

DEVELOPMENT WORKSHOP

ON INDIGENOUS BUILDING METHODS IN THE THIRD WORLD
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کارگاه توسعه

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SOLAR TIMBER KILNS

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prepared by Allan Cain

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Solar Timber Kilns

As the costs of building materials rise and their demand begins to produce scarcity, the need to increase the efficiency of their use becomes apparent. Timber, a basic material in rural building, is feeling these pressures. If it is to continue to play a major role in rural housing its use must be rationalised. In this paper we discuss ways of improving the quality and life span of this material.

Seasoning

The simplest and cheapest method for improving timber quality is through proper drying or seasoning. The term seasoning suggests the traditional practice of keeping the fresh cut timber for a season to allow it to dry before using it for building or carpentry. Through this process water evaporates from the cells of the freshly cut green or wet timber, giving it greater rigidity and strength. Seasoned timber is more disease resistant, shows less sign of cracking, bending or warping, is much more workable, and holds nails better.

Initial moisture content in green wood can be found to be anywhere between 30 to 80%. Optimum moisture content for timber for building or carpentry is about 12%, although 15% is acceptable for most structural purposes.

In many rural areas in developing countries timber is used without proper seasoning. Timber is often left to dry in the open, in contact with the ground, and improperly stacked. The quality and usable life of building, particularly roofing and joinery (doors and windows) could be greatly improved by the adoption of rationalised, simple and low-cost seasoning methods.

Air Drying

The simplest of all timber seasoning methods is air drying. This method merely requires timber to be kept off the ground and stacked loosely so that air can pass around and between logs or planks. A simple pitched roof with an overhang is required to shed water, and protect timber from direct solar radiation.

Air drying can bring timber's moisture content to below 20%, depending

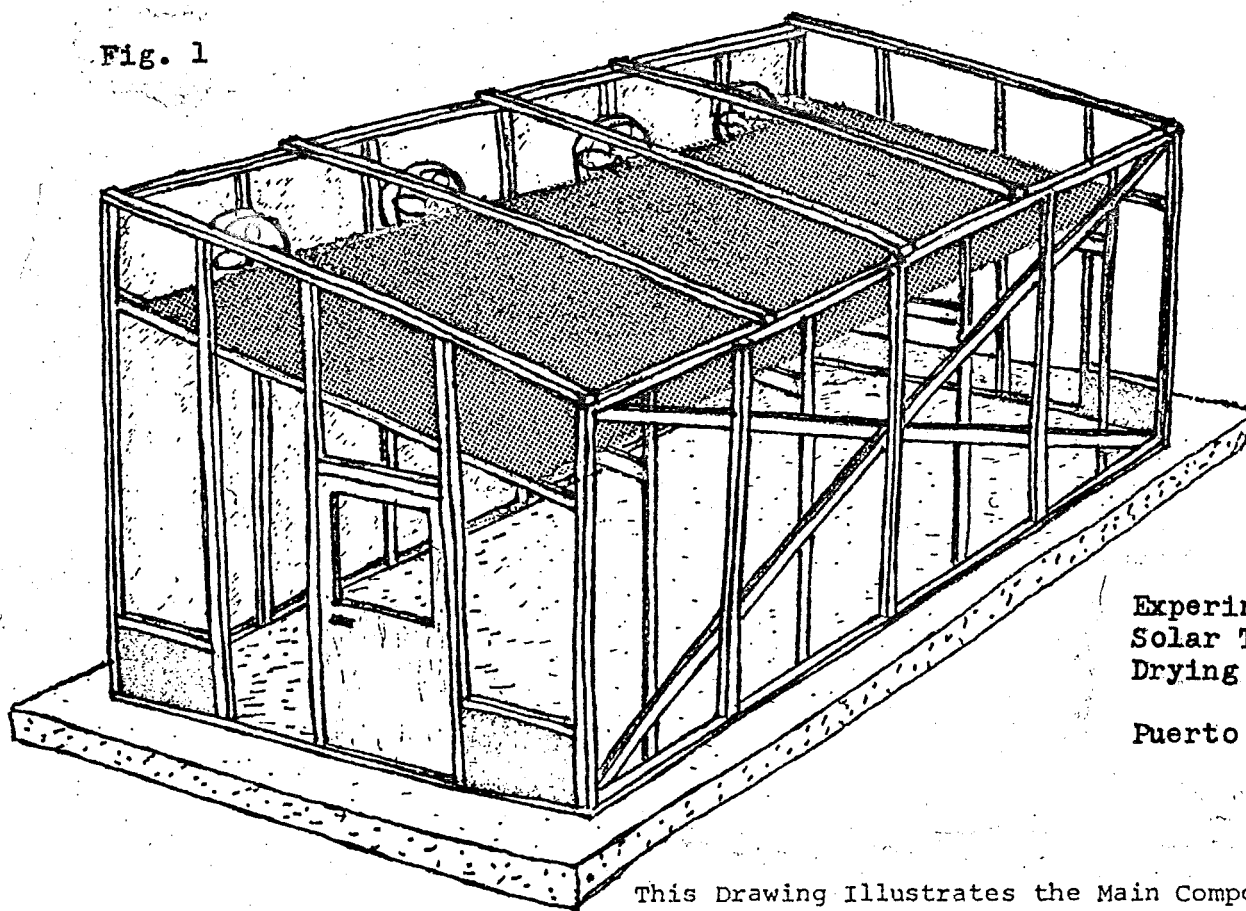
on climatic and humidity conditions. Air drying normally takes several months. Timber cut in the late fall or early spring can be ready for use in the early summer (fall cutting is normally recommended).

Solar Kiln

Kiln seasoned timber can, under controlled conditions, be brought to an optimum moisture content relatively quickly with the minimum of cracking, splitting or warping. Kilns are normally heated by combustible fuels, often employing a contained steam system. This requires a separate boiler and combustion system and radiators within an enclosed timber storage chamber. An electric fan normally provides air circulation and ventilation.

Kilns of this type are of a relatively high cost and the mechanical systems require careful design and maintenance. A major problem is their continuous energy consumption, particularly in many developing regions where fuel is at a premium and must be imported from outside.

Fig. 1



Experimental
Solar Timber-
Drying Kiln

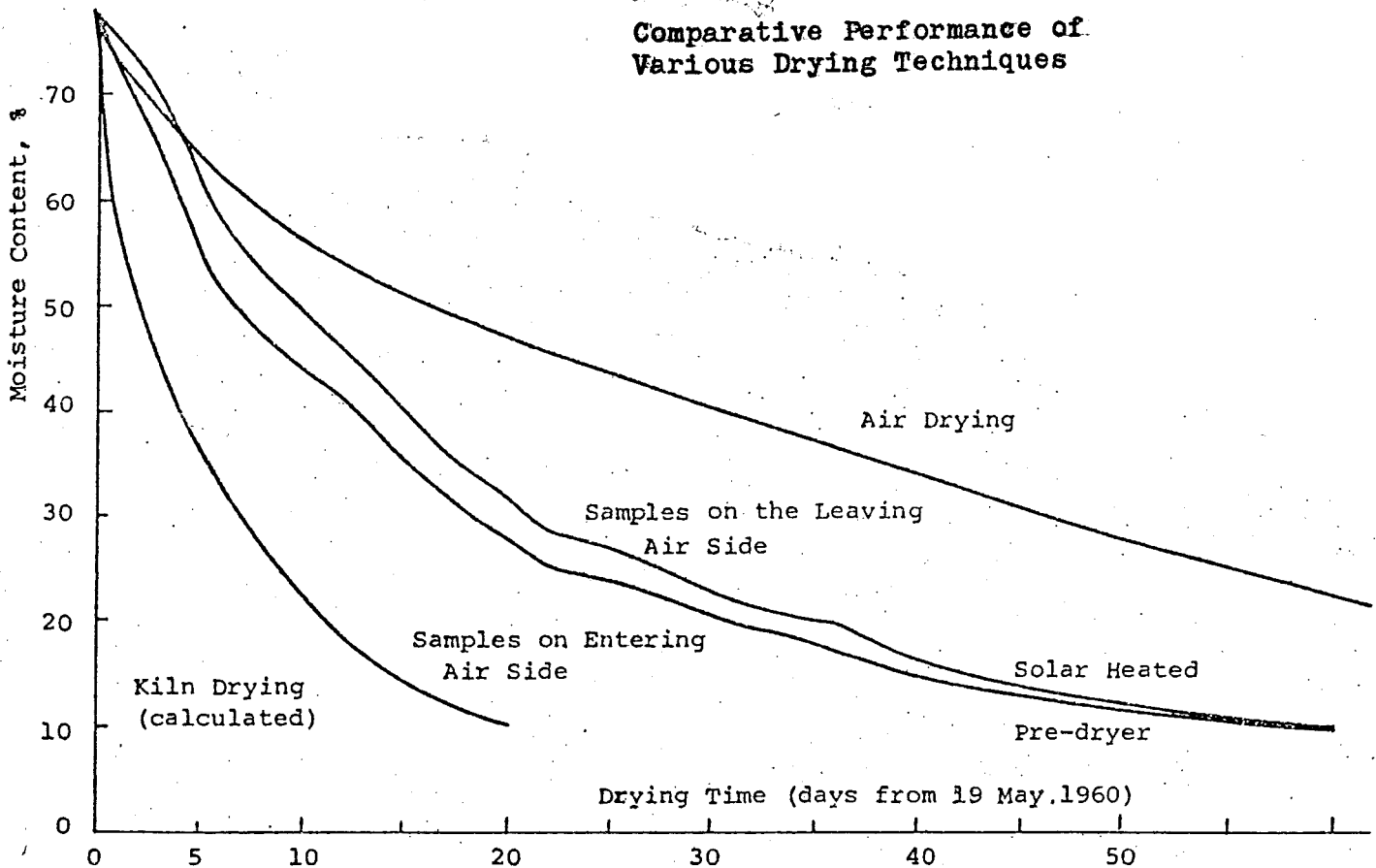
Puerto Rico

This Drawing Illustrates the Main Components of the Lumber Dryer: the Four Fans, the Blackened Metal Sheet Absorber and the Louvered Vents.

Energy from the sun's radiation can be utilised to season timber in a solar heated kiln. A few such kilns have been tested in India, Japan, Africa, and Latin America. Costs are only a little more than air drying sheds and show savings over artificially heated kilns of about 60% in construction costs and over 75% in fuel costs. In these prototype designs solar energy either supplements or replaces the combustible fuel heater, and leaves only the electric fan ventilation system to be run by an external energy source. Solar kilns use large quantities of low temperature heat at about 60°C. to produce rapid but controlled seasoning of timber.

Fig. 2

Comparative Performance of Various Drying Techniques



Comparison of Drying Curves for Air-Dried and Kiln Dried (calculated) Lumber with Those Obtained for Lumber in Charge 1 Dried in the Solar Heated Pre-Dryer.

Solar kilns are able to attain optimum moisture content and increase the drying rate of timber over the air dried method as well as control cracking and warping. Drying times can be reduced by 60% over air drying, and moisture contents as low as 7% can be attained, a figure well below that possible by air drying.

2.5 cm. thick planks can be dried in about 30 days, from green wood to an optimum moisture content for building of 12%. 7.5 cm.x 10 cm. structural timbers can be dried to 12% moisture content in 30 to 40 days, depending on the type of wood.

Fig. 3

Experimental Solar Kiln

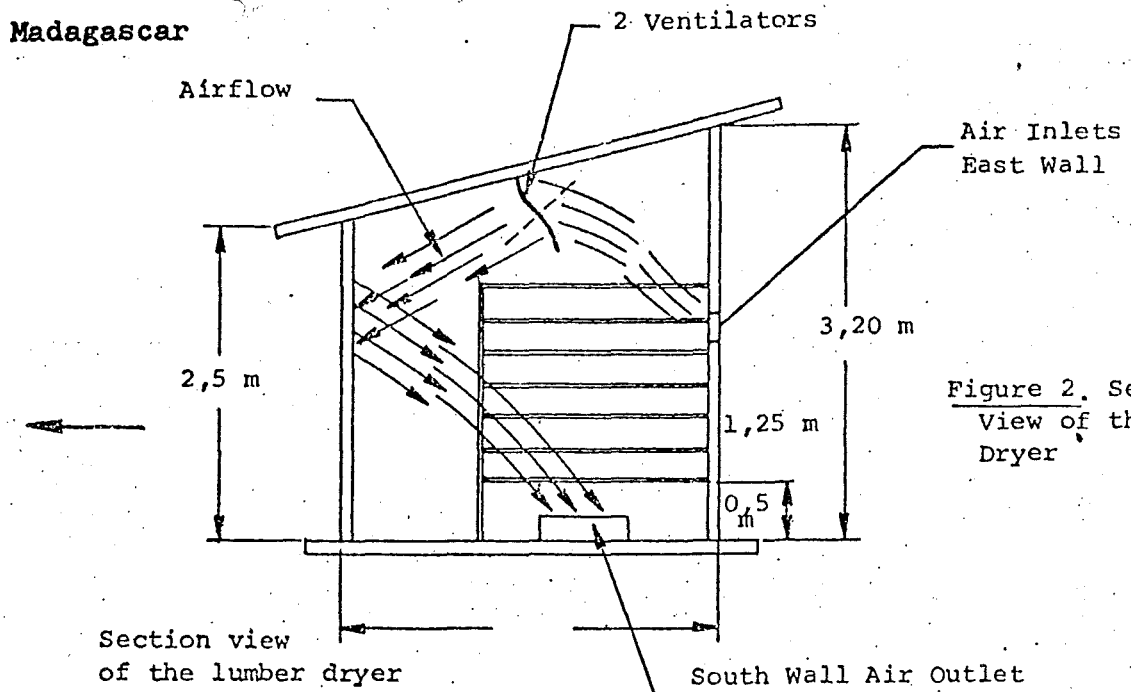


Figure 2. Section View of the Lumber Dryer

Materials of Construction:

Drying Chamber:

- Transparent cover: polyester reinforced clear corrugated fiber glass sheets, 0,9 m thick
- Frames: pine boards
- Insulation: none
- Trays: 2 cm thick wood lath shelving

Location: Tannanarive, Madagascar

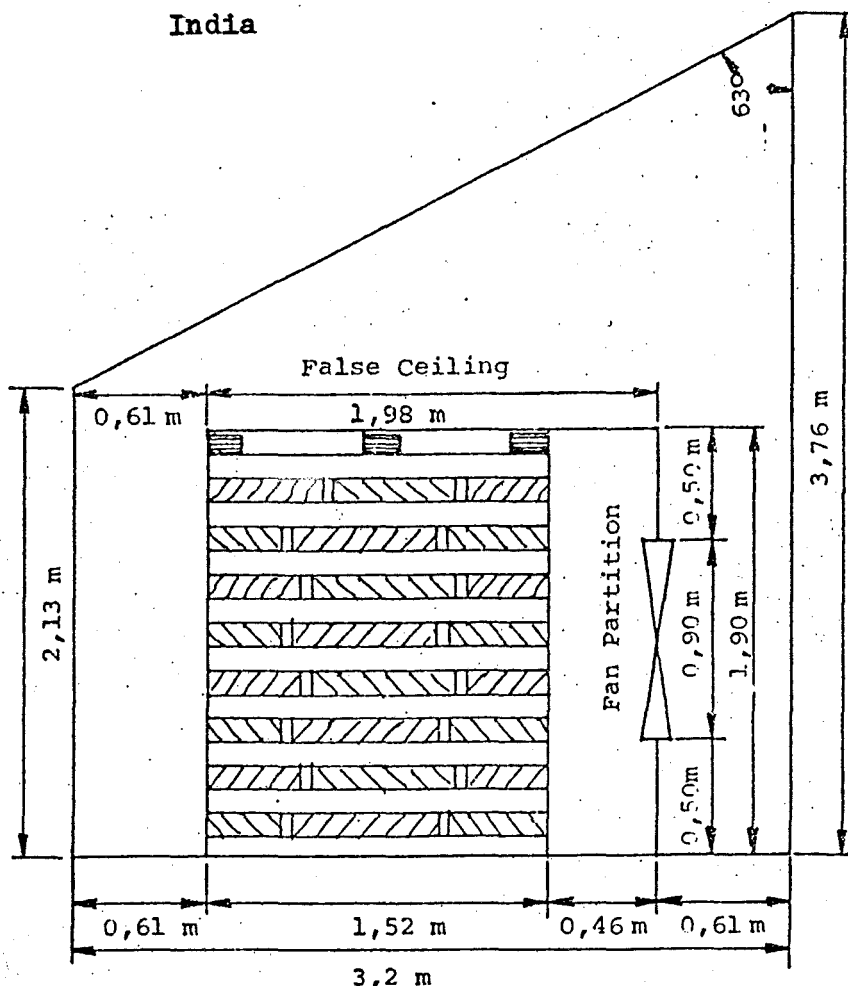
- Latitude: 10°55'S
- Longitude: 47°32'E
- Altitude: 1433 meters

A solar timber kiln will be effective for about 8 months of the year in most climates and longer in hotter and drier regions. Tests carried out in Rajasthan, India (lat. 25°N.) showed that during summer, temperatures can be developed in a solar kiln which are 10°C. above ambient air temperatures when drying green wood and 20°C. above as wood approaches its dry state. Similarly in late fall (November) the kiln can develop 15°C. excess with green timber and 28°C. excess with drier timber.

Fig. 4

Experimental
Solar Timber-
Drying Kiln

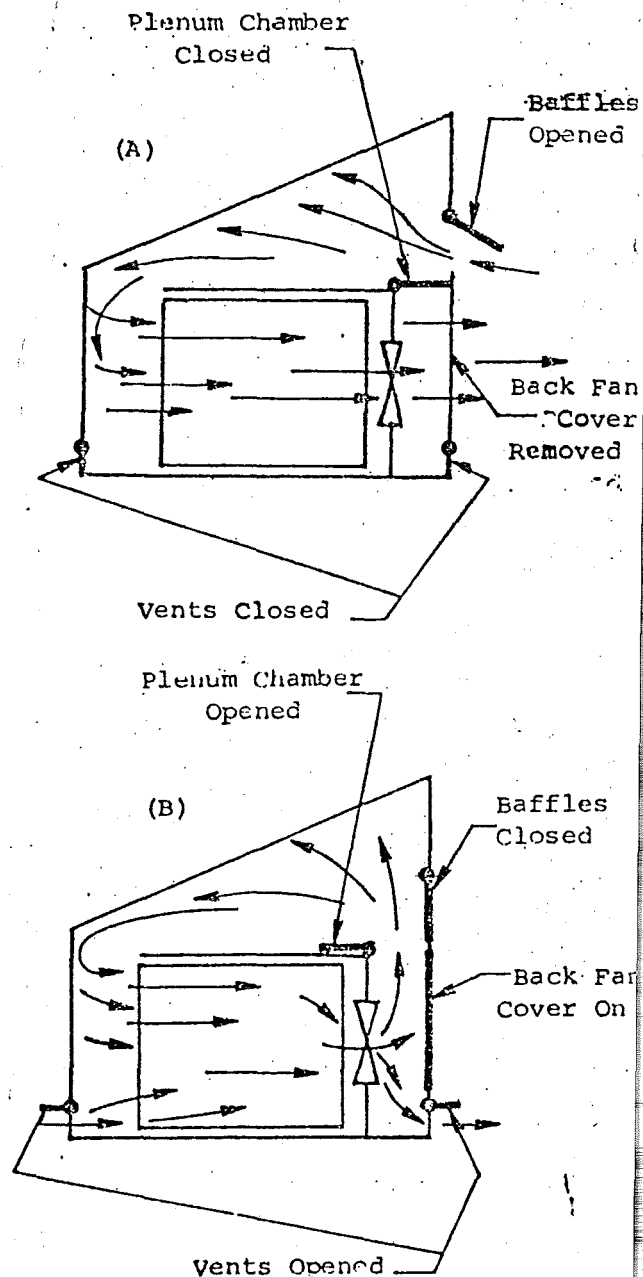
India



Plan of the Solar Timber Seasoning
Kiln - Side View

Fig. 5

Drawing Showing the Kiln Working as (A)
(A) A Single Pass Forced Air Dryer;
(B) A Recirculating Air Dryer with
Partial Ventilating



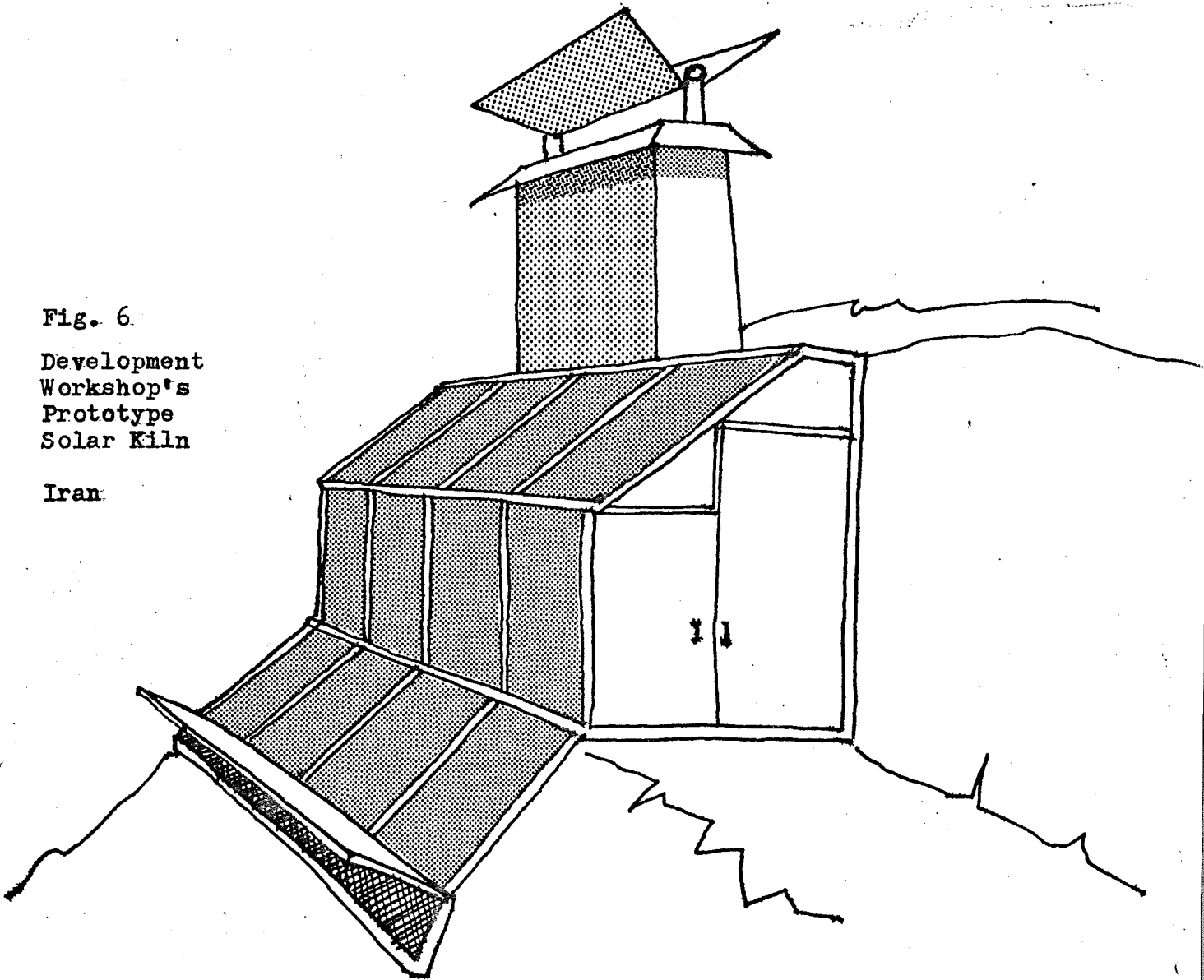
Naturally Ventilated-Solar Kiln

Prototype Design by Development Workshop

Fig. 6

Development
Workshop's
Prototype
Solar Kiln

Iran



Solar kilns designed and tested to date, though utilising free energy in the form of solar heating, have employed electrical fan powered ventilation systems not unlike those used in the expensive fuel fired kilns. In the solar systems described over 1/3 of the initial construction cost goes for the fan and motor apparatus and almost 80% of annual running costs are for energy. As electricity is as yet unavailable in many rural areas in Third World Countries the kiln design becomes complicated with the addition of a separate generator or petrol engine to operate a fan.

The system proposed here is designed to utilise thermal convection to ventilate the timber in the storage chamber. The structure is built into an exposed south face of a hill or slope. The design incorporates a solar-collector air heating panel as a pre-heater. Air is drawn through an adjustable air intake strip-opening at the base of the pre-heater. Air passes over and under a black metal sheet which heats up due to solar radiation. The air draws heat from the panel and flows naturally upward due to convection principles. The efficiency of this kind of collector (i.e. ratio of useful heat absorbed into the air stream over energy transmitted through the glazing) is between 64% and 88%. This pre-heated air passes directly into the timber drying-storage chamber at floor level.

The drying chamber is a green-house like structure, built on an east-west axis, against the side of the hill, with a single-pitch roof facing south. The roof glazing must be of a translucent material which will diffuse direct solar radiation which might damage boards exposed at the top of the timber pile. Timber is loaded or unloaded through large doors at the east and west end walls.

By digging the storage-drying chamber into the side of a hill and using stone or brick materials with a high thermal mass, heat will be retained in the floor and back wall and re-radiated into the chamber at night. Both inlet and outlet openings must be closed in the evenings to trap this heat.

A ventilation tower extends several metres above the drying chamber and opens onto the north wall. Convictional air movement through the system is due to a stack effect, much like a chimney. The higher the exhaust opening the greater the pressure differential, hence the greater the warm air movement through the pre-heater, the drying chamber, and then the ventilator shaft. The ventilator is oriented at right angles to the prevailing breeze. In windy conditions a wind trap at the top of the ventilator directs air horizontally across the mouth of the tower. This air stream creates an additional low pressure within the shaft, which sucks the air up and through the system at an increased velocity. Increased air movement improves the drying rate of the timber. During calm periods convection and the "stack effect" once more take over and induce air movement and help drying.

The naturally ventilated solar kiln described here should be cheaper to build and maintain than previous solar systems, and have the advantage of being completely autonomous, requiring no external energy inputs at the operational stage.

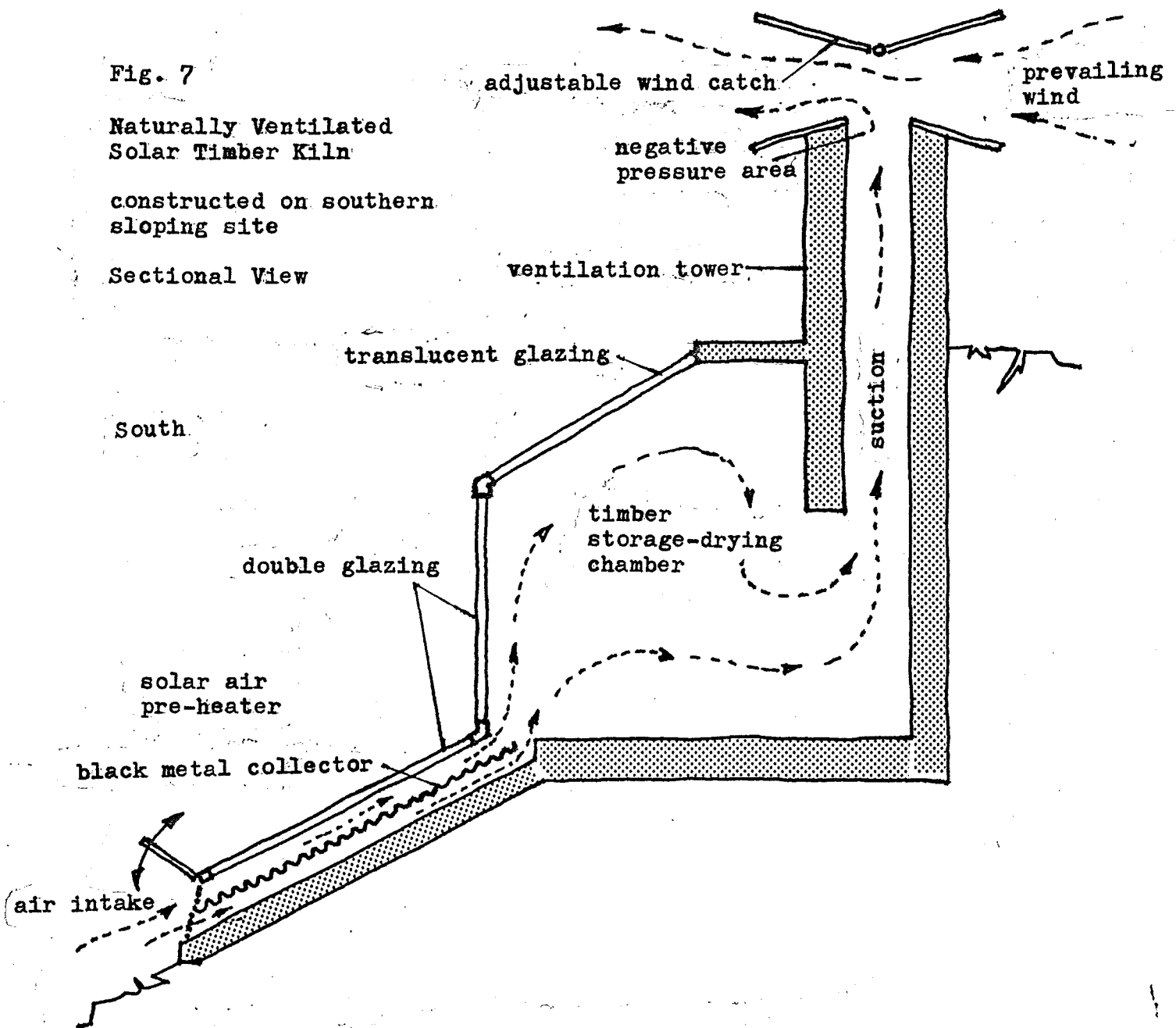
The solar kiln linked with a timber mill and carpentry workshops form a small-scale industry suited to the aims of a decentralised economic rural development program. Such industries, depending on little initial capital outlay and exploiting local renewable resources, can employ many of the growing rural population.

Fig. 7

Naturally Ventilated Solar Timber Kiln

constructed on southern sloping site

Sectional View



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(Figs. 6 & 7)

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