.

Details

Making the bowl is easy, if materials are cut as shown in the drawings. Cut according to Figure 2, then nail the metal sheet around the curved back of the mold. Attach the two front pieces with the large nails through the loose-fitting holes for easy removal. The extension on piece no. 1 is important so that the bowl will seal well below the water level. This type of mold, being easy to make and inexpensive, has the advantage over cement molds since manufacture is limited by drying time. The more molds used, the more bowls that can be made during the work session.

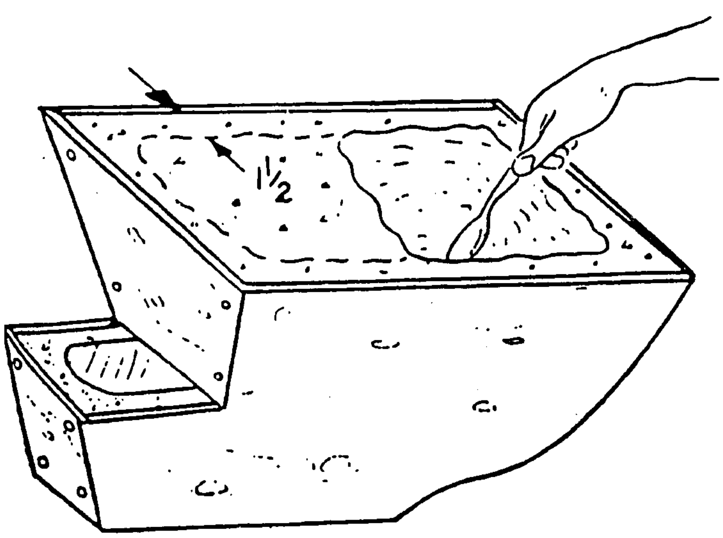


FIG 3

Since the mold has no bottom, find a flat place to work where the mold can be propped against a wall. Fill the mold with a mixture of one part cement to two parts fine sifted sand. Use only enough water to make the mixture workable. Pack it in so that there are no airpockets. Allow to set for 15 to 20 minutes until the mixture is stiff. Next, with a ruler, measure a 1½ inch wall around the top and outlet and dig out the inside with a tablespoon.

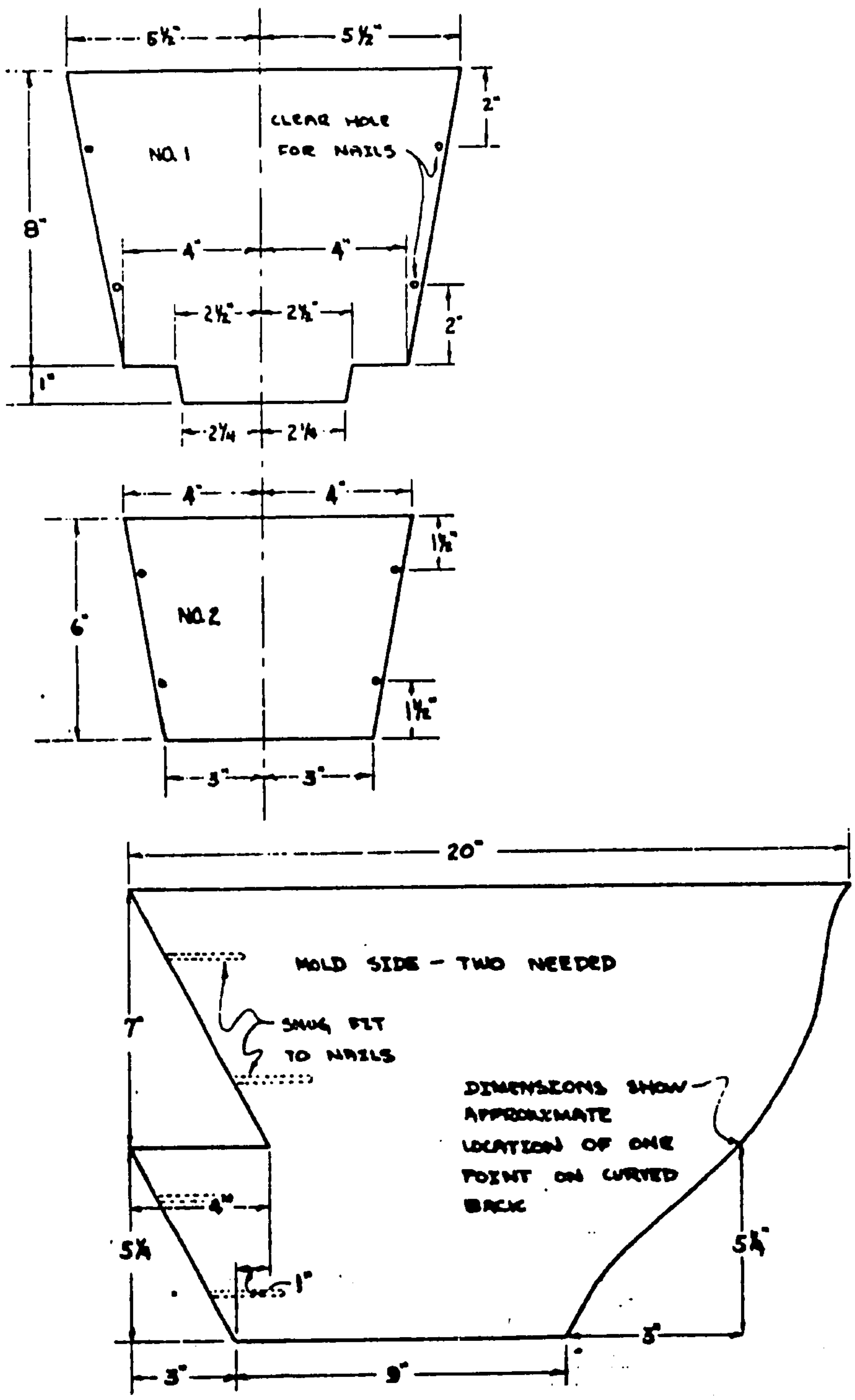


FIG. 2 WOODEN MOLD PARTS

(Figure 3). Keep a straw handy to gauge the thickness of the walls while digging, as it is difficult to judge otherwise.

Dig out the large interior first, then the outlet. The finished iterior of the bowl looks like Figure 4.

Be sure you can insert three fingers vertically (2 inches) through the hole leading to the outlet. And be careful to release front piece No. 1 by inserting the spoon around the edges, Figure 5.

After the interior has been dug out, the walls will have slumped down about an inch. Use the cement taken from the interior to build the walls back up; then smooth all exposed surfaces with the back of the spoon, Figure 6. In order to be completely sanitary, the bowl must be as smooth as possible so that germs cannot accumulate in any crevices.

To apply the finishing coat, one of two methods may be used: immediately after smoothing, sprinkle dry cement over the still wet surfaces and smooth again with the spoon. Or, let the bowl set for half an hour and apply a mixture of pure cement and water -- a coconut husk brush is good enough. Either method gives good results. See Figure 6.

The finished bowl should be left in the mold to dry 48 hours. It cam be removed after 24 hours only if extreme care is taken. Pull out the front nails and remove pieces No. 1 and No. 2; pull the sides and back away from the bowl.

Since digging by hand is rather a tedious method, and such great care must be taken to insure consistent thickness of the walls, it is better and faster to use an interior mold. After the first bowl has hardened thoroughly, fill the outlet with dry sand so that the cement cannot flow in and prevent the interior mold from being removed. Line the large interior with paper and fill it with cement -- a four to one (4:1) mixture is good enough. See Figure 9. Insert a heavy wire loop in the top so that the interior mold can be positioned on the exterior mold with an iron bar or bamboo pole.

When an interior mold is used, it is only necessary to dig out the outlet. It is a good idea to have several interior molds, but not necessary to have one for each exterior mold. The interior mold should be removed after 15 to 20 minutes so that the bowl can be smoothed and finished. Then it can be used to make the next bowl.

To use the interior mold, fill the wooden mold about five inches from the bottom and insert the interior mold in the correct position. See Figure 8. Push the cement around the mold with a stick and pack well to keep out air spaces. After the molds are removed, the finished bowl should be left to dry until it is rock hard -- a week is usually safe -- before delivery.

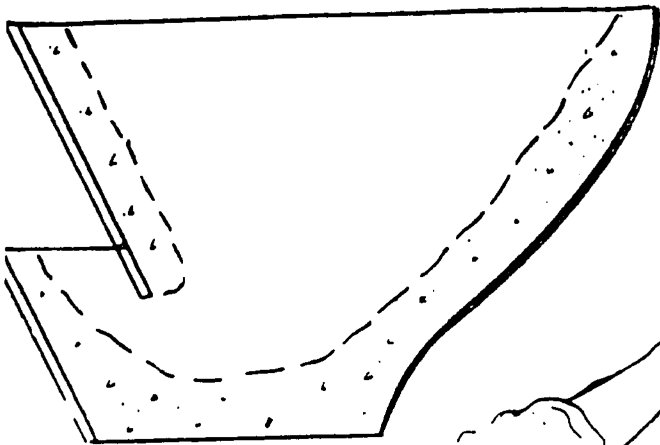


FIG 4

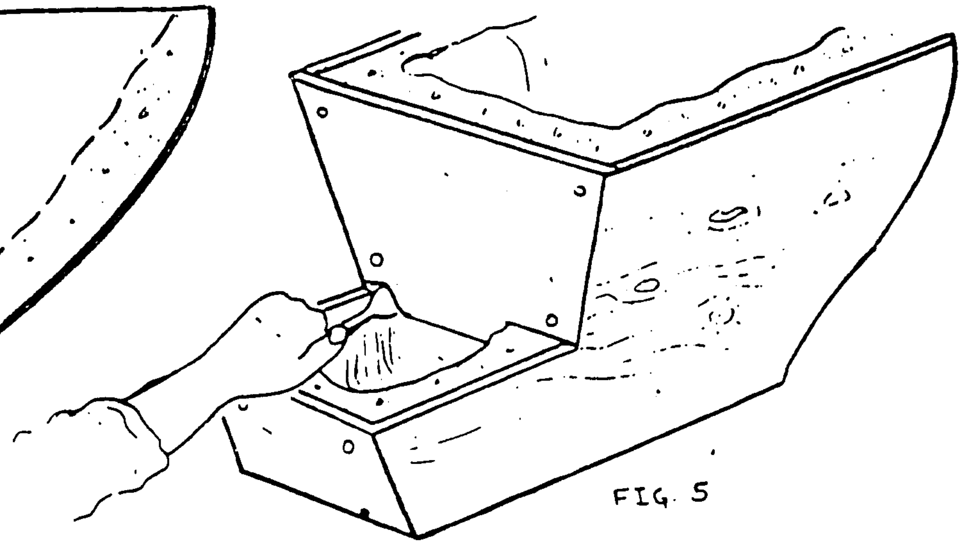


FIG. 5

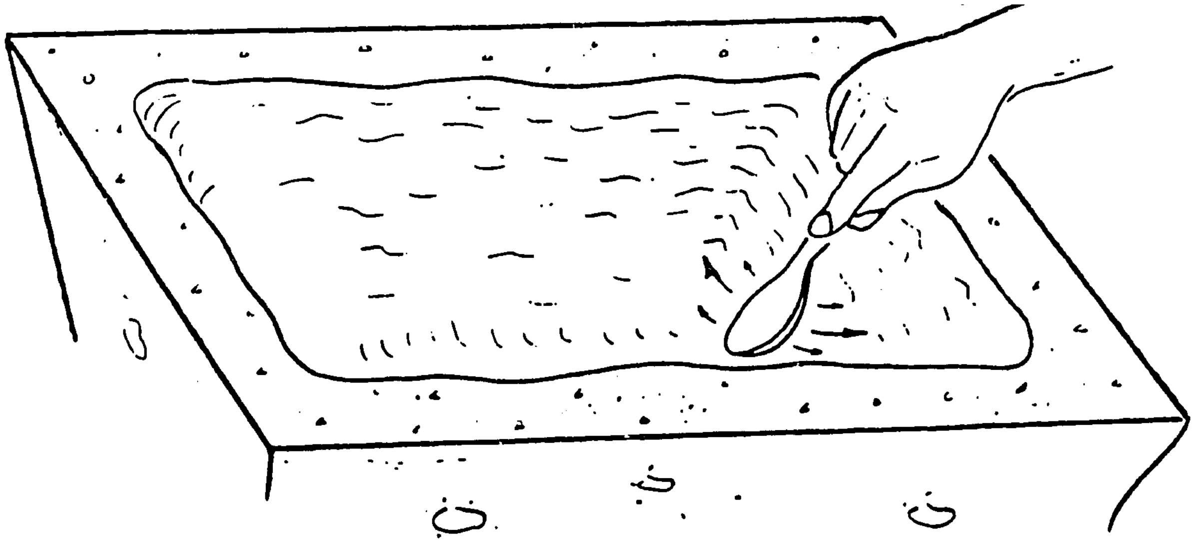


FIG. 6

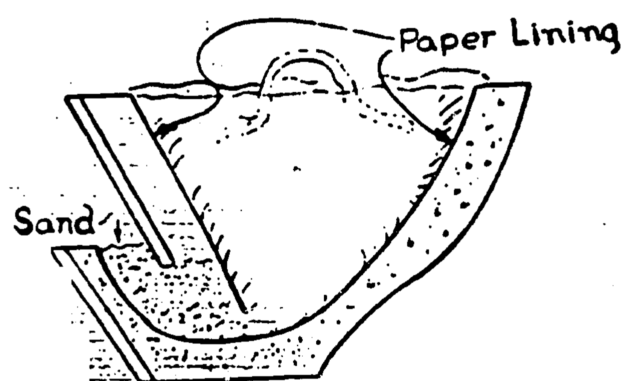


FIG. 7

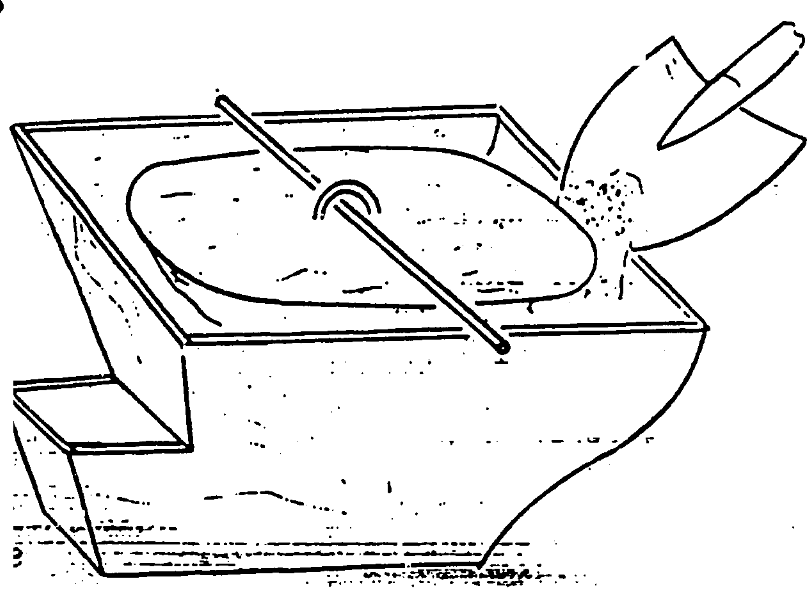


FIG.

61
40

For a luxury product, use white or red cement for the finishing coat; several coats are necessary.

The boys manufacturing bowls in Malitbog recently changed the mixture from 2:1 to 2½: 1 and no bowls have broken yet. A wider ration than this might sacrifice too much strength for profit; dissatisfied customers may result and profits may drop. There are many ways to strengthen cement and experiments may bring a cheaper and better product. Adding short coconut husk or abaca fibers is one possibility.

Installing the Toilet - For use in private homes, dig a pit about five feet deep and three feet square (the deeper the pit and the smaller the width the better, since a small slab is cheaper). It can be dug even under the house -- especially for use in cities -- sice the toilet gives off very little odor, unless of course this position endangers the household water supply. The pit may be lined or unlined, depending upon the soil. Hard clay soil need not be lined. But, if the house is near the sea or on sandy soil, the pit should be lined with bamboo poles, hollow blocks, etc. as shown in Figure 9.

Place boards around the outside of the pit six inches from the edge of the pit to form the perimeter of the slab. Place large pieces of bamboo split in half across the pit as a base for the slab. Place the bowl between two of the bamboo pieces with a piece of wood under the front and back; nail these to the bamboo. After the bowl is positioned in this way, pour water into it to be sure it will seal off the outlet. The top of the bowl should be three inches above the bamboo base. See Figure 10.

Now put bamboo slats across the pit at right angles to the large pieces of bamboo, completely covering the pit. Cover this with several thicknesses of newspaper. Pour cement around the bowl until the slab is about four inches thick. A mixture of two kerosene cans of gravel, two of sand and one of cement is good. The slab can be reinforced by placing bamboo slats between two layers of cement. Make sure that the outer edge of the slab is higher than the bowl and slants toward the center, so that the toilet can be easily cleaned. Apply a finishing coat of pure cement to the slab. Many people prefer to add foot rests and a urine guard--there is room for imagination.

It is a good idea to have an oil drum or small cement tank nearby to supply the toilet with water. Do not use the toilet for at least three days -- a week is best.

The 5 x 3 foot pit should last a family of eight about five years. One person uses approximately 1 cubic foot every year. When the pit is ful the entire slab can be easily moved to another pit.

It is extremely important to have an ample water supply at hand, since approximately one litre of water is required to flush the toilet, and the necessity of going out to get water discourages its proper use.

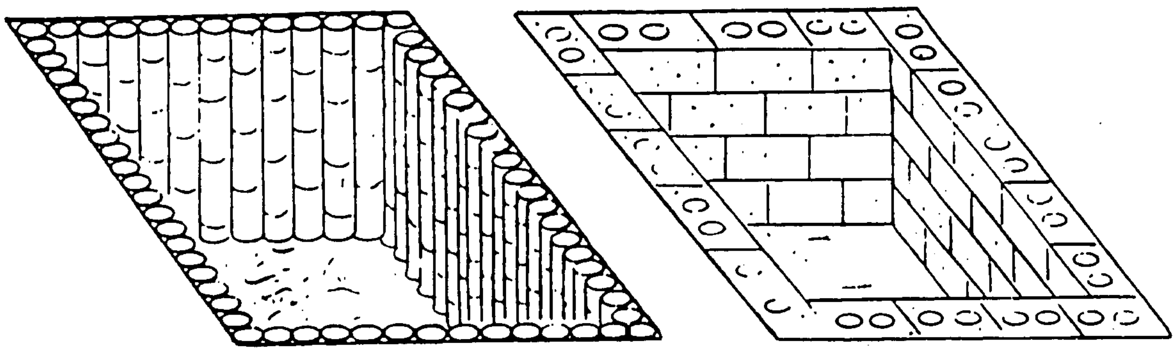


FIG. 9

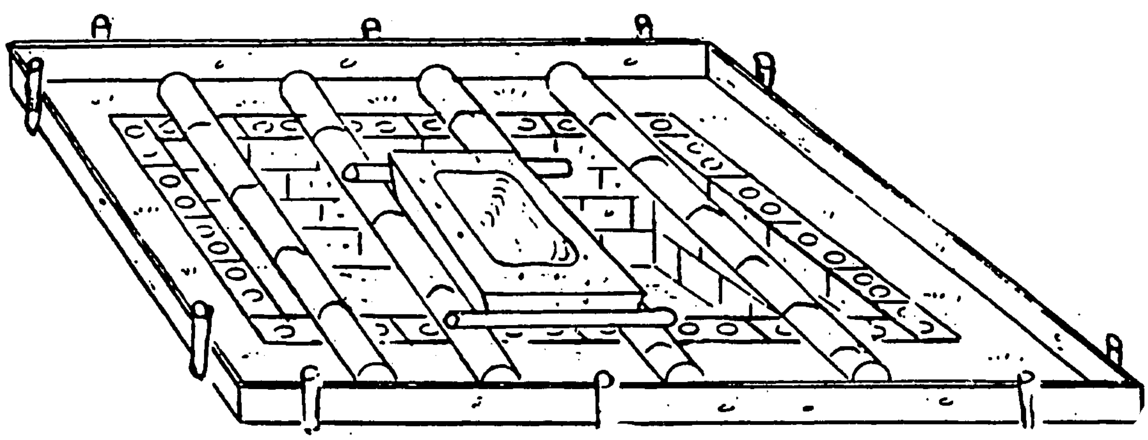


FIG. 10

63
42

Evaluation

This design was brought to the Philippines from Europe by one of the Philippines Department of Health's Regional Sanitary Engineers. It is both simple and efficient and was designed specifically for use in areas such as the rural Philippines. The design was used in a successful campaign, undertaken jointly by municipal organizations and Peace Corps Volunteers, to spread the use of sanitary toilets. In November 1962, five months after the start of the campaign, over 400 such toilets were installed and in use. The report on the campaign is recommended reading for anyone interested in promoting acceptance and local manufacture of water sealed latrines.

Material From - "Campaigning for Water-Sealed Toilets" by Gordon Zaloom, Peace Corps Volunteer

FIRST INTERNATIONAL SYMPOSIUM ON FUEL-EFFICIENT STOVES

第一届国际高效灶研讨会

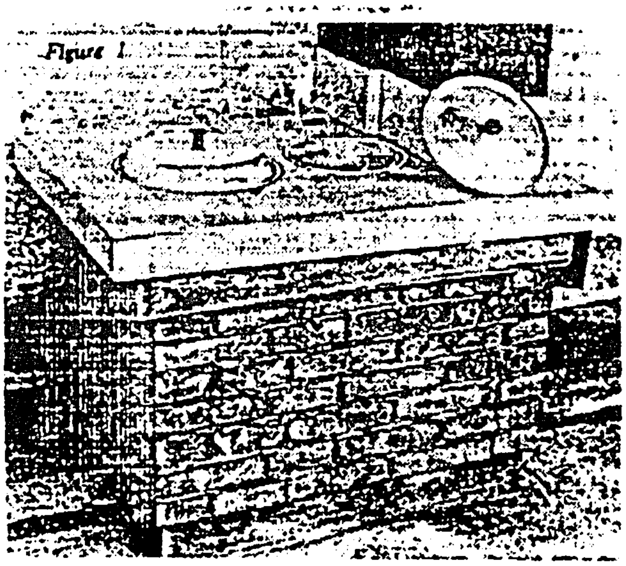
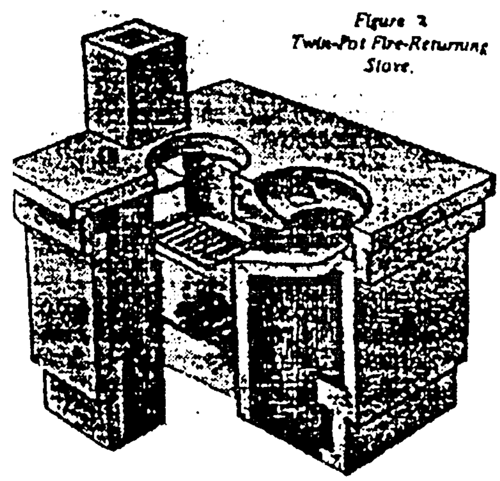


Figure 1

Figure 2 Twin-Pot Fire-Returning Stove.



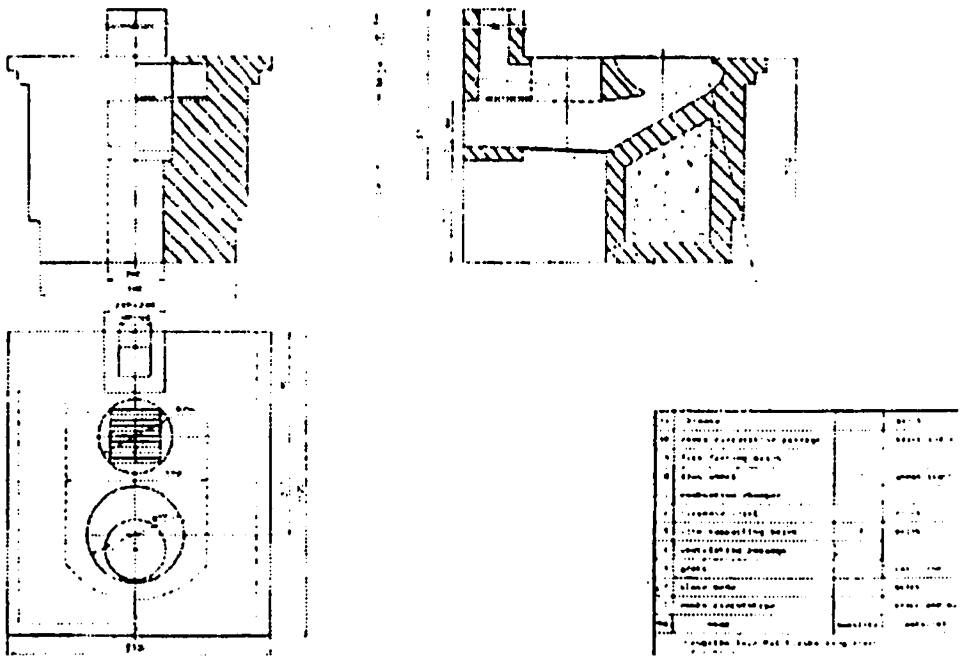


Figure 3
Drawings of Twin-Pot Fire Returning Stove.

e) The size of the stove door:

The size of the stove door is 18cm x 15cm (50% smaller than the old-fashioned one). This perfect size can reduce the excess air to enter the chamber.

f) Heat preservation method:

Using slaked lime to decorate the inside of the chamber can preserve the heat and the surface looks smooth.

The Design of the Grate and the Place Where Ash can Drop

The grate should be made of pig iron with seven holes. The size is 16cm x 32cm; the size of ash-dropping place is 4cm x 18cm. Installing a grate can make more oxygen while burning. According to the speciality of the stove, the grate should be put under the rice pot. With the ash-down room, the ash can drop directly, not through the grate.

Ventilating Passage Design

The height of the passage is 39cm and the width is 18cm. The passage should be vertical with the central line of the pot. When the ash drops from the chamber, it can heat the air and the heated air can not only offer oxygen to help burning, but also prevent the cold air from entering the chamber.

The Chimney

The section size of single-stove-chimney is 12 x 12 sq. cm. and that of the double-stove-chimney is 18 x 12 sq. cm the height is 300 cm. It is estimated that with the new type chimney, the speed of smoke moving is 1m/second, the temperature of smoke is about 100 degrees centigrade. So that the loss will be less.

The height of the stove

75cm is suitable for most of the people.

Heat Function Analysis

In order to ensure the accuracy of the data, we invited the engineer from Shanghai Institute of Energy Research to make the project of determination and be technologist.

The result of the testing is that everything is OK according to the standard in "The Testing Method of the Heat Function of civil use Stove and Oven" made by the People's Republic of China. Following is the result of the testing (One Stove with Double Pots").

			*1	*2	*3	The Total Heat Efficiency		
						I	II	Average
*FX	Rice Pot	I	5.429	0.056	0.600			
		II	6.206	0.088	0.650			
		Average	5.818	0.072	0.625	32.66	36.26	34.46
	Dish Pot	I	5.067	0.028	0.675			
		II	5.944	0.047	0.725			
		Average	5.506	0.038	0.700			

"1" stands for: the speed of temperature increasing.
"2" stands for: the speed of water evaporating.
"3" stands for: the speed of the heat returning.
"FX" stands for: Fengxian One Stove with Double Pots.

From the table above, we can see that the index of each heat function is more advanced. And the total heat efficiency has reached to 34.46%. Compared with the old-fashioned one, the heat efficiency has increased 2.4 times.

Economical Efficiency

"One Stove with Double Pots" has higher economical efficiency because of the reasonable structure; quick conduction of heat; equally spersed flame; higher heat efficiency.

1. Reasonable price.
   To make a new stove only costs about 30 yuan to buy some bricks, lime cement and a grate.

2. Convenient and economical.
   The new stove can save 60% straw and 50% time compared with the old one. Each family can save 54.45 yuan in the purchasing of fuel.

Conclusion

1. This stove enjoys advanced heat function, is suitable for various of straw (wood) and can save time and fuel.

2. Convenient and reasonable price.
   It is warmly welcomed by the peasants. It can relax the energy tension. So it is worth popularizing wider.

3. Reasonable structure.
   Because of the high technology, the workers who make it should strictly do as the design requires.

AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

INFORMATION MEMORANDUM

SUBJECT: Availability of S&T/FENR Agro-forestation TECHNICAL SERIES Publications

I continue to add new publications to the S&T/FENR Agro-forestation TECHNICAL SERIES Publications. Some of the publications I have written wholly myself, others are compilations in which I have done a summary, still others are copies of publications normally not available to people working in the developing countries.

NOTE: The numbering of this series has little relevance to the chronological order of the printing of the articles, compilations or reprints of publications. Rather, this is a list of subjects that I put together based on information that I felt was not easily available to field people. At that time, I gave a SERIES # to each subject on my list, and when I have enough information to cover the subject adequately, I compile it. As new subjects come to light, I add them to the list. **As of this date, TECHNICAL SERIES # 3, 8, 9 and 11 are not available.** If you desire additional copies or a copy of one which you have not received, or would like me to mail copies to host country technicians or others, let me know and I will send the copies requested. Some of the publications are available in languages other than English, as indicated.

- #1. Selected Tree Seed Sources in Australia, India, Holland and the United States. **This publication is dated and some of the companies listed have gone out of business.** Therefore, I suggest that you send for a copy of Multipurpose Tree & Shrub Seed Directory (May 1986), International Council for Research in Agroforestry (ICRAF), P.O. Box 30677, Nairobi, Kenya.
- #2. The Potential of Starch Graft Polymers "Super Slurpers" for Forestry and Agriculture
- #3. Minimizing Livestock Damage to Trees Through the Use of Trenching, Living Fences and Game Repellant
- #4. The Comparative Advantages and Disadvantages of Root Trainers, Dibble Tubes, Plastic Bags and Bare-Rooting
- #5. Neem (*Azadirachta indica* juss): The Cornucopia Tree
- #6. Windbreak and Shelterbelt Technology for Increasing Agricultural Production
- #7. Growth Yield Increase of Trees Through Fertilization
- #8. Ground Preparation: Hillside Ditching, Catchment Systems, Trenching, Placement of Trees on Terraces to Increase Establishment and Growth Rate of Trees
- #9. Advantages of Vegetative Propagation and Tissue Culture for Seed Orchard Establishment
- #10. Casuarinas: Trees of Promise

7/4v

#11. Termite and Rodent Protection for Seedlings and Trees
#12. Agroforestry Systems: Contour Hedgerows of Woody Perennials (Alley-Cropping) Reduce Erosion, Improve Soil Structure, Increase Food Crop Yields, and Produce an Abundance of Fodder and Fuelwood (available in English, French and Spanish)
#14. Jojoba: A Promising New Crop For Arid Lands
#15. Solar Curing Barns, Fast-Growing Trees and Agroforestry Offer a Solution to the Deforestation Caused by Tobacco Production in Thailand, Tanzania, Sri Lanka, Nepal, Philippines and Other Developing Countries
#16. Excerpts from: Evaluation of and Recommendations for Research on Fast-Growing Tree Species for Wood Energy Production in the Dendro-Thermal, Charcoal Production and Gasification for Irrigation Projects in the Philippines
#17. Leucaena leucocephala: A Tree That "Defies the Woodcutter"
#18. State-of-the-Art: Acacia albida
#19. Guide Book for Rural, Cottage and Small and Medium Scale Industries and Paddy Rice Cultivation
#20. Soils, Crops & Fertilizer Use (Peace Corps)
#21. Handbook of Tropical and Subtropical Horticulture (USAID)
#22. World Literature on Leucaena
#23. Paulownia, "The Princess Tree," an Excellent Candidate for Agroforestry
#24. Utilization of Neem (Azadirachta indica juss) and Its By-Products
#25. Leucaena leucocephala: An Excellent Feed for Livestock (English, French, Spanish, Thai, Indonesian and Portugese)
#26. Living Yam Poles (English and French)
#27. Moringa: A Tree That Purifies Water and Whose Leaves and Fruits Are Rich in Vitamins A & C, Protein, Calcium, Iron and Phosphorus
#28. Fertilizing Fruit Trees with Leucaena and Other Legumes Results in Increased Growth and Yields
#29. Contour Hedgerows for Fodder, Planting Stock, Fuelwood and Increased Food Production and for Minimizing Soil Erosion in Highland Regions
#30. More Tree Planting Through School Nurseries (English, French and Spanish)
#31. BAYANI [Giant Ipil-ipil (Leucaena leucocephala)] A Source of Fertilizer, Feed and Energy for the Philippines
#32. Sesbania in Agriculture (a most promising plant that grows in a variety of ecosystems and is excellent for forage, fuelwood and green manure)
#33. The Lorax Talks for Trees
#34. Watershed Management in Jamaica
#35. Leucaena Research in the Asian-Pacific Region: Proceedings of a workshop held in Singapore, 23-26 November 1982.
#36. Participatory Low-Cost Housing

7 3/41

If you have any comments on the relevance of this information, I would like to hear from you.

Michael D. Benge
Agroforestation Officer
Bureau for Science and Technology
Office of Forestry, Environment, and
  Natural Resources (S&T/FENR)
Rm. 515-D, SA-18
Agency for International Development
Washington, D.C. 20523
May 30, 1990

48
75