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## The Village Texturizer

by: Meals for Millions Foundation

Published by:

Volunteers in Technical Assistance  
1815 North Lynn St. Suite 200  
P.O. Box 12438  
Arlington, VA 22209 USA

Paper copies are \$ 3.95.

Available from:

Volunteers in Technical Assistance  
1815 North Lynn St. Suite 200  
P.O. Box 12438  
Arlington, VA 22209 USA

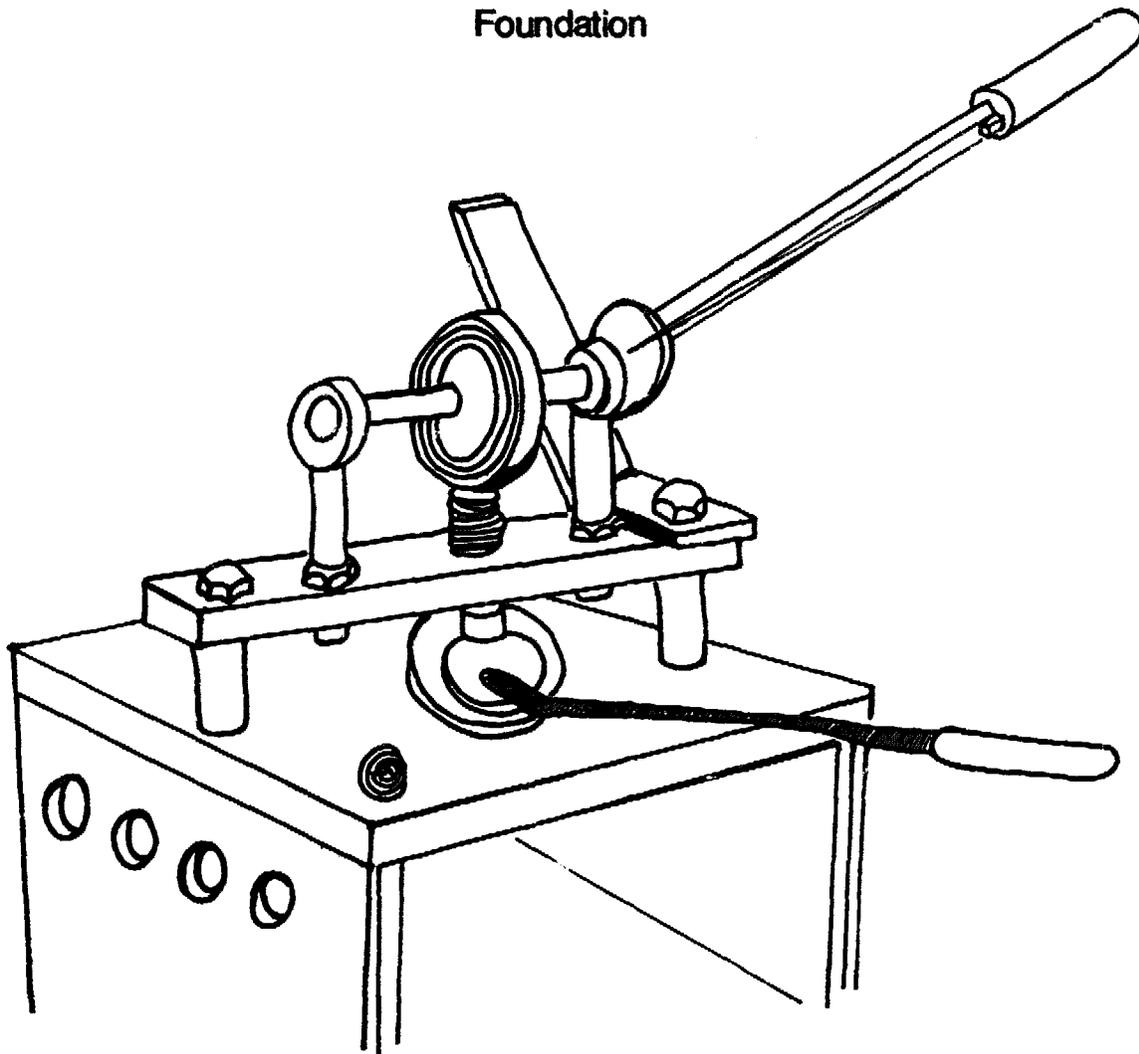
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# ***The Village Texturizer***

**A low-cost machine for preparing  
texturized food products at  
the village level.**

**DEVELOPED BY  
Meals for Millions  
Foundation**



**Self-Help for a Hungry World  
MEALS FOR MILLIONS  
FOUNDATION**

*a* **VITA** *publication*

## ACKNOWLEDGEMENTS

The Meals for Millions Foundation wishes to extend sincere appreciation to the following individuals and organizations for their contributions:

General Service Foundation, St. Paul, Minnesota  
Mark M. Sterner, Nutrition Resource Bank,  
Corona, California  
Mark H. Sterner, MFM, Santa Monica, California  
John C. Anderson, MFM, Santa Monica, California  
Susan A. Andraus, MFM, Santa Monica, California  
Hector Legrand, VITA, Baltimore, Maryland  
Laurel Druben, VITA, Mt. Rainier, Maryland

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## PREFACE

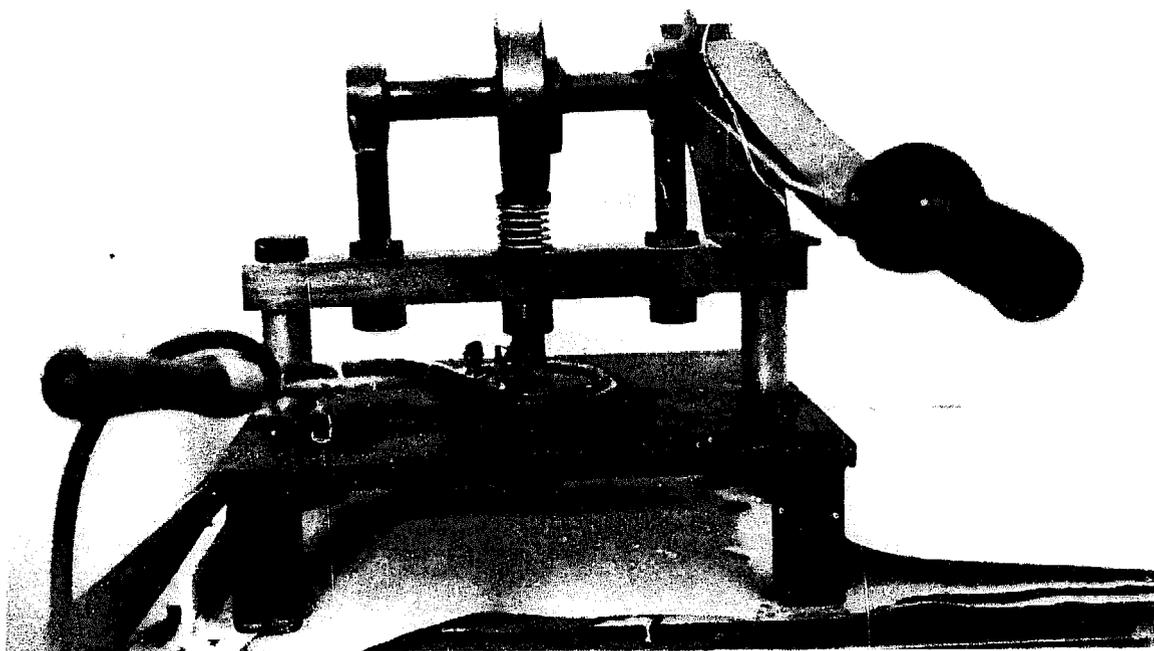
This manual was prepared for Meals for Millions Foundation (MFM) by Volunteers in Technical Assistance (VITA). MFM and VITA cooperation in the production and dissemination of this handbook is part of a growing movement toward collaboration among private, non-profit organizations having different, but complementary skills and the shared goal of making the world a better place for all. MFM engineers and specialists designed and tested the technology over a number of years; VITA prepared the final draft and camera-ready layout. The quality of this handbook is testimony to the strength made possible by combining such resources.

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# Introduction

The machine described in this manual is an excellent example of an intermediate technology: its construction costs are low (it can be built with pieces of metal and old auto parts for roughly U.S.\$50); its operation is labor-intensive; it requires no special knowledge (only experience) to operate and a minimum of maintenance; it can produce a wide variety of products which are both highly nutritious and tasty; it can be used in a variety of situations--from home to small business.



## Background

Meals for Millions first began seeking a simple machine for producing texturized food products in February 1973. The machine selected for adaptation and testing was found in Korea, where it had been used for a number of years to make a circular puffed snack food from rice-like pellets of sweet potatoes. In Korea, the machine was and is used by street vendors who place the apparatus on a small cart so that it can be moved from one place to another. Preparation of the snack food is done right on the spot.

MFM felt this machine could be adapted to quick-cook a variety of flour-like substances made from food materials. If, as MFM felt, this machine could be inexpensively constructed and could yield protein-rich products from locally available foods, then its potential as a useful tool in the fight against world hunger and nutrition problems could be significant.

MFM subsequently adapted, built, and tested the machine to determine its usefulness for producing low-cost, high-protein and/or high-calorie food products at the village level. The results of this research have been extremely promising. Tests have shown that the Village Texturizer, the name given the machine by MFM, can be used to quick-cook flours made from starches, cereals, legumes, and oil seeds--and, further, that flours made from these food groups can be combined and processed successfully.

MFM has used the texturizer in its California, USA, facility since 1975. Food technologists from developing countries, while participating in MFM's training programs\* have tested a variety of materials; among them mung beans, soy, defatted soy, peanut, maize, rice, black beans, red beans, and cow peas.

A special word should be added about the use of soy in texturization. For a long time it was felt that 1% fat was all that a mixture being texturized could contain. Through adaptation of this machine and experimentation with a variety of mixtures, MFM found that it is possible to produce a texturized product from full-fat soy flour containing 37% protein, 20% fat and 30% carbohydrates.

This successful use of the texturizer to process full-fat soy flour is significant. Soy is recognized as one of the best and most inexpensive sources of vegetable protein, and more and more countries around the world are placing emphasis on the production of soybeans. While there is no doubt of its nutritional value, soy is not usually considered tasty; therefore, it benefits greatly from cooking with ingredients which make it more appetizing and more easily digestible--particularly by children. The texturizer can be an extremely helpful tool in programs aimed at introducing soy products into the diet of local populations.

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\*More information on MFM and its activities can be found in Appendix C.

# The Manual

This manual is divided into three sections. Section I gives a somewhat broad, but hopefully informative discussion of the important part texturized products and, particularly, texturized vegetable products can play in a village diet. Food technologists and nutritionists are already familiar with such foods, of course. But this machine, because it is inexpensive and easy to use, makes it possible for a government extension agent, a community development worker, a volunteer to begin introducing new foods and nutrition concepts through its use.

Indeed, it is the technology transfer agents, those who work in the villages, who will decide the ultimate use and value of the texturizer for their situations. Laboratory use proves the machine works, and a similar machine produces food in Korea. Now MFM wants to make the technology available to those who will introduce it in the field. The discussion in Section I, therefore, is intended to provide background and guidance for such transfer agents as they work with the texturizer.

Section II contains construction details for the texturizing machine. Construction of the texturizer requires access to a shop or facility where some of the parts can be made. However, the parts are quite easy to make, and require use of a minimum of equipment. Step-by-step illustrations of the assembly process are provided.

Section III is the Operator's Guide to machine use. This section includes guidelines for experimenting with possible products, determining proper temperatures and pressures, and operating the machine.

## Evaluation and Followup Assistance

Publication of this manual represents the culmination of over four years of adapting and testing the texturizing machine described here; there is no doubt that the device works. However, as stated previously, a new period of "testing" must begin as users build the machine in village situations, work to adapt products to local taste, and find local materials which can be used in the texturizer--materials both highly nutritious and acceptable to consumers.

Meals for Millions hopes to make the texturizer and the results of its use available to as many people around the world as possible. Those who construct and use this machine are asked to fill in and return the enclosed questionnaire so that MFM can incorporate the results of users' adaptations, modifications, and experiences into future materials. In turn, MFM, will make every attempt to answer inquiries relevant to use of the machine.

# 1 An Introduction to Texturized Products

## The Case for Texturized Products

Texturized products are created through use of the machine detailed here from flour-like materials which contain varying amounts of protein and carbohydrates--whether from animal or vegetable sources. But while it is possible to use animal protein in mixtures being texturized, this manual focuses primarily on vegetable protein because it is generally cheaper, more readily available, and acceptable to people of all religions.

Throughout this manual, the term "texturized products" will refer to those foods produced when a flour or mix of different flours is heated under pressure with the village texturizer. These flours, which contain 15-35% moisture, are pressure cooked in the cup of the village texturizer: cooking is done by a combination of the (1) heated surface of the cup and lid (2) tight seal obtained when the lid is pressed into the mixture in the cup, and (3) steam that is generated as the moisture in the flour heats. When the lid is released, the steam which has been building under the pressure escapes with a loud bang. The texturized product is now cooked and has a puffed, crisp texture.

Texturized product is a general term which refers to all foods produced by this machine. However, because all flours do not have the same characteristics (for example, some contain more natural oils than others), there are a number of types of texturized products, depending upon the combinations of materials. The type of texturized product about which this manual will talk most is structured vegetable protein (SVP).

SVP is produced in the village texturizer when mixtures of high-protein, low-fat flours are cooked: soy and peanut flours are good examples of high-protein flours which will produce SVP when texturized. SVP products have a meat-like structure and, therefore, may be handled differently after cooking.

Those texturized products not made with high-protein flours lose their shape when added to water or other liquids. These products can be eaten directly or can be broken into pieces, mixed with small amounts of water and eaten as a thick cereal or porridge. On the other hand, SVP products can be added to soups and stews to replace meat because they retain their shape and are chewy like cooked meat. Or SVP products can be flavored and fried as discussed later.

SVP has been used for some time in a number of countries. In the US, for example, SVP is added to some kinds of meat and other foods so that nutrition remains high while costs are lowered. The US, Britain, Sweden, Israel, Japan, Mexico, India, among others, produce such vegetable protein products commercially. Until relatively recently, production of SVP was feasible only for those having enough money to buy the necessary, expensive equipment and to train and pay skilled machine operators.

## Texturized Products for Developing Countries

The machine described in this manual represents one answer to the problems associated with producing nutritious pre-cooked food products in a village situation.

Use of this device can lead to introduction of protein- and calorie-rich food into more and more deficient diets. Texturized products, especially SVP, can be an important food source for developing countries because:

- . they can be made from a number of materials, such as certain nutritious oil seeds and legumes, which otherwise might not be eaten at all;
- . they can be made from materials which are available locally and SVP can be both cheaper than and as nutritious as meat, which is often in poor supply;
- . products are easily digested, especially by children;

- . the user can create foods with different protein and calorie levels to meet people's needs;
- . products do not spoil quickly and, therefore, pose far fewer storage problems in rural areas where storing meat, for example, is difficult or impossible;
- . products can be flavored and used in a variety of ways to respond to the customs of a country or location;
- . they are pre-cooked and therefore are convenient.

## Meeting Community Needs with Texturized Products

All the above reasons are good ones; yet SVP and other texturized products are not going to be a success until they are accepted by consumers. And this acceptance will depend upon how wisely the products are introduced to a given area. The following paragraphs seek to provide basic information and guidelines to aid the introduction process.

The texturizing machine should not be constructed until a thorough study of community needs and preferences indicates (1) what people in the area most require and/or lack in their diets; (2) what local materials are available from which to make appropriate texturized products; (3) which local food habits and customs texturized products would best fit into and in what form; (4) how such products can best be introduced when all other questions have been answered. While these points must be considered locally (from one area to another), there are some basic guidelines which are useful generally.

### Determining Need

It is often not hard to see that there is a nutritional deficiency among a certain group. There are very noticeable signs for most nutritional diseases. The place to start, therefore, when determining how to meet a need with a texturized product is to discover the cause of the nutritional problem. For example, if the staple or main ingredient in the local diet is a plantain or tuber, such as potato, it is more likely that protein is lacking in the diet because plantains and tubers do not contain abundant protein. On the other hand,

if a major ingredient in the diet is a cereal grain and there is plenty, yet there are signs of malnutrition, e.g. blindness in children, the problem may be a diet which, although it seems to be plentiful, has a poor balance of vitamins and minerals.

Texturized products, and particularly SVP, can be developed to combat such situations simply by thoughtful combining of ingredients. In both of these cases a texturized product combining legumes with the other ingredients might be what is needed. For example, combining cereals and legumes makes it possible to present a balanced diet without having the food be too bulky, especially for a child's stomach. Small children can consume limited amounts of food in a day. A balanced diet insures that a child consumes enough nutrients to maintain growth. Although it is not always true that more food is better than less food, it may prove difficult to convince consumers that a smaller amount of a texturized product is really providing a better source of food than a much larger quantity of the local staple.

## Finding Mixtures to Meet Needs

Once the nature of the deficiency has been determined, it is possible to develop mixtures to meet the need. Finding the right combinations is done by looking at possible ingredients which are easily available and by studying local food and social customs. It may be that this step results in possibilities for several texturized products; for example, a SVP meat extender or substitute to be eaten by adults and a light snack food to be given to children as part of a school program. But whatever the outcome, the starting point is determined by the most popular staples in the area. Remember that what must be sought is the combination having both the best nutrition and the best chance of acceptance. If more than one staple is available and accepted, choose the most nutritious, always keeping in mind the major need of the area for protein or calories, as the case may be. If culturally acceptable, cereal grains are much better bases for texturized products than the less nutritious tuber and plantain--which contain much fiber and water but relatively few calories and protein.

The following chart was prepared to guide those introducing improved foods for children into villages. It also provides a handy reference for those working with SVP--especially as a guide when working to combine ingredients.

APPROXIMATE PROTEIN CONTENT AND AMINO ACID DEFICIENCY  
OF MAIN CATEGORIES OR VEGETABLE FOODS  
USED IN MULTIMIXES

Type of Food	Approximate protein content (%)	Amino acid deficiency
Tuber or plantain	1-2 <i>a</i>	Lacking in lysine
Cereal grain	+10	Lacking in lysine
Legumes	+20 <i>b</i>	Lacking in methionine
Dark green leafy vegetable	4-10 <i>c</i>	Lacking in methionine
<i>a</i> Dried: 3% <i>b</i> Soya beans: 40% <i>c</i> Dried: 30%		

*From the chart it can be seen that foods contain differing amounts of amino acids, which are what protein is made of. Therefore, good combinations balance a cereal, say, which is lacking in lysine, but has methionine, with a legume which lacks methionine but has lysine. For more information on combining ingredients scientifically see Appendix A and the Bibliography.*

The following are good ingredients for texturized products which should be looked into for local availability:

- . Oilseeds -- soy, sesame, groundnut (peanut)
- . Legumes -- black beans, cow peas, lima beans, chick peas  
                  red beans
- \*. Skim or whole milk powder
- . Cereal grains -- corn, rice, wheat
- \*. Fish protein concentrate or other dried fish products.

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*\*It is worthwhile to restate the fact that it is possible to use animal protein in texturized products. SVP, however, is made only from vegetable sources.*

Legumes will often provide the best local source of protein (milk and fish powders are not available everywhere); choice will depend upon protein content, availability, cost, acceptability, digestibility. If a higher calorie product is desired, oilseeds can be used in the mixture. Such seeds provide fat while keeping the bulk of the product relatively small.

In sum, if the staple in the area is a tuber, such as sweet potato, it may be possible to increase protein in the diet by mixing flours made of the staple and a local legume in varying amounts. If more calories are needed, it is possible to decrease the amount of staple and to add another flour made from one of the oilseeds. If still more calories are needed, without adding bulk, small amounts of sugar or crushed, dried fruits can be added.

When assessing raw materials which can be prepared in the texturizer to meet community needs, it is probably easiest to say that all edible cereals and legumes in flour form can be texturized, including rice, corn, sweet potato, cassava, soy and peanut, glandless cotton seed, chick peas, red beans, and so on. These materials may already be available in flour form, but they may be ground by any number of hand or machine methods. The general rule for grinding for the texturizer is to have the material as finely ground (flour-like) as possible.

Any other animal or vegetable materials which can be ground into a fine flour may also be added in varying amounts to basic ingredients. The thing to remember here is that each time the ingredients are changed, the characteristics of the texturized product are likely to be different, and this of course may affect local acceptability.

## Introducing Texturized Food Products

By now even a casual reader of this manual has some idea of which materials can be texturized and of how to combine materials to meet nutritional needs. At this point, it is necessary to find the product or products which have the best chance for successful introduction. This is a crucial step. Eating patterns are not easy to change, so it is probably best to try to fit texturized products into local patterns or even to create distinctive, tasty new foods which find acceptance on their own merits.

Snack foods are an obvious way to accomplish the latter. By using a mixture which has a lot of starch, such as corn or rice, processing in the texturizer gives a crisp product which is often well accepted as a snack food. Experimentation can lead to a snack food or to a diet supplement for children which is not only nutritious but largely accepted.

Addition of other ingredients will cause the texture to change. When ingredients used are vegetable materials high in protein (i.e., legumes), the texture of the product can be similar to meat; this means that eating SVP feels much like chewing cooked meat. The flavor, of course, is not the same at all. But because the flavor of the SVP itself is likely to be very bland, SVP can be added to other dishes and will take on the flavor of the other foods. This makes SVP an excellent meat substitute or extender in soups and stews made with other materials. SVP products made on the village texturizer resemble patties. It is possible to take the patties after processing and soak them in water containing flavoring. (The amount and type of flavoring depends upon local tastes.) After the patty is soaked and flavored, it may be drained and then fried in oil before eating.

Materials having a high-fat, high-protein content, e.g., flour made of full-fat soy, have yet another texture--they are soft and spongy after processing.

Much of the success of introducing texturized products will depend upon the extent to which local customs and tastes are taken into account and upon the creativity and skill of those who are combining raw materials to produce products. This point cannot be stressed enough: without attention to such factors, the texturizer is likely to remain only a machine and not become a tool for combatting hunger, malnutrition, or even unemployment (by serving as the basis for a small business operation).

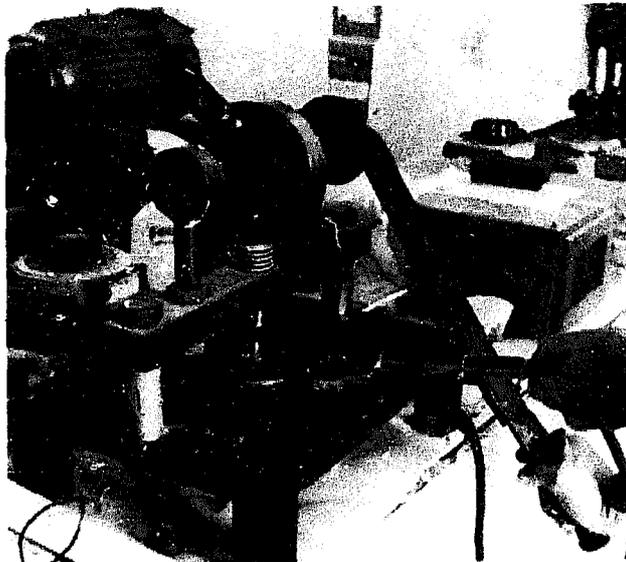
## Additional Considerations

There are several other factors which probably are best considered before construction begins.

### Heating the Machine

A good heat source is essential to the texturizing process. Heat for the Village Texturizer may be obtained from a variety of sources--charcoal, kerosene, fuel oils, wood, coal, gasoline, and electricity. The type of heat used depends upon what is available and not too expensive. In Korea, operators burn one coal and clay briquette at a time, and, in general, they use three briquettes in the course of an 8 to 10 hour day.

The texturizer, as detailed for fabrication in this manual, has not been illustrated for use with electricity because (1) so many places where it will be in demand do not have electricity and (2) the electric model is not portable and, as is the case in Korea, a major use may depend upon the machine being taken easily from one place to another.



*The village texturizer in use. This laboratory model has been set up for use with electricity. The model presented in this manual could be modified in much the same way.*

It is best to decide on the heat source before beginning construction so that heating can be figured into design considerations and added into cost calculations. The following table gives some indication of the amount of fuel which will be required for one hour of operation and can serve as a guide in cost calculations.

APPROXIMATE		FUEL REQUIRED	ROOM TEMP. @ 70°F-21°C
Material		Amount per Hour	Preheat for ½ hour
Kerosene (using whatever burning method is available)		3 ounces/85 grams	8 ounces/227 grams
Charcoal		5 ounces/142 grams	12 ounces/340 grams, provides heat for pre-heating and ½ hour operating time.
Electricity: base		770 watts	½ hour to preheat at operating watts
	lid	330 watts	½ hour to preheat at operating watts

(Tubular heaters are used on the lid and base plates. They come in a variety of lengths and voltage)

## One Machine or Several

One last subject which should be mentioned and considered before beginning to construct the texturizer is how many machines are needed and can be built and used successfully. This, of course, will depend upon the decisions made regarding kind(s) and uses of products. Is the machine to be used by a family? As part of a small business? To produce food for a school lunch program?

Remember, each different texturized product may require a different temperature and pressure range, which may necessitate having at least one machine for each purpose--if such products have to be made at the same time. But before planning more than one machine, make sure that each one will be used as fully as possible.

At some point, it will be possible to produce another booklet on uses and products of the texturizer and to provide additional guidelines for introducing the texturizer into a variety of village situations. (Appendix B of this manual does contain information on operating a small business based on use of the texturizer.) The main aim of this volume, however, is to introduce the machine so that experimentation can be gotten underway.

# 2 Construction and Assembly of the Texturizer

## Construction

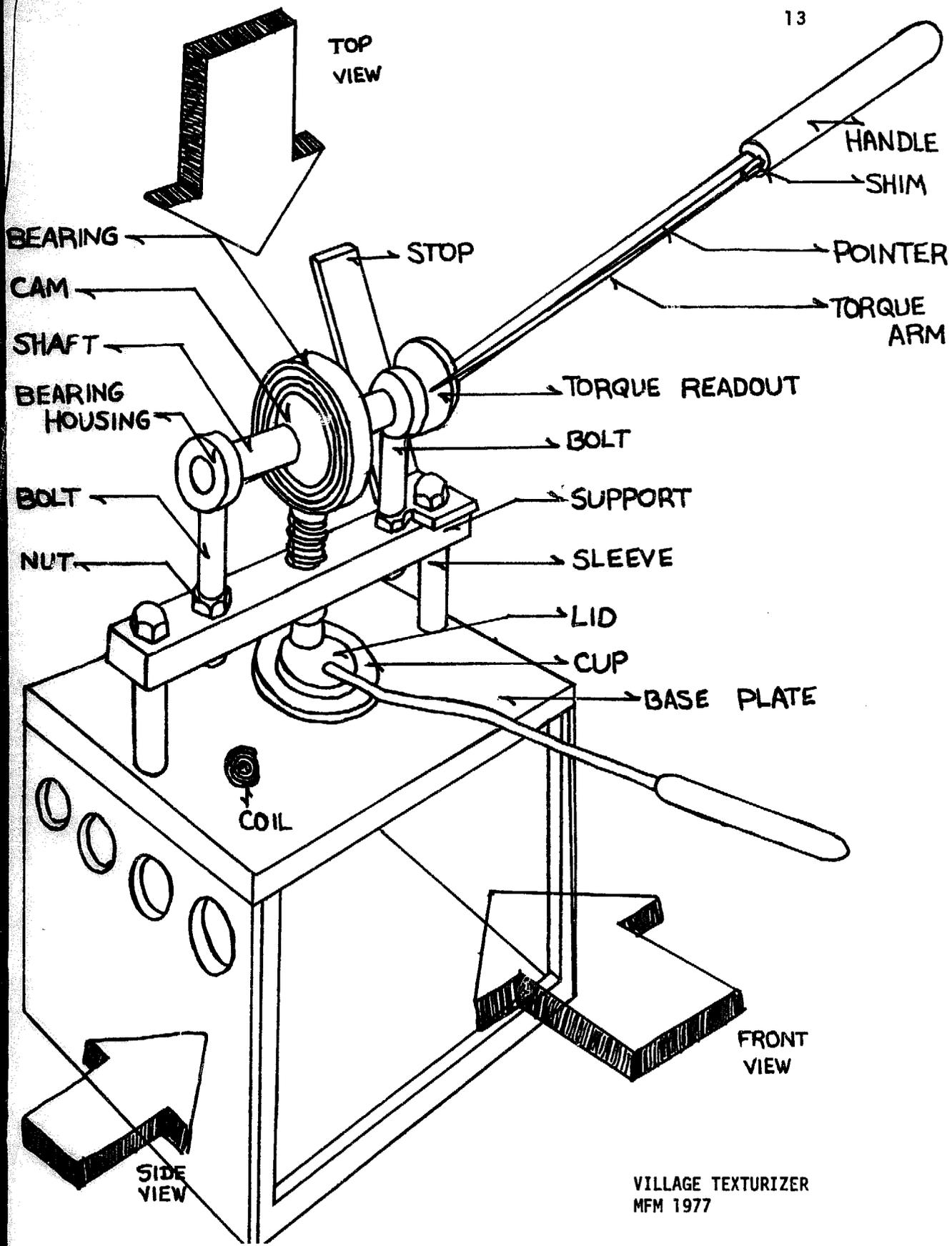
This section is divided into three parts:

- . Gathering the Materials
- . Making the Components
- . Assembling the Machine

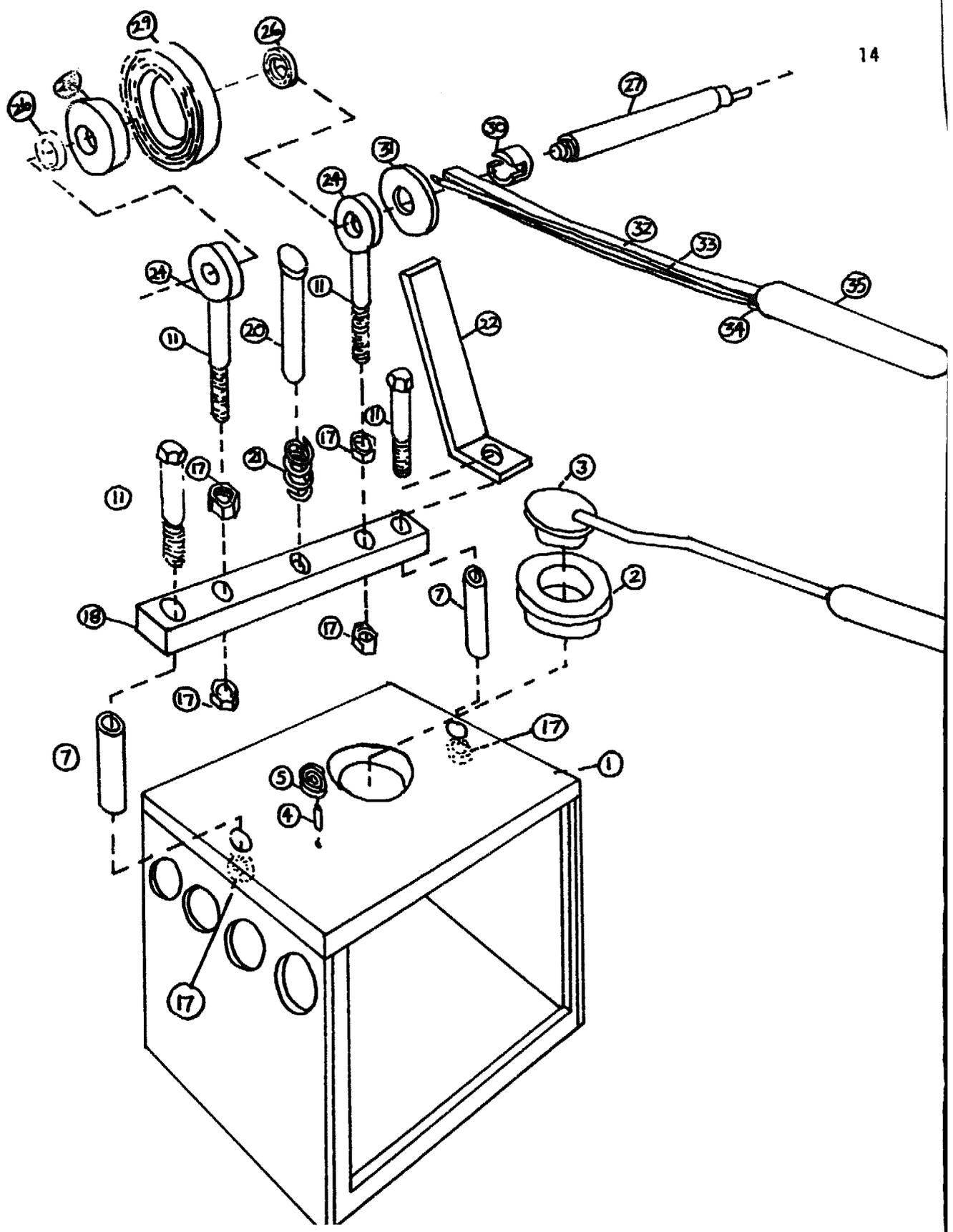
As stated in the Introduction, manufacture of this texturizer will require access to facilities for basic machine shop work. And, although the directions are presented in detail and machine-shop terminology is explained, this handbook will be used most easily by individuals who have basic machining skills.

Meals for Millions recommends that the user read through both this section and the operator's section which follows before constructing the machine. This will give the builder a better grasp of each part of the texturizer and its function in relation to the machine as a whole. Such familiarity with the machine is particularly helpful if the builder is forced to make substitutions for components and materials recommended here.

Two illustrations are provided here to assist the reading and construction processes. One drawing indicates each of the components by name so that it is easy to visualize where each component appears on the machine; the other illustration is an exploded view which shows how the components (labelled by number) fit together. These drawings have been left unbound so that they can be removed and consulted as readers use the manual.



VILLAGE TEXTURIZER  
MFM 1977



# Part 1

## Gathering the Materials

The following is a list of materials required for building the texturizer. Abbreviations used are:

L = Length  
W = Width  
T = Thickness

OD = Outer Diameter  
ID = Inner Diameter  
D = Diameter

<u>COMPONENT NO.</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>MATERIAL NEEDED FOR COMPONENT</u>
1	Base Plate	1	L380 x W300 x T13mm Plate Steel
2	Cup	1	D114 x L28mm Round Stock
3	Lid	1	D80 x T19mm and (D80 x L19mm Solid Round) (D10mm x L250mm ROD - D25 x)
4	Pin	1	D6 x L25mm Round Stock
5	Coil	1	Manifold Thermostatic Coil
7	Sleeve	2	D33 x L76 Tubing
11	Bolts	4	24m x 178mm long
17	Nuts	6	24m (no reference sheet)
18	Support	1	L380 x W50 x T32mm Bar Stock
20	Cam Plunger	1	D38 x L152mm Tool Steel
21	Spring	1	OD38 x L90 35kilograms (2.35 wire 8mm pitch)
22	Stop	1	L350 x W64 x T32mm Strap Steel
24	Bearing Housing	2	D64 x L35mm
26	Bearing	2	OD52 x ID25 x W15 (6205)
27	Shaft	1	D312 x L32mm Round Stock
28	Cam	1	D76 x L40mm Round Stock
29	Bearing	1	ID60 x OD130 x W31mm (6312)
30	Hub	1	D50 x L50mm Round Stock
31	Torque Readout	1	D89 x T3.2mm Sheet Metal
32	Torque Arm	1	L549 x W38 x T5mm Auto Spring Steel
33	Pointer	1	D5 x L300mm Round Stock (See page 13)
34	Shim	1	L40 x W11 x T5mm Bar Stock (See page 13)
35	Handle	1	D32 x L127mm Wood (See page 13)

## Part 2

### Making the Components

This section details manufacture of the components required for construction of the texturizer. Each additional page shows a drawing of the component (including measurements), and instructions for fabrication, where relevant.

Special note should be made of the fact that there are *two* ways to construct the *Torque Arm*: one method outlined on page 33, depends on use of auto spring steel; if this is not available, the torque arm can be constructed using a steel bar or pipe as follows:

#### Alternate Torque Arm Construction:

*A round, solid, steel bar or thick-wall steel pipe can be substituted for the described subassembly consisting of torque arm 32, pointer 33 and shim 34 as follows:*

- . Delete Torque Readout 31
- . Substitute 13mm wide slot in Hub 30 for a cross hole on one side only. This cross hole will have a diameter slightly larger than the diameter of the rod (or pipe). This hole will receive one end of the rod.
- . Delete flat (38mm x 11mm) on end of Shaft 27
- . Spot weld end of Shaft 27 to end of Hub 30
- . Rod length should be the same as Torque Arm (about 560mm)
- . Insert rod into hub hole and spot weld
- . Adjustment should be made as described in Assembly Step 23.

### Some Machining Terms

Below are definitions of a number of terms which will be used when referring to the machine procedure:

*Chuck*: A clamp-like device, such as on a lathe, by which the tool or work to be turned is held.

*Ring fit*: Parts fit without perceptible play.

*Press fit*: Strong pressure which produces permanent assembly.

*Loose fit*: Parts move and turn easily and are not affected by temperature changes.

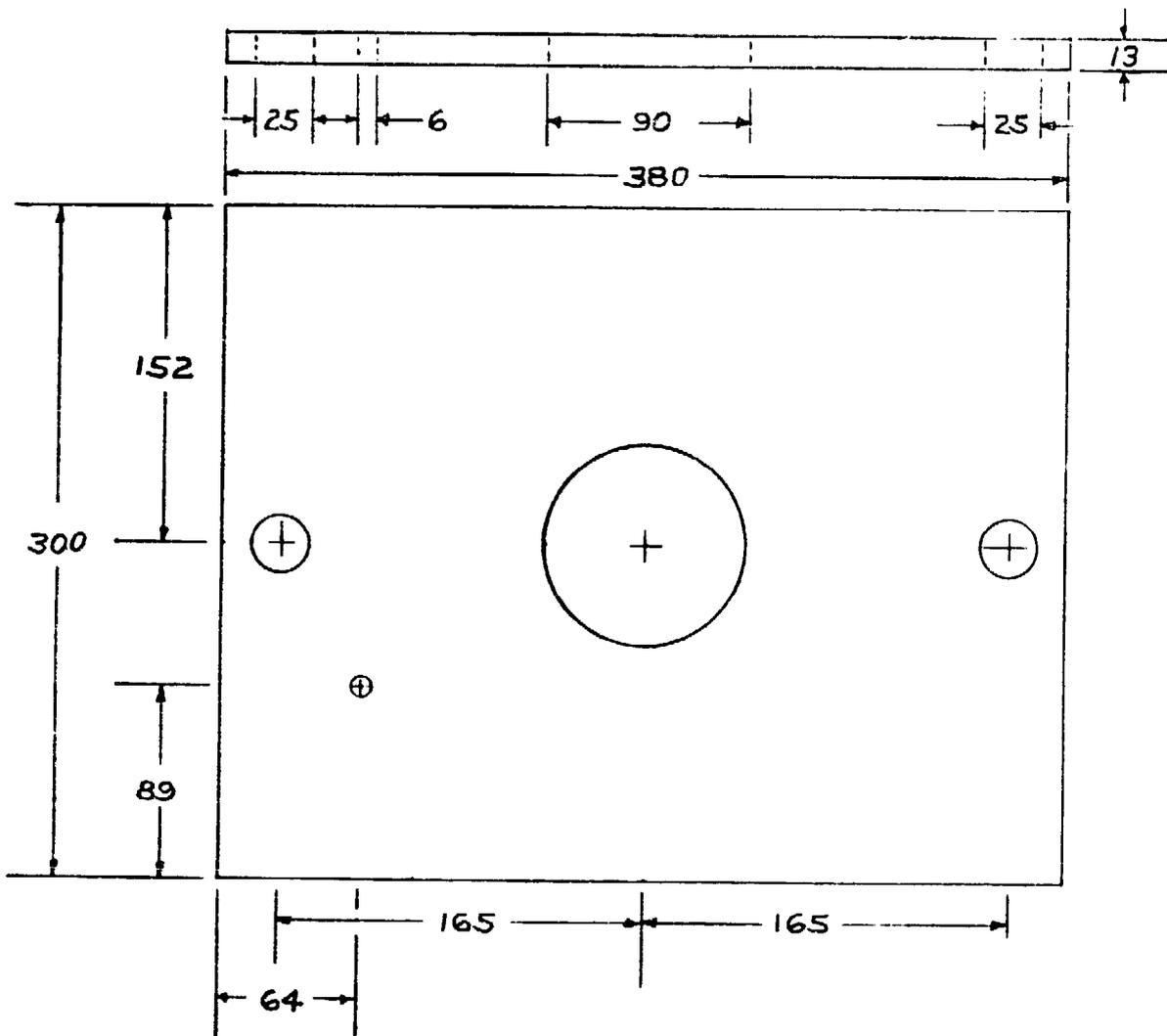
**Face:** Remove materials from surfaces perpendicular to the axis of rotation in an engine lathe.

**Turn:** Remove material from peripheral portions of stock rotating in an engine lathe.

**Heat treat:** Harden steel by heating to red; cool using oil, water, or air depending upon type of alloy.

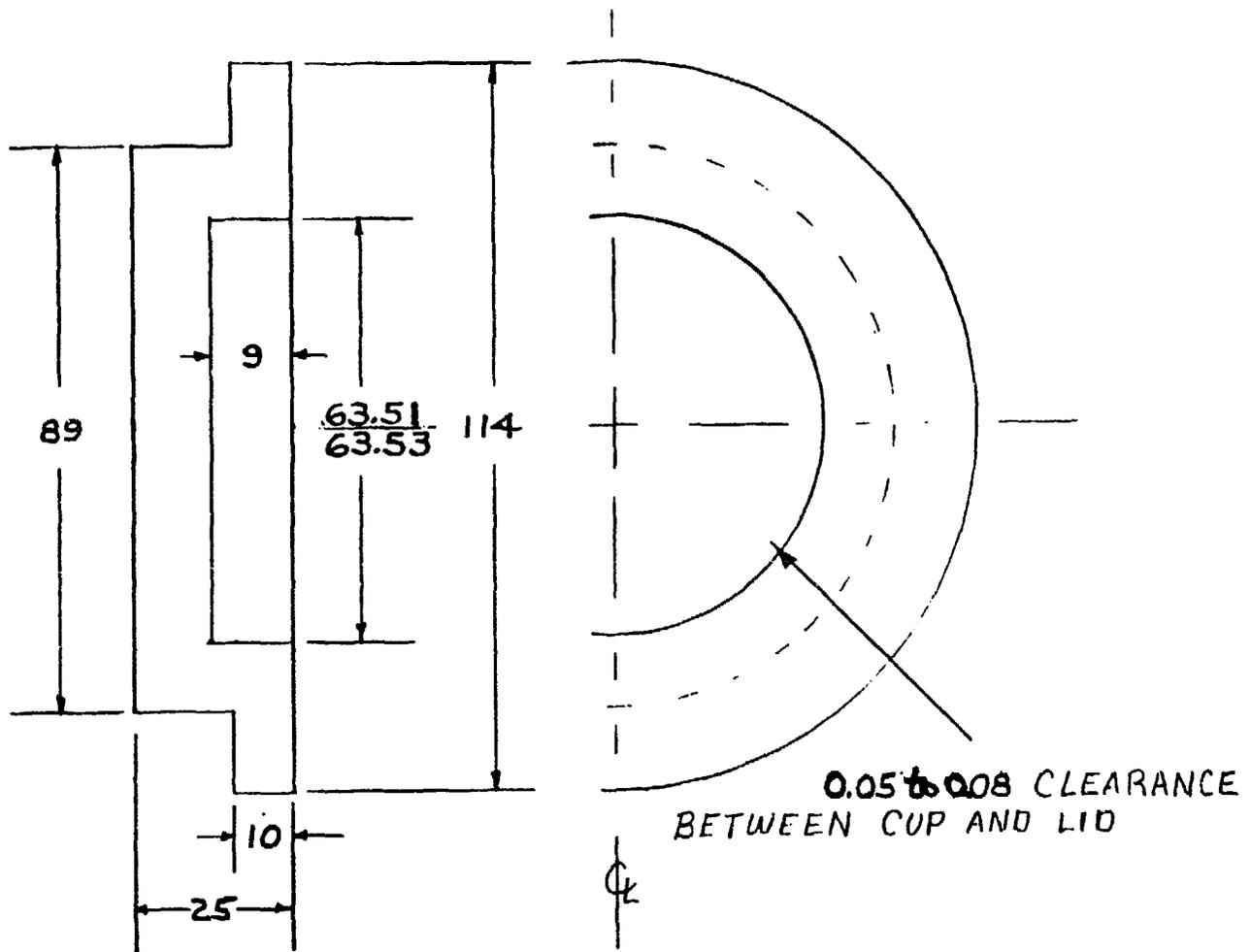
# Component No. 1

**BASE PLATE:** Cut out a 90mm diameter hole in the center of plate, either by acetylene torch or by bore arm mill, and drill other holes as shown on print. The outer base plate dimensions may vary considerably; the 90mm hole should be centered, and placement of remaining holes kept in reference to it.



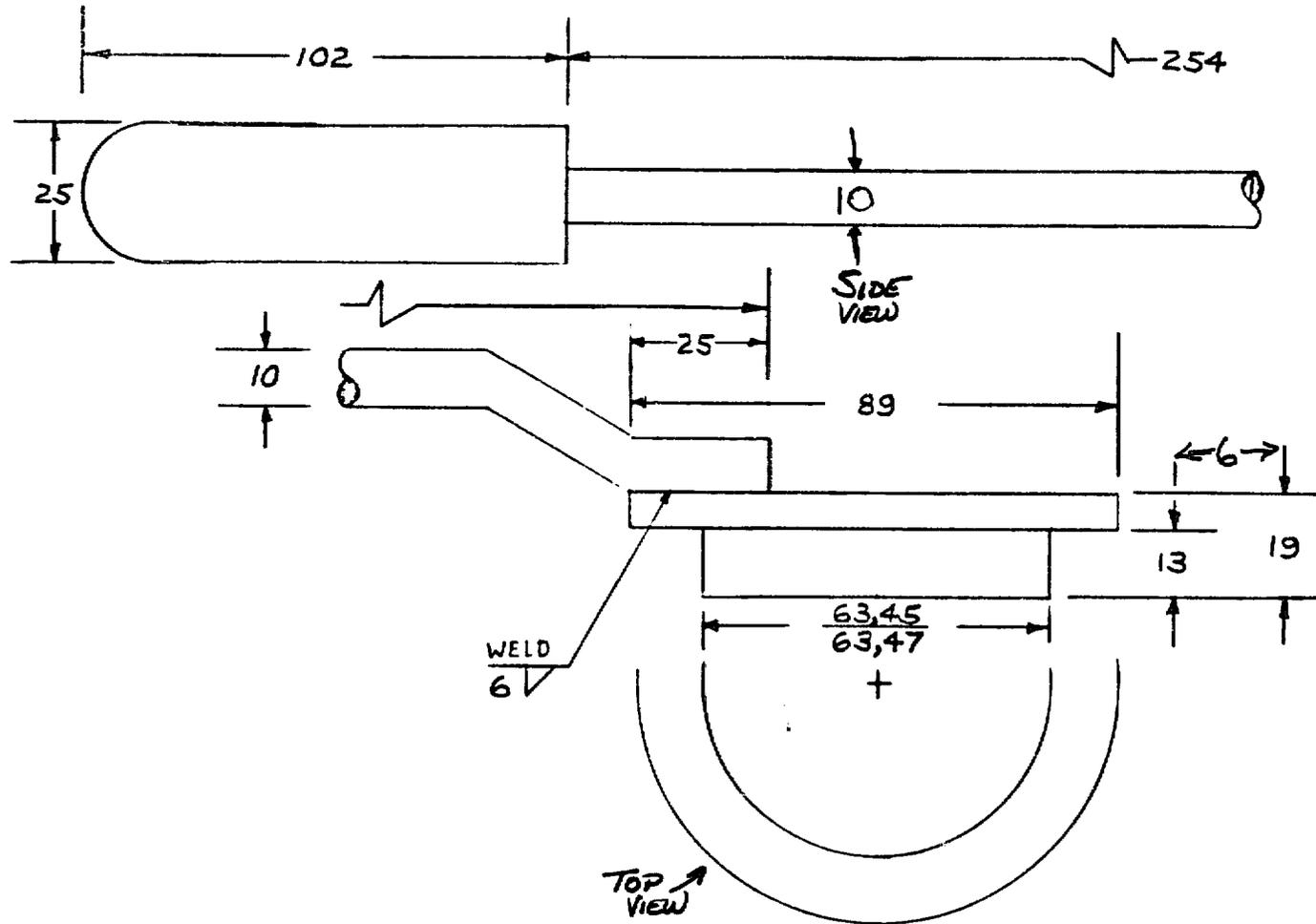
## Component No. 2

CUP: Chuck 114mm diameter material in engine lathe.  
Face and turn 89mm diameter - 15mm long. Reverse part  
in the chuck and bore 63.5mm cup.



# Component No. 3

LID: Machine lid 63.4mm diameter, 6mm, and face to obtain 13mm. Reverse in chuck and face to 6mm. Bend 10mm rod to print. Handle can be wood, metal or plastic, and fastened by glue (depending on the handle material). Rod is attached to lid by welding.

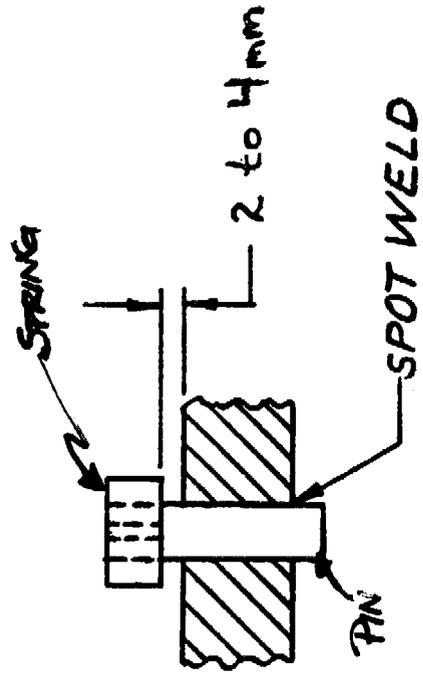
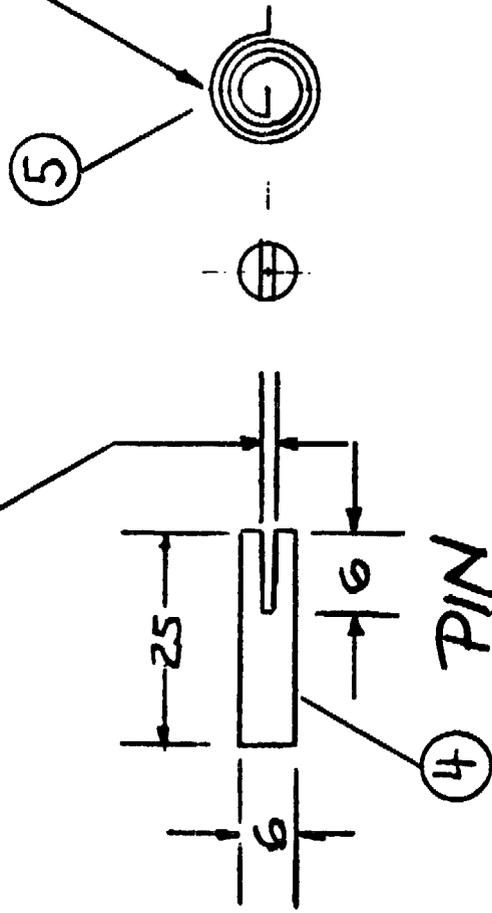


# Component Nos. 4 & 5

HACK SAW

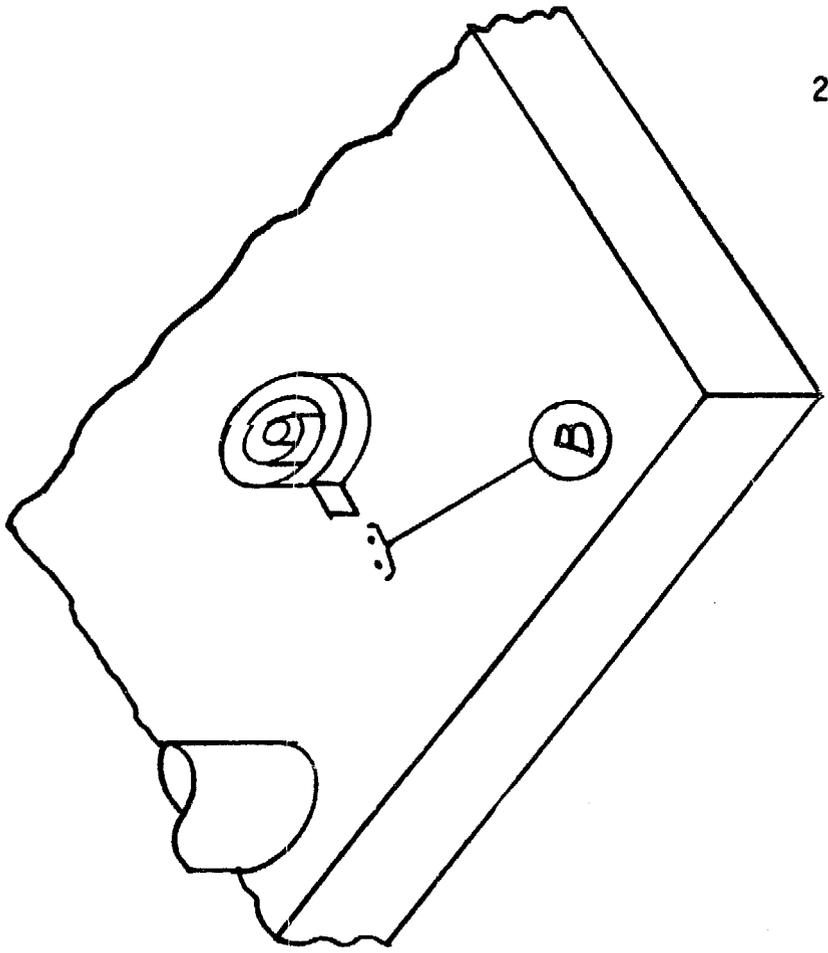
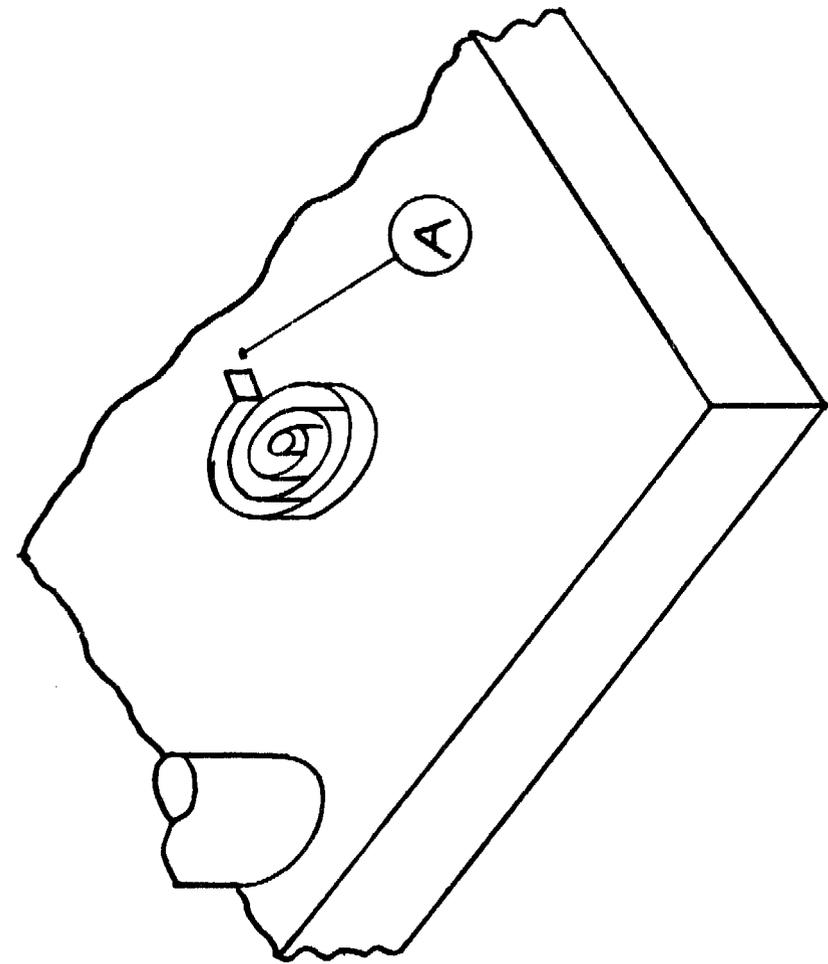
2

THERMOSTATIC SPRING



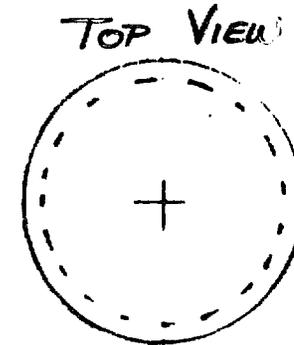
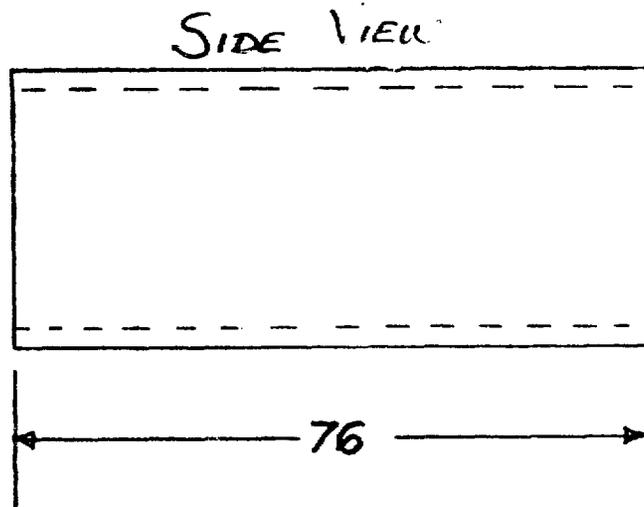
VIEW SHOWING ASSY  
IN BASE PLATE

# Component No. 5



# Component No. 7

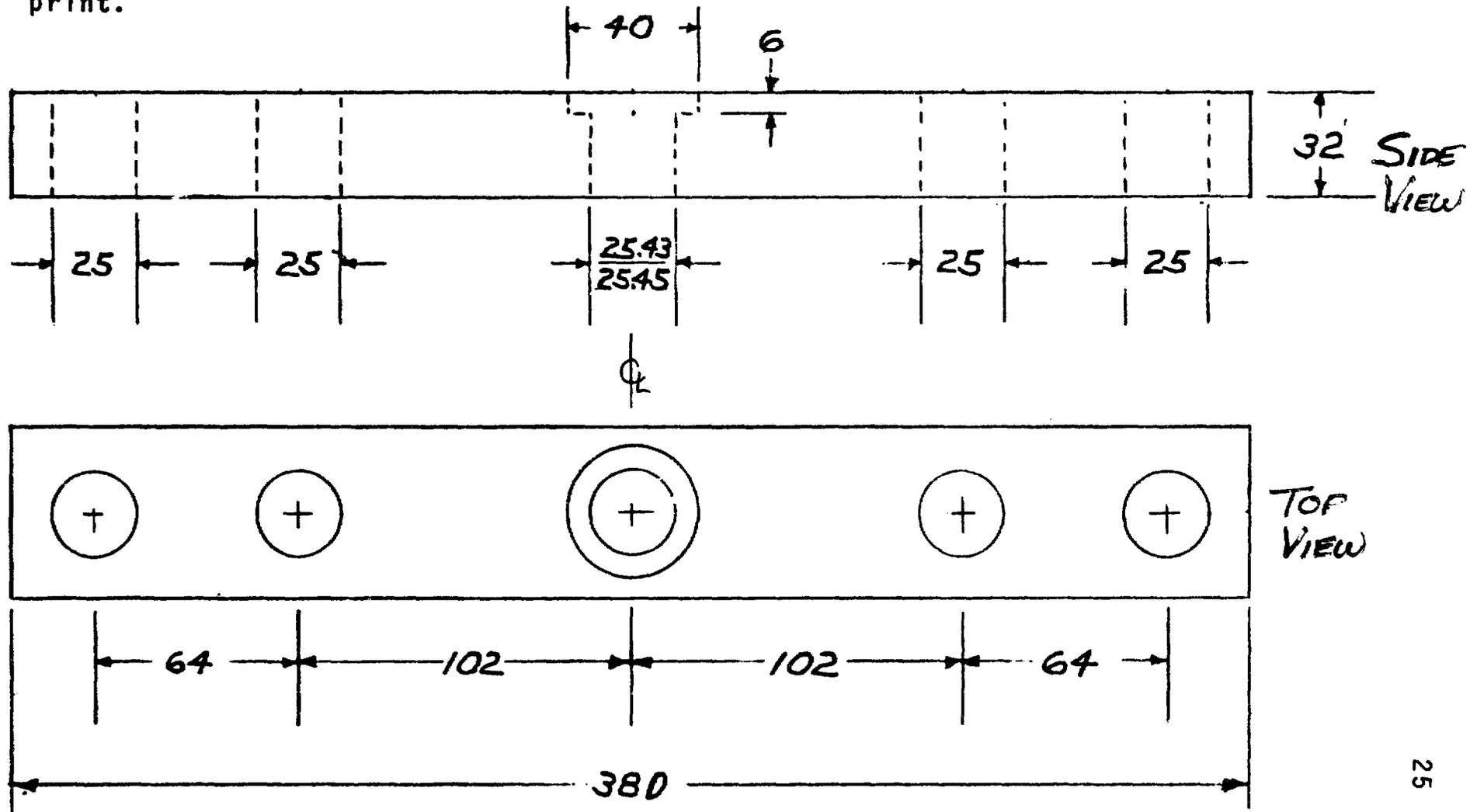
**SLEEVE:** This sleeve can be made from standard pipe if a 24mm bolt will fit within pipe ID. Sleeve length can be cut with a pipe cutter or hacksaw and faced to length on a lathe.



25MM SCHEDULE 10 OR 40 PIPE

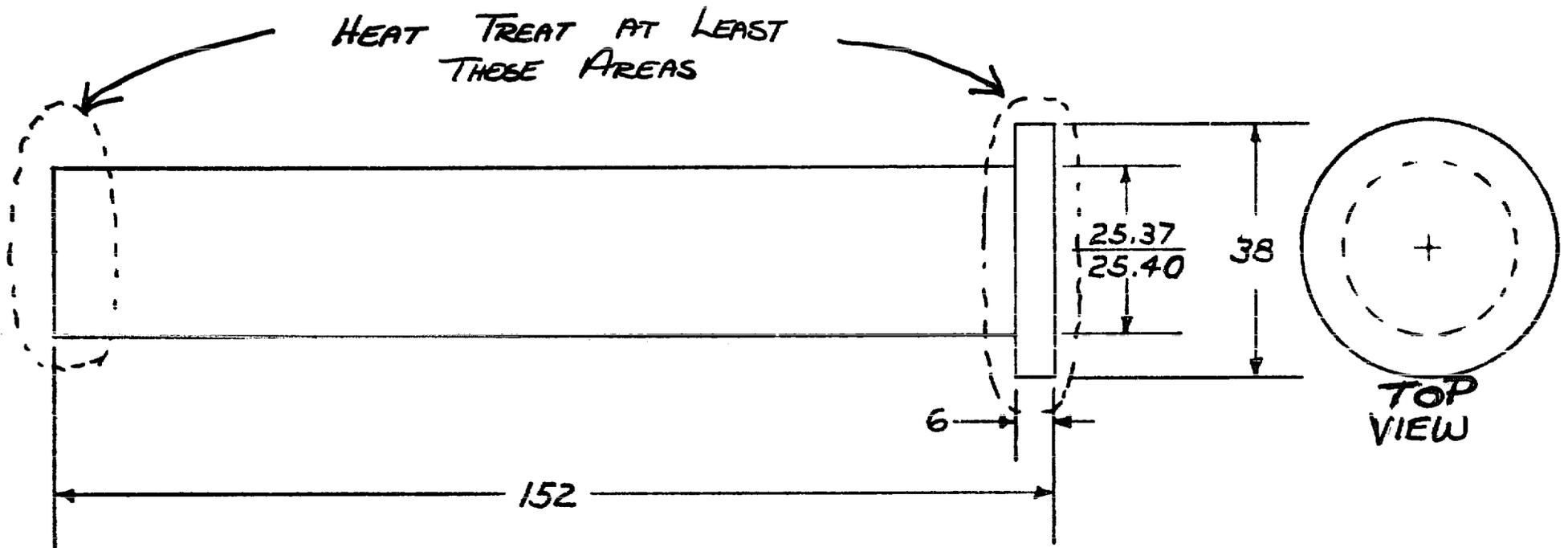
# Component No. 18

**SUPPORT:** Drill and bore 25.43mm hole with 40mm x 6mm counterbore hole. If drawing tolerances are not possible, turn brass sleeve for press fit. Drill other holes to print.



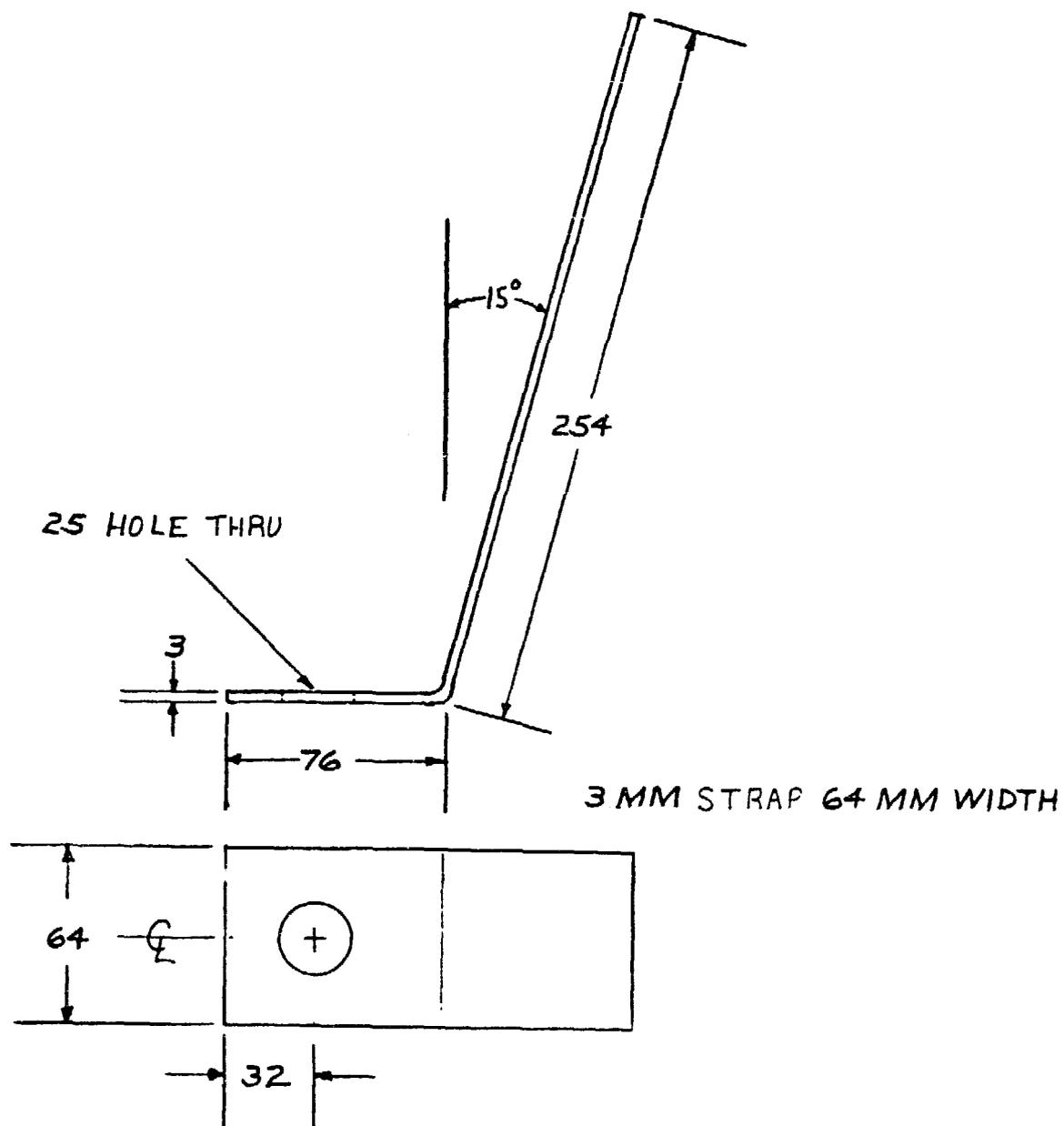
# Component No. 20

**CAM PLUNGER:** Chuck on 6mm of material, and machine 25.4mm diameter. Turn around and face to length. Heat treat cam plunger to maximum hardness possible.



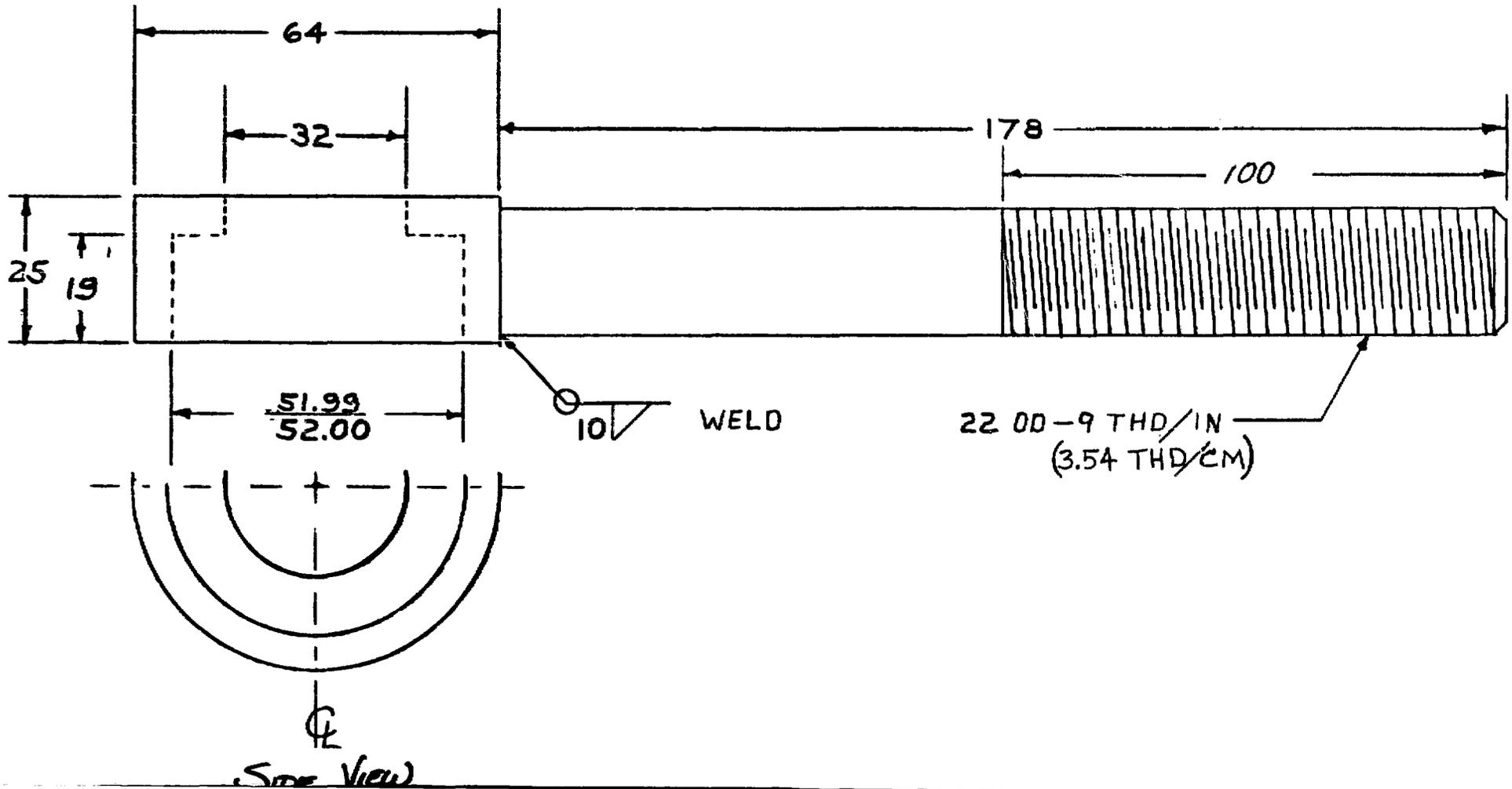
# Component No. 22

STOP: Drill 25.5mm hole and bend according to print.



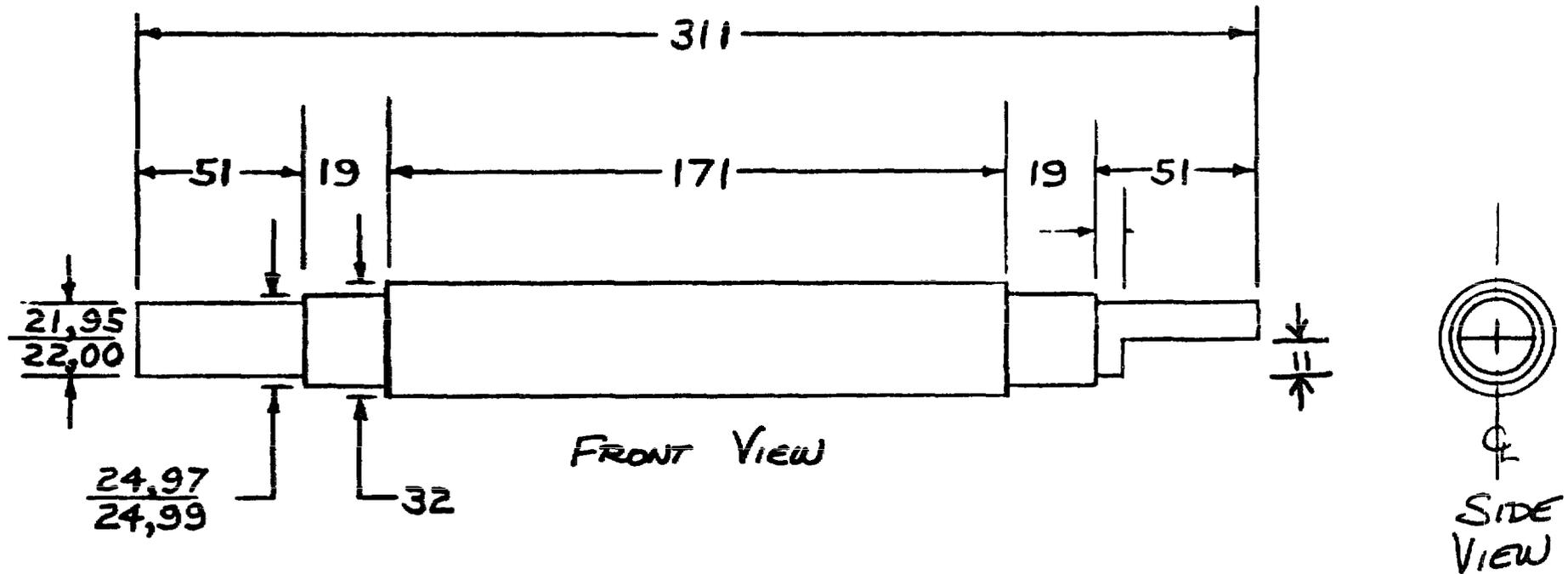
# Component No. 24

**BEARING HOUSING:** Components 24 and 11 are used to create the bearing housing. The subassembly works this way: Using component 11, cut off head of 24mm bolt and weld to bearing support. **NOTE:** 52mm ID is a ring fit to ballbearing with OD 52mm and ID 25mm.



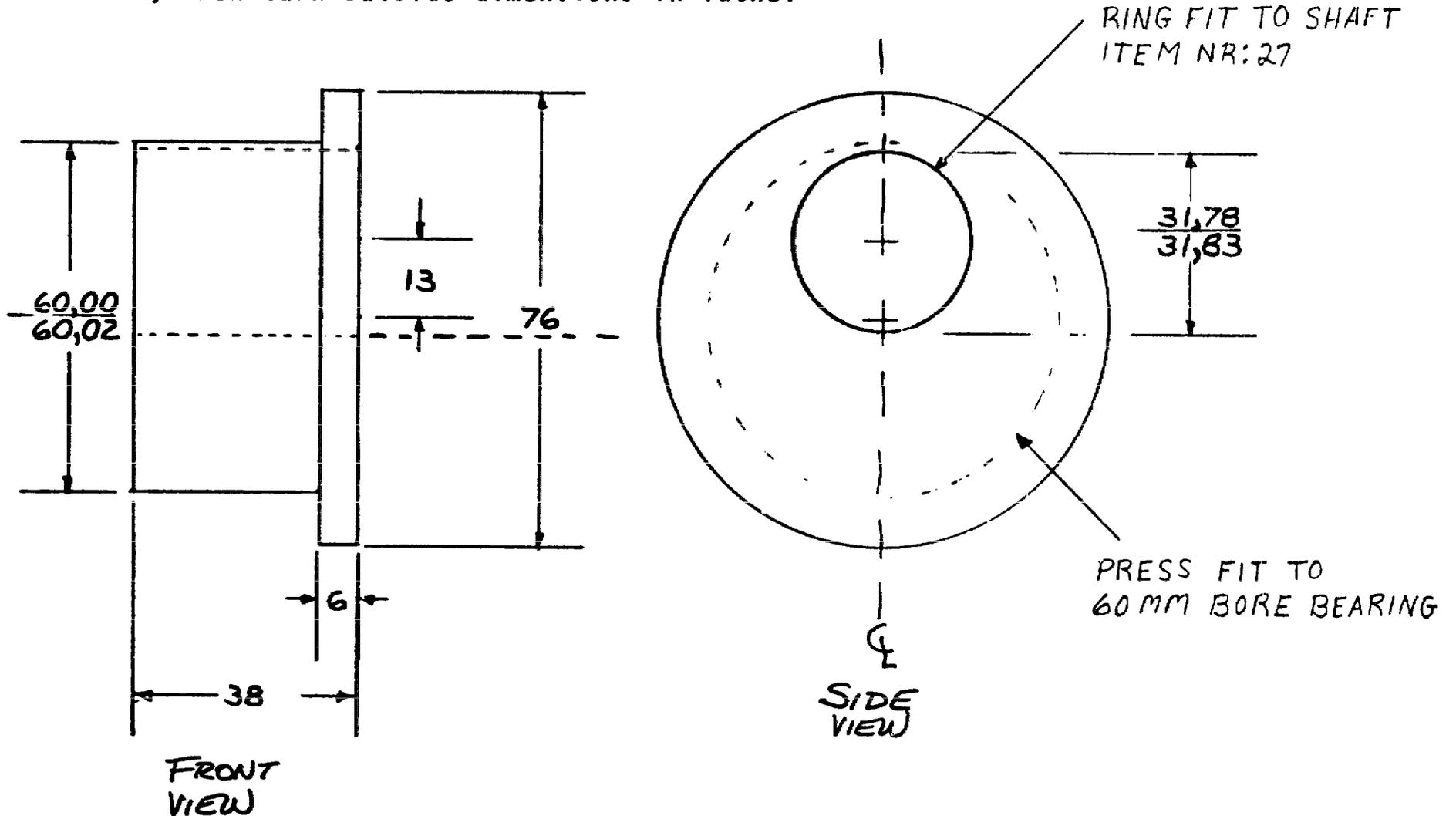
# Component No. 27

**SHAFT:** Manufacture to print on engine lathe and cut out 11 x 38mm notch with hacksaw or mill out. Before manufacture, decide method of torque arm construction. See page 33. If Alternate Torque Arm Construction is used, do not cut out the 11 x 38mm notch.



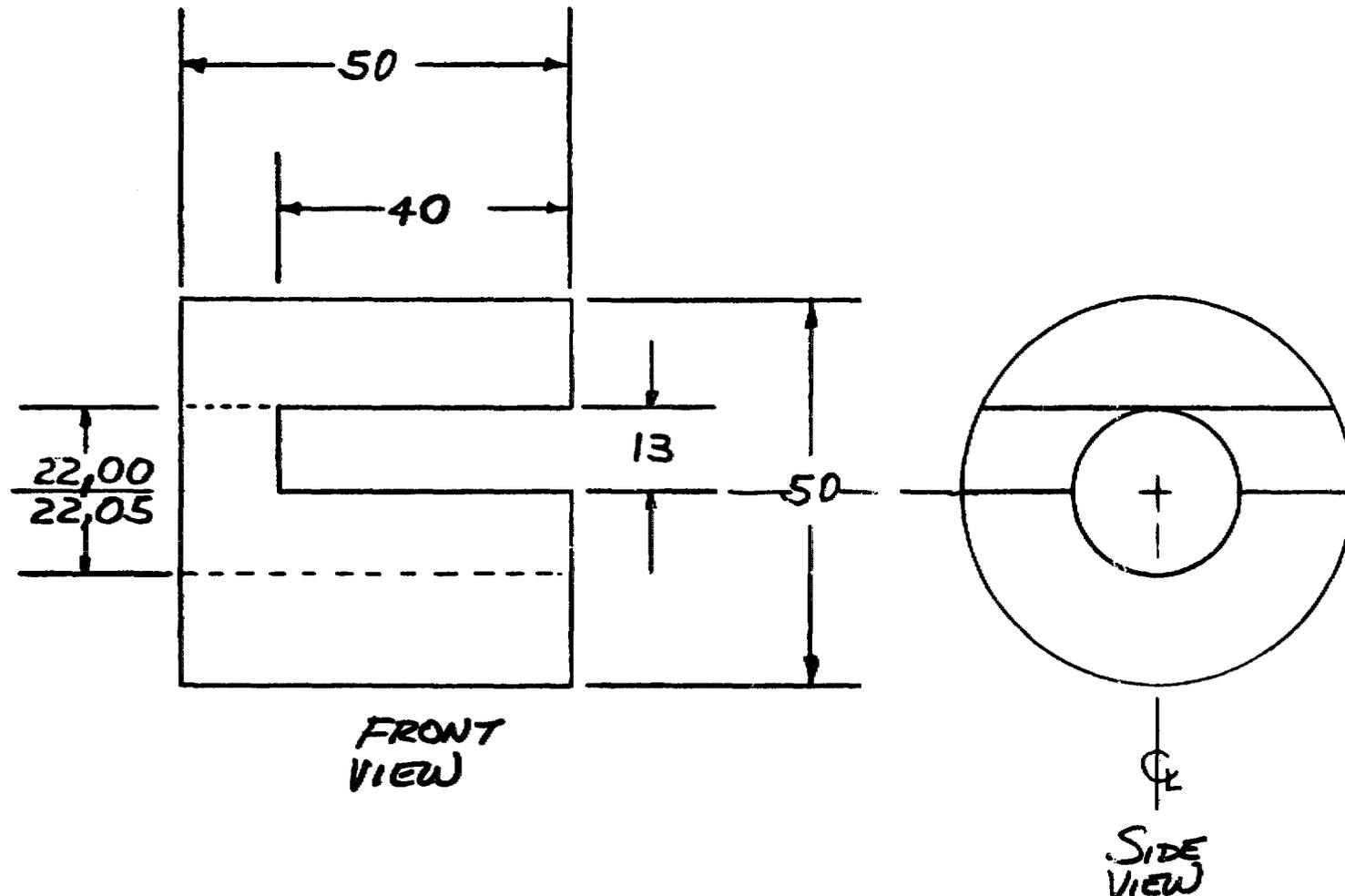
# Component No. 28

CAM: Turn outside dimensions to print; then drill hole which can be done in engine lathe with independent jaw chuck. This part could also be drilled out by drill press or mill; then turn outside dimensions in lathe.



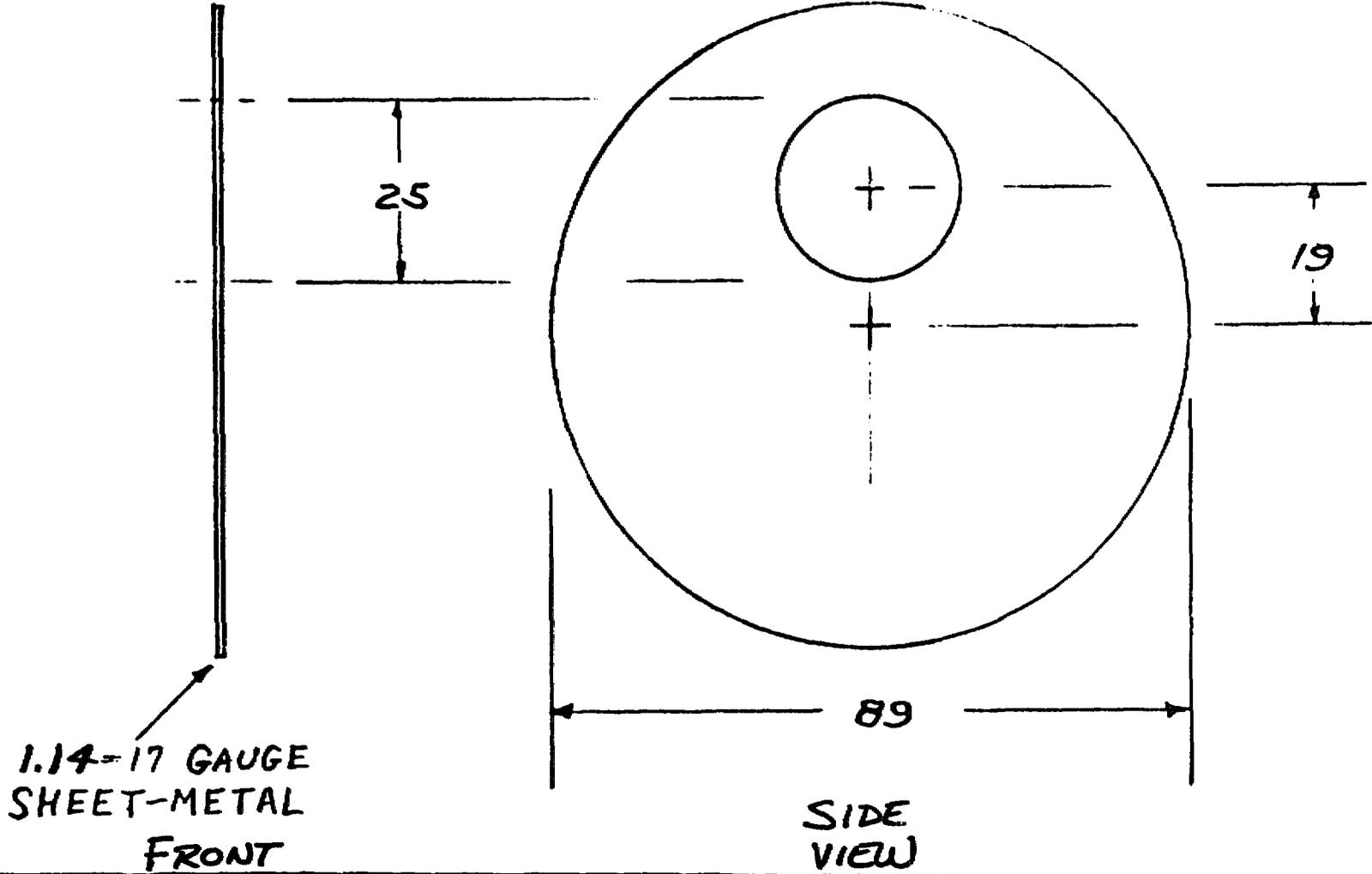
# Component No. 30

HUB: Drill and bore hole to size; then mill 13 x 40mm slot and deburr. If Alternate Torque Arm Construction is used substitute 13mm wide slot in hub for a cross hole on one side only. This cross hole will have a diameter slightly larger than the diameter of the rod or pipe. This hole will receive one end of the rod.



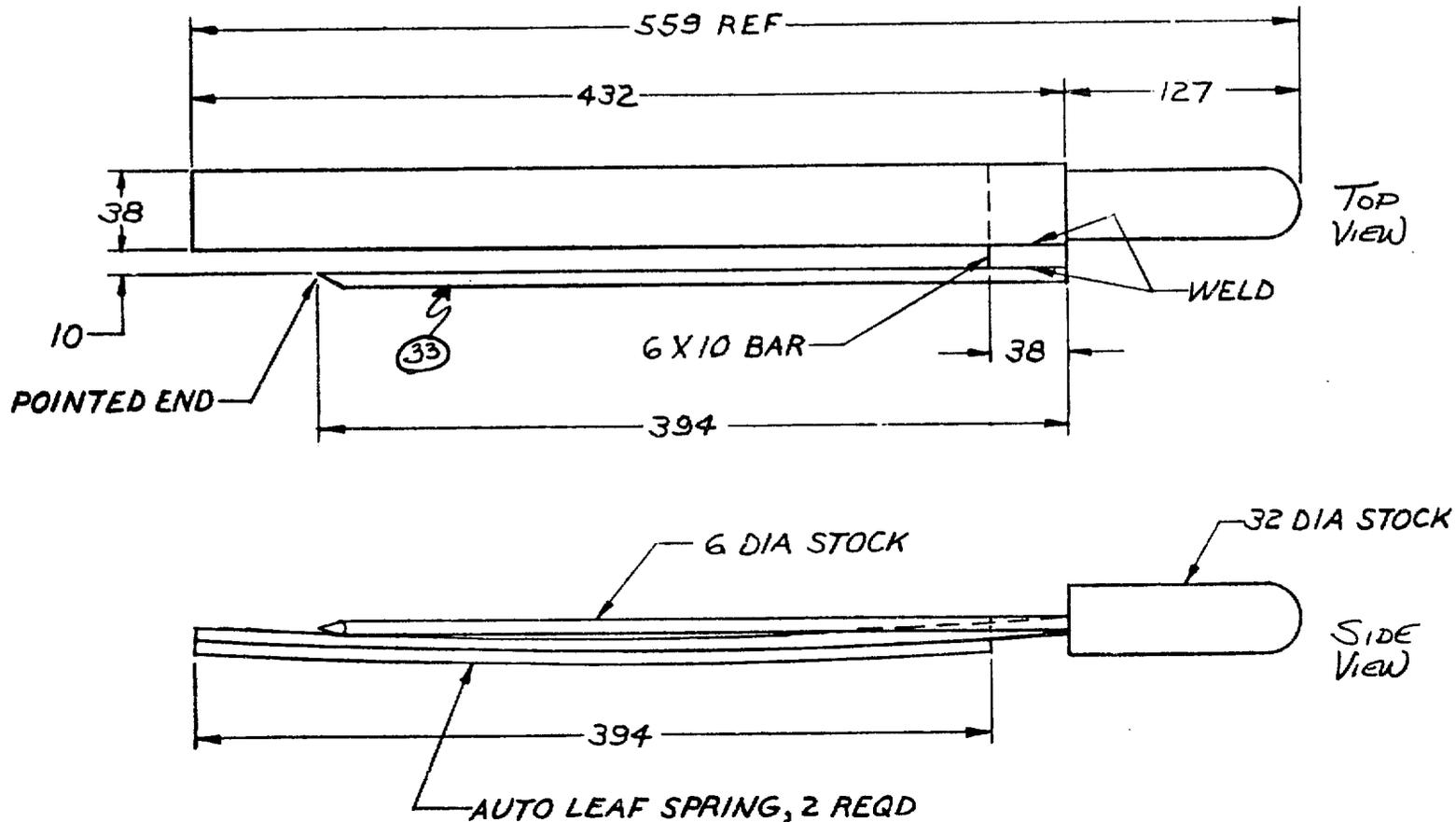
# Component No. 31

**TORQUE READOUT:** NOTE: Before manufacture, read procedures on page 33 for torque arm. This part is not required if the Alternate Torque Arm Construction is chosen. Manufacture according to print. This part can be fastened to Component No. 30 (Hub) by bolt or spotwelded, whichever is desired.



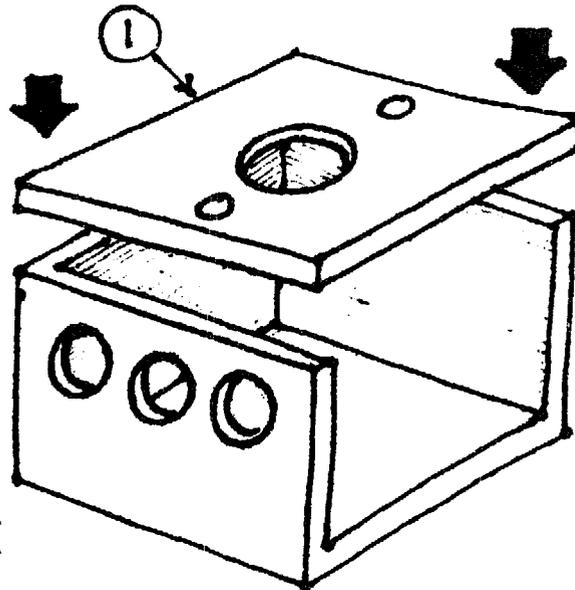
# Component No. 32

**TORQUE ARM:** Two-piece strip of metal (L379 x W38 x H5mm) is an automobile leaf spring from any compact car. If the leaf spring is thicker than 11mm, total dimension of Shaft and Hub can be changed to suit leaf spring thickness. If two leaf springs are used, fasten only upper leaf to handle. Complete arm according to the drawing. *NOTE: If Alternate Torque Arm Construction is used, a round, solid steel bar or thick-wall steel pipe can be substituted for the described subassembly consisting of Torque Arm 32, Pointer 33 and Shim 34. See page 17 for full details.*



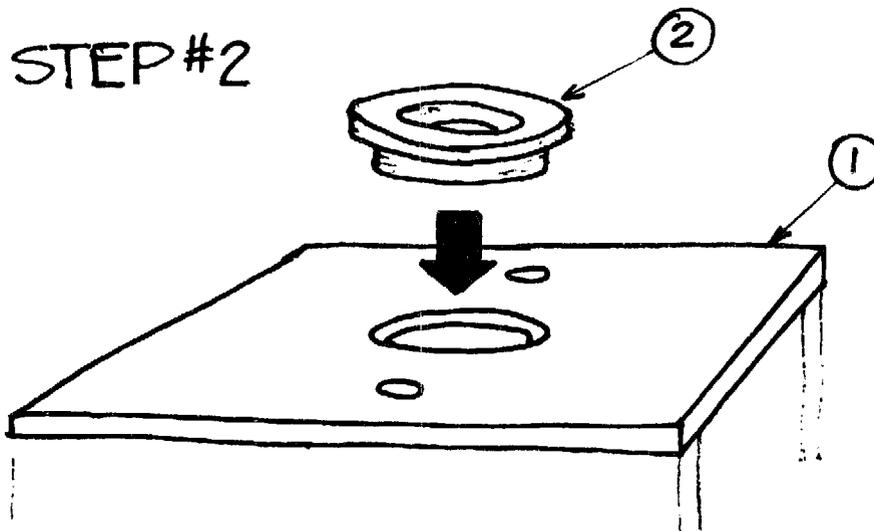
## Assembling the Machine

With all the parts fabricated, the machine can be put together quite easily. Each assembly step is pictured here to ease the process. Remember, however, that if the *Alternate Torque Arm Construction* is being used, the assembly steps will be somewhat different.



### STEP #1

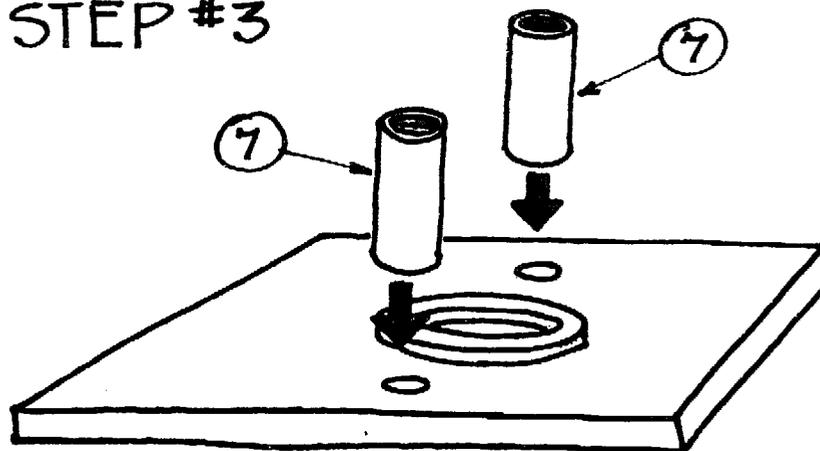
Mount Base Plate 1 either on brick firebox or on steel base.



### STEP #2

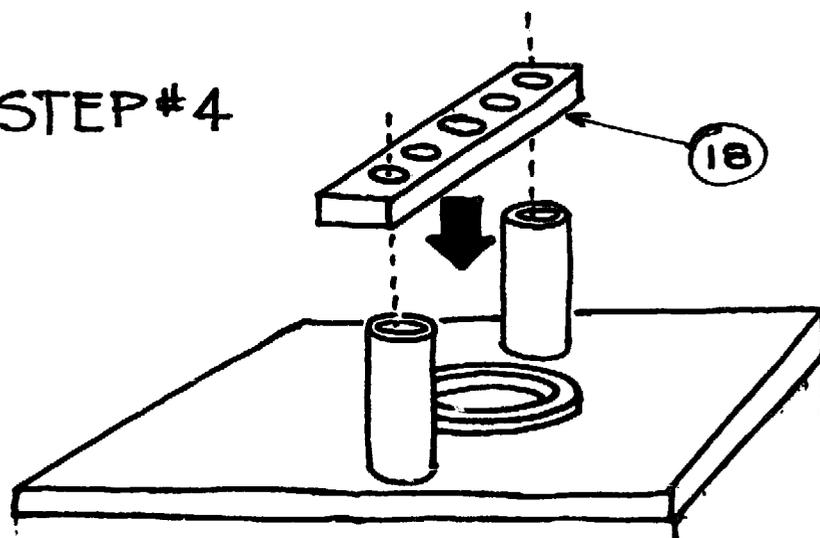
Place Cup 2 in center of hole of Base Plate 1. This cup can be welded to Base Plate 1 after alignment with the lid to enhance heat transfer.

## STEP #3

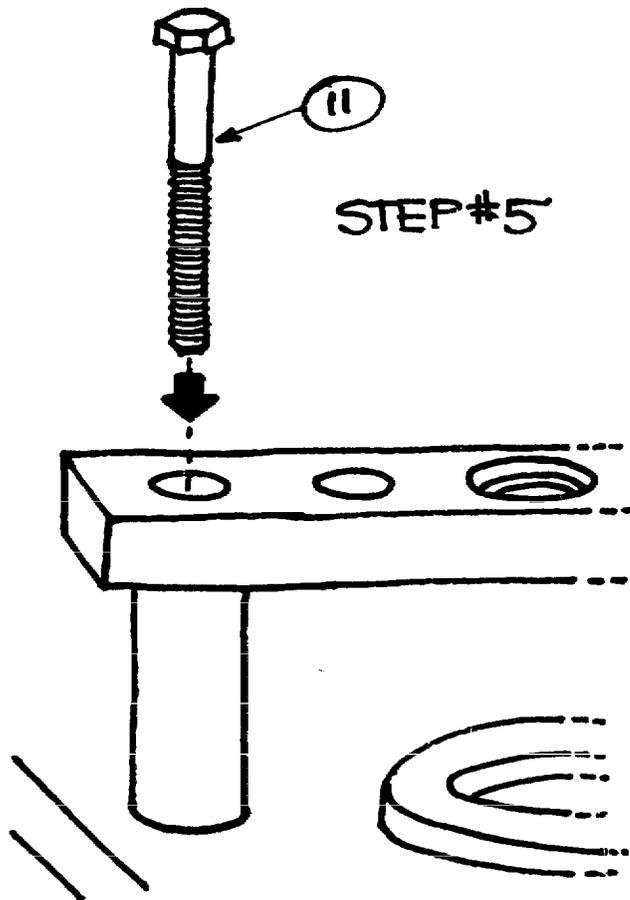


Place Sleeves 7 on Base Plate 1. Center over 25mm holes.

## STEP #4

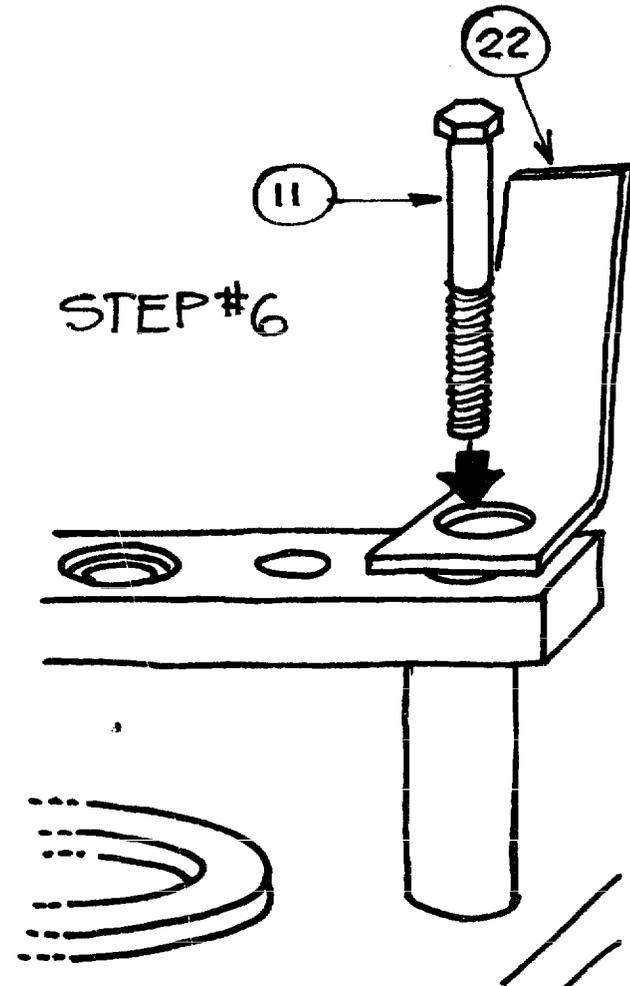


Position Support 18 on Sleeves 7. Smaller diameter of center hole of 18 should face Base Plate 1.



STEP#5

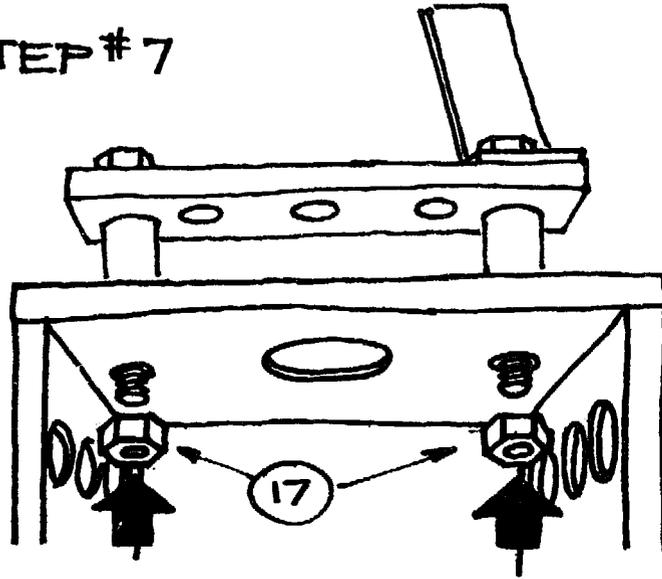
Put M24 Bolt 11 through left outside hole on Support 18, Sleeve 7 and Base Plate 1.



STEP#6

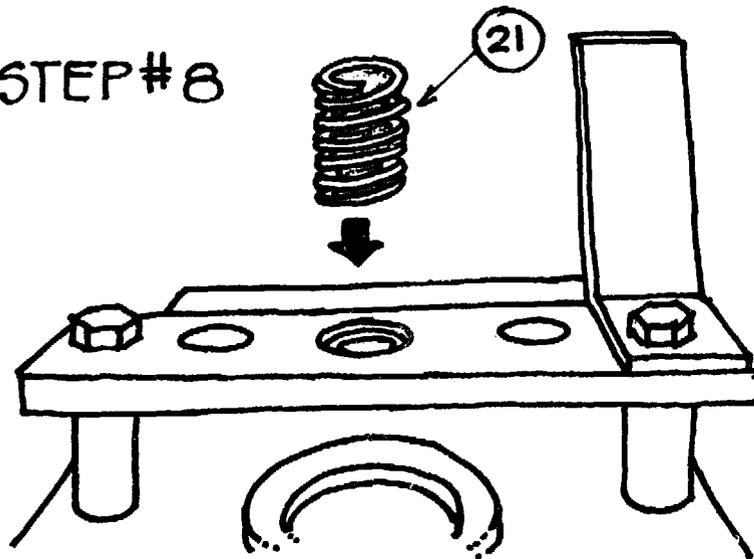
Put M24 Bolt 11 through Stop 22 outside hole on right side of Support 18, Sleeve 7 and Base Plate 1.

## STEP # 7

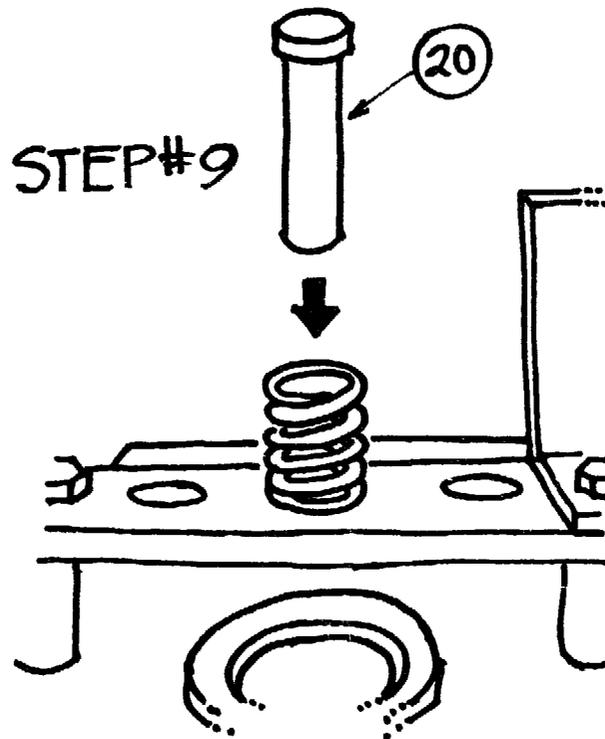


Screw Nuts 17 on both Bolts  
11 from bottom of Base Plate.

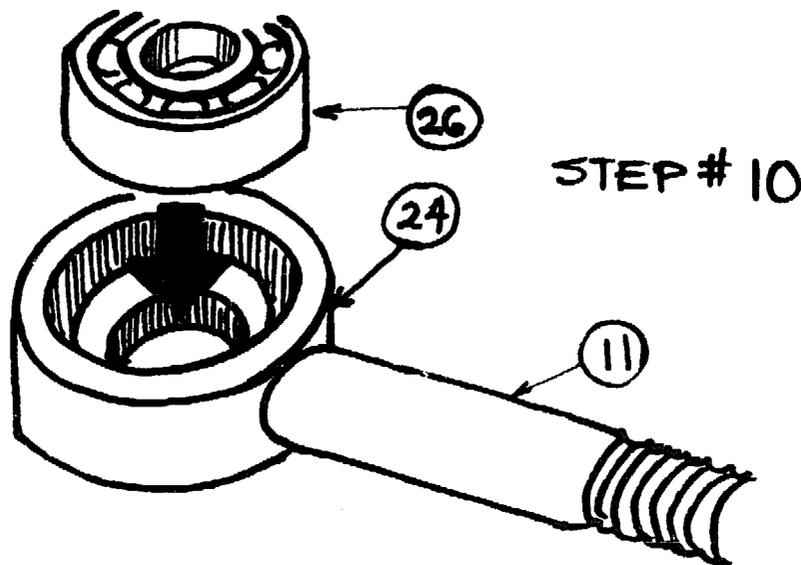
## STEP # 8



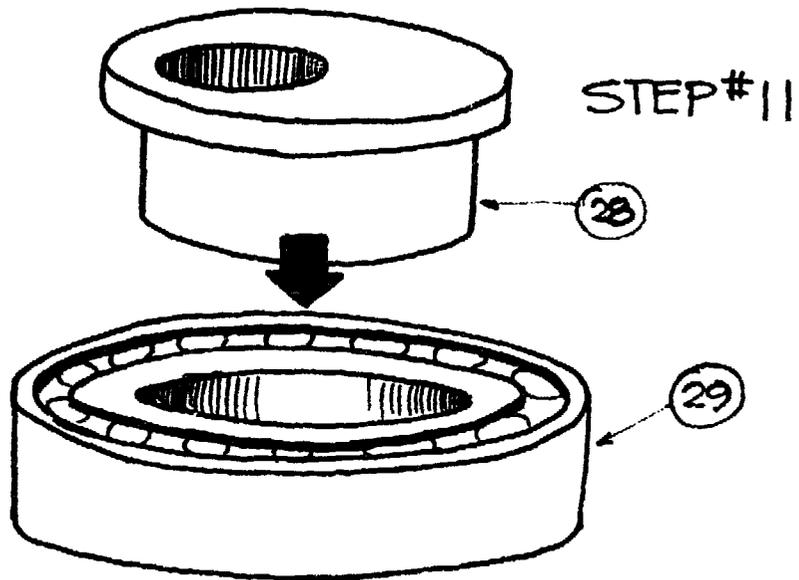
Place Spring 21 into hole in  
center of Support 18.



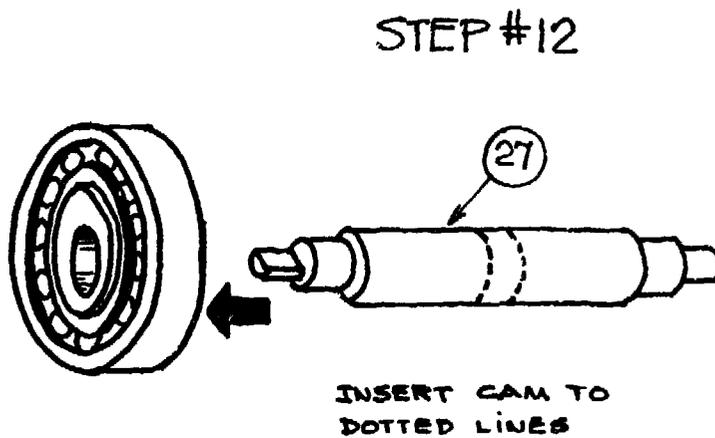
Insert Cam Plunger 20 through Spring 21 and center hole in Support 18. Allow Cam Plunger 20 flange to rest on Spring 21.



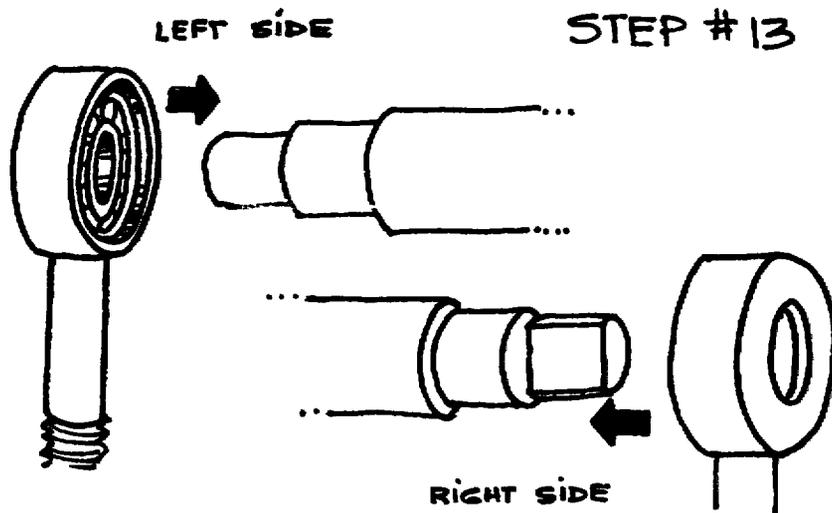
Complete subassembly Bolt 11 and Bearing Housing 24. Press 52mm Bearings 26 into Bearing Housings 24.



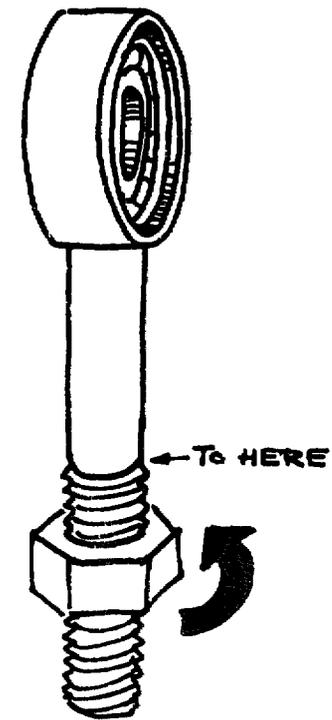
Fit Cam 28 into Bearing 29.



Insert Shaft 27 into Cam 28  
until Bearing is centered on  
Shaft 27.

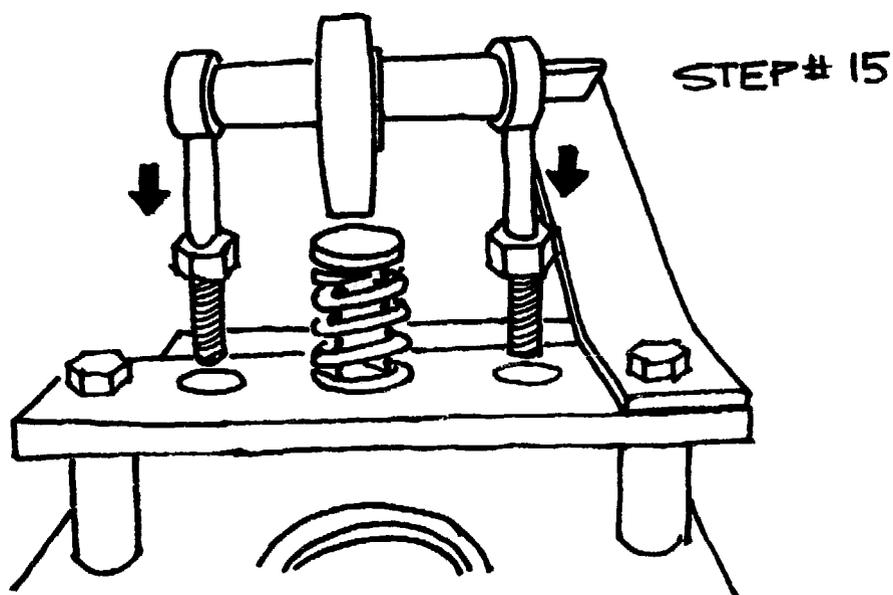


Insert ends of Shaft 27 into Bearing Housings 24 with bearings facing each other.

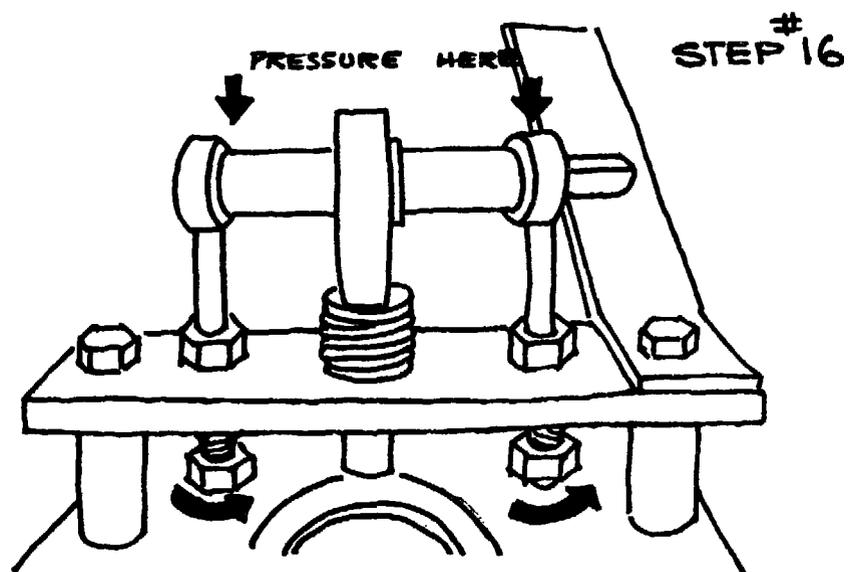


STEP #14

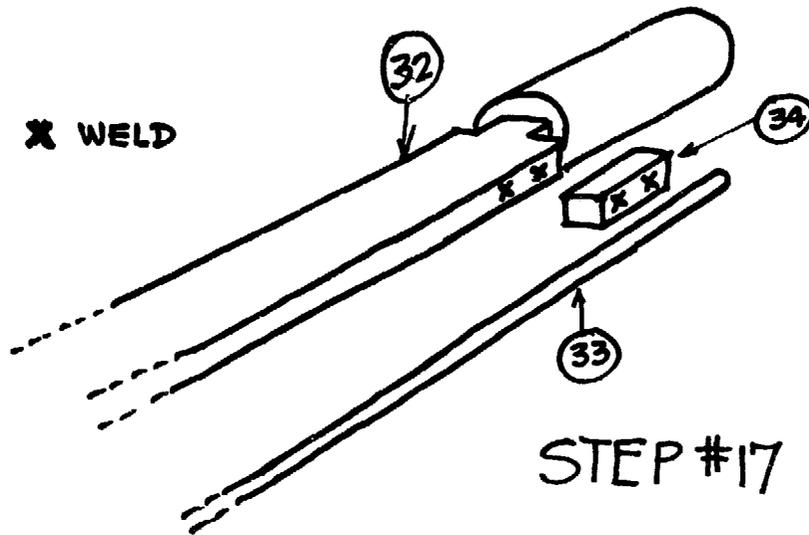
Screw M24 Nuts 17 onto thread portion of Bearing Housing 24 as far as threads permit.



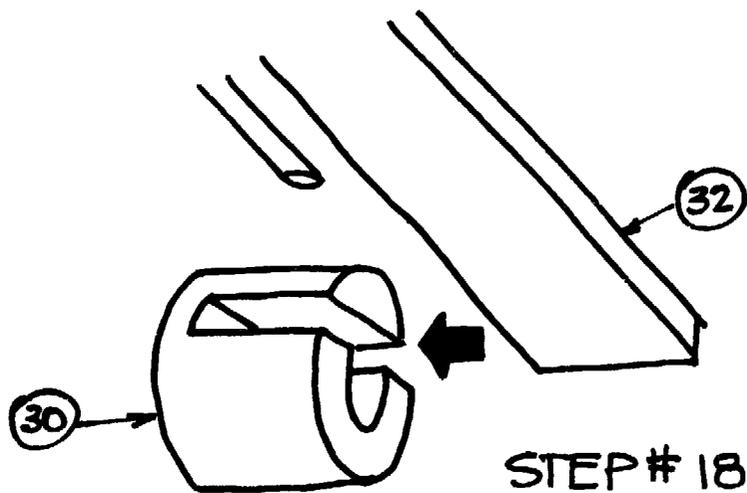
Holding complete assembly of Shaft 27, insert Bearing Housing Bolts 11 into remaining holes on Support.



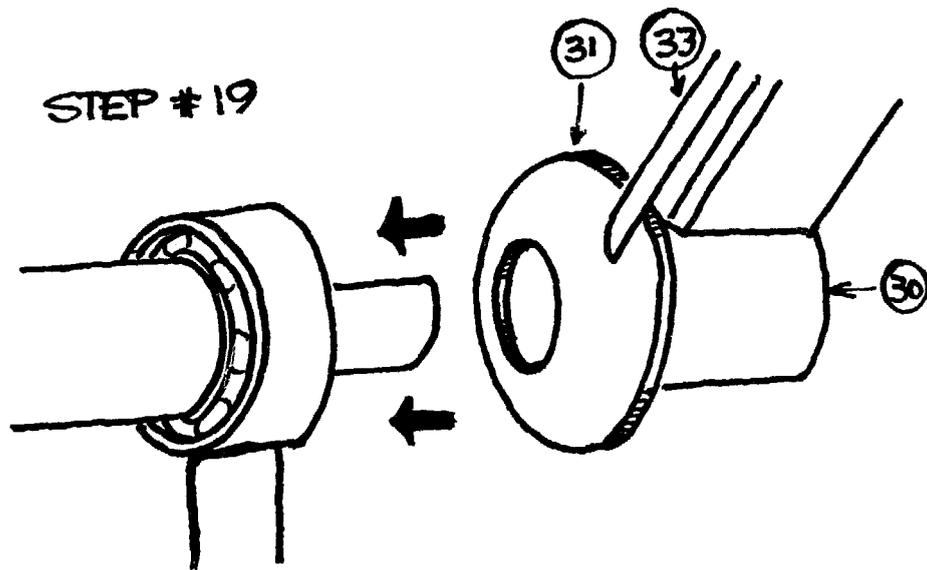
Maintaining pressure down against opposing pressure of Spring 21, thread on Bolts from bottom of Support onto Bearing Housing Bolt 11 until tight.



Weld Shim 34 and Pointer 33  
to Torque Arm 32 at points  
as shown.

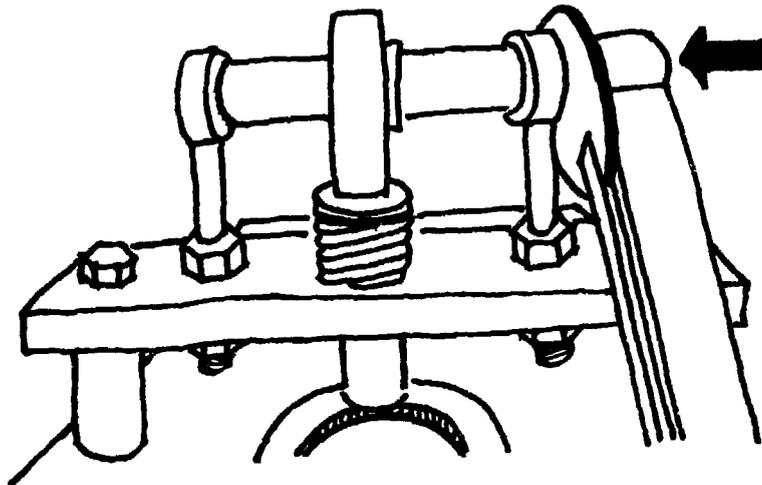


Position Torque Arm 32 onto  
Hub 30. Hub slot should be  
on upper half. This acts as  
a key on Shaft 27.



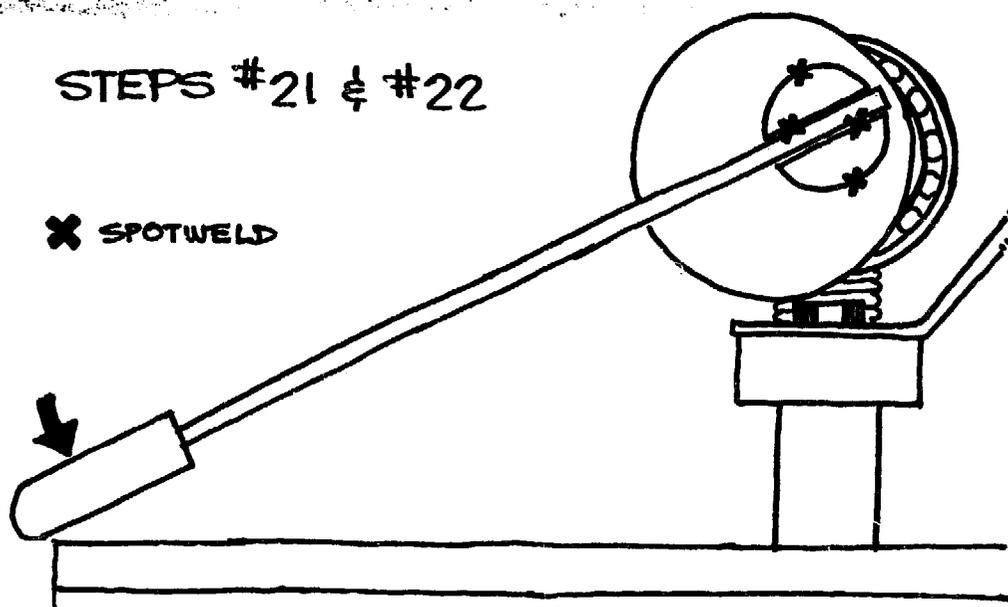
Position Torque Readout 31  
behind Pointer 33. Center  
holes of Hub 30 and Readout  
31.

STEP #20



Slide assembly components 30  
31 and 32 over flat section  
of the Shaft 27.

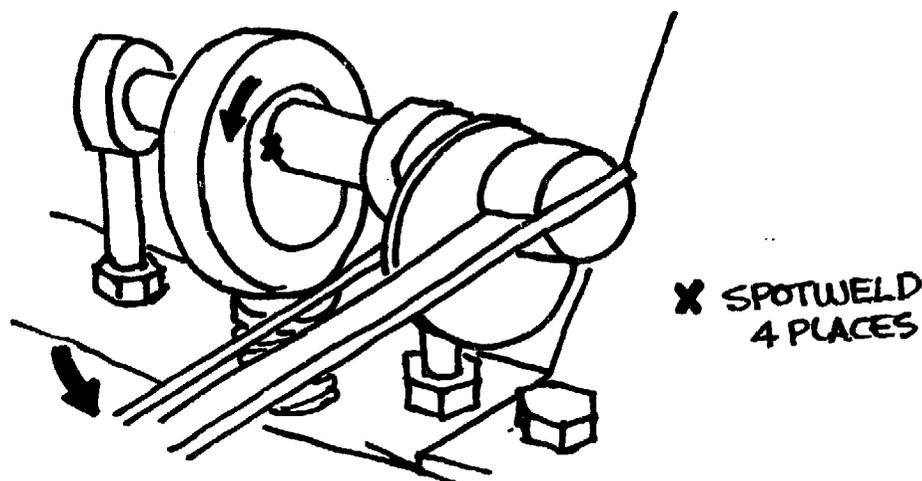
## STEPS #21 & #22



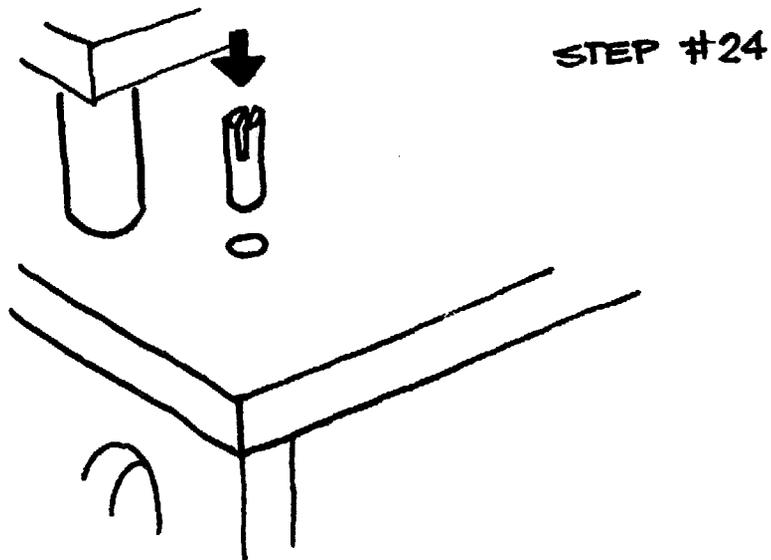
Step 21: Hold Torque Arm 32 down against Base Plate 1 and position Readout 31 so largest portion is towards Pointer 33.

Step 22: Spotweld Readout 31 and at this point also Torque Arm 32 can be tacked (spotwelded) to Hub 30.

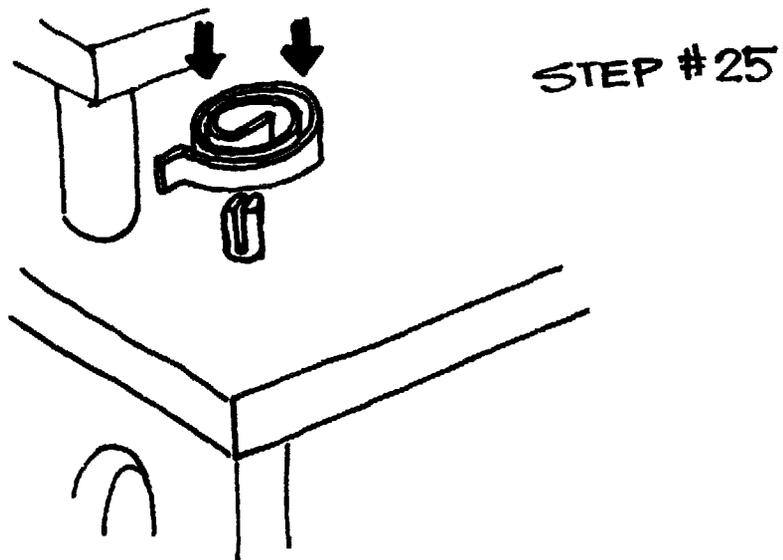
## STEP # 23



Holding Handle 35 against Base Plate 1, rotate Cam 28 so as to move Plunger 20 down as far as it will go. At this point, spotweld Cam 28 to Shaft 27.

**STEP #24**

Press Pin 4 into Base Plate 1. If fit is loose, Pin 4 can be tackwelded to Base Plate 1 from bottom of Base Plate.

**STEP #25**

Place Manifold Thermostat Spring 5 over Pin 4 so center of spring fits into 7mm deep slot.

Minor adjustments could be made:

If in operating the machine, Torque Arm 32 does not come close to Base Plate 1 on compression of material, this can be adjusted by moving Bearing Housing up by means of 24mm Nut 17 above and below Support 18.

# 3 Product Experimentation and Machine Operation

## Key Factors in Texturizer Experimentation and Operation

The range of raw materials that can be used in the texturizing process has already been discussed in this manual. Here experimenting with these on the machine is considered. For successful experimentation, it is necessary to understand the importance of moisture, pressure, temperature, and timing in the context of texturizer operation. Too much or too little of any of these factors can result in an unsatisfactory product.

### Temperature

With the exception of electricity, the heat source is placed in the small compartment under the base plate. Too low a temperature results in undercooking and non-texturization; too much heat burns the product.

In general, it takes the texturizer approximately one-half hour to heat up--regardless of heat source. The thermostatic spring expands as the temperature rises and therefore indicates the amount of heat available. Each time a material is tested the user should measure the distance the spring has expanded from its position at room temperature. Later, after each variable has been tested and the right combination established for the desired product, the spring position is marked so that uniform products can be produced: information on this step is provided later in this section.

## Pressure

Temperature and pressure work closely with one another. Pressure is applied to the product by pushing down on the torque arm. Too little pressure means the product will not expand as it should and that it will not be sufficiently cooked. Too much pressure can cause the product to burn and/or break apart.

For every temperature measurement, the user should also take a pressure measurement. This is done by measuring the distance the lever was pushed down each time. It is important to record results at different combinations of temperature and pressure: what is being looked for is the pressure and temperature combination which produces the best product.

## Processing Time

For each amount of pressure and temperature, it is necessary to note the length of time the material was pressed between the hot surfaces before being released. So, the user is now working with three variables--pressure, temperature, and time.

## Moisture

This, too, is a critical factor in the texturizing process. Although moisture is not related directly to operating the machine--as the previous factors are--the moisture in a mixture relates to various temperatures and pressures in different ways; moisture thus becomes a fourth variable to be tested. Each raw material already contains a certain amount of moisture, but generally this is not enough for cooking. Therefore, moisture will have to be added in varying amounts depending upon the amount of moisture already in the material and the texture desired in the final product.

## Guidelines for Experimentation

Each raw material or combination of materials will require a certain moisture level, temperature, pressure, and processing time to achieve a given product. To standardize the products, it will be necessary to experiment until "recipes" are available for each. Essentially this means that the machine operator must

work with all these factors at the same time. The following table, which results from Meals for Millions' work, can provide a starting point for local testing and adaptation.

MATERIAL	TEMP.(c°)	MOISTURE (%)	PRESSURE (PSI)	TIME (SEC)
Rice	200	30	600-700	10
Corn	220	25	600-700	10
*Cassava (Tapioca)	200	30	400	10
Cassava + Soy 1:1	170	30	600-700	10
Chick Pea	165	35	600-700	10
Red Beans	175	35	600-700	10
Defatted Peanut	180	35	600-700	10
Defatted Glandless Cottonseed	205	20	600-700	10
Defatted Soy Flour	350	30	600	10
Full-Fat Soy Flour	300F	40	400	5

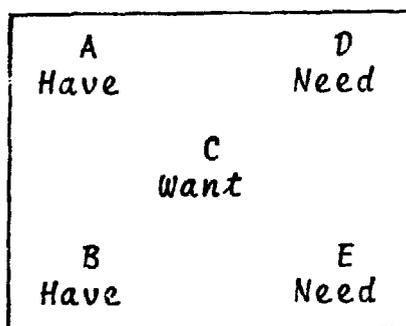
*\*Cassava does not have a good structure; due to very low protein content the patty shrinks immediately after production. However, mixing cassava with high protein flour results in a good product.*

- Remember the finer and more flour-like the material, the better product the texturization process will yield.
- The temperatures given above were measured with special equipment in a laboratory situation, which is probably not available in the field. However, these temperatures are of value to show the variation in heat required for processing different flours: a user working successfully with rice, for example, knows that it is likely the machine is too hot for working with chick peas and not hot enough for texturizing soy flours.
- The moisture column indicates what percentage of a given material must be moisture in order for texturization to take place. Again, in a field situation, exact percentages are both hard to obtain--and probably unnecessary at this stage. Experimentation will yield the final measures.

## Moisture

Some special guidelines are helpful for experimentation with moisture levels. For purposes of mixing ingredients, start with the assumption that the mixture already contains 12 or 13% moisture, i.e., perhaps half of the moisture it must contain. (Most common techniques used for drying foods, especially without benefit of commercial dryers, leave about 12-13% moisture within grain or other material.)

Then use the table on page 51 as a starting point to determine how many parts of a given mixture will be water and how many will be flour. For example, the user who wants to process rice flour containing 12% moisture needs to know how much water must be added to the flour to make the proper mixture for texturizing. From the table, the experimenter sees that 30% moisture is needed to texturize rice flour. It is then possible to calculate the proper amounts of water and flour by using the Pearson Square, shown here:



*Pearson Square for determining correct proportions of water and flour.*

**Legend:**

- A = the percentage of moisture already in flour
- B = 100%
- C = the percentage of water required for the mix
- D = the proportion of flour needed
- E = the proportion of water needed

Taking the information already available, the user fills in the square in the following way:

A=12%	D=?
C=30%	
B=100%	E=?

E is found by subtracting A from C. E = 18  
 D is found by subtracting C from B. D = 70

12%	70
30%	
100%	18

Therefore, the mixture must contain 70 parts of flour to 18 parts of water.

Now say the material being used is chick pea flour which requires 35% moisture. Fill in a Pearson Square as follows:

15%	65
35%	
100%	20

From this, it is easy to see that when working with chick pea flour, the proper mixture consists of 65 parts flour and 20 parts moisture. The mixture then has 85 parts.

Now it is possible to translate this into percentages. First, find the percent of flour:

$$65 \div 85 \times 100\% = 76.5\%$$

Then the percent of water (added to get 35% total moisture):

$$20 \div 85 \times 100\% = 23.5\%$$

Once the percentages are calculated, it is possible to estimate how much flour is needed to produce a given amount of mixture. For example, to calculate the amount of flour needed to make 150kg of mixture for a day's use, multiply 76.5% by 150kgs as shown:

$$76.5\% \times 150\text{kgs} = 114.75\text{kgs}$$

The amount of water required can then be calculated by multiplying 23.5% x 150kgs = 35.25kgs--or by subtracting 114.75kgs from 150kgs.

Therefore, to produce 150kgs of material containing 35% moisture requires 114.75kgs flour and 35.25kgs moisture.

It is obvious that many of the materials available for texturizing are not included in the table on page 51. Meals for Millions hopes publication and dissemination of this manual will lead to development of more extensive tables. But it is possible to see certain patterns emerging from even this chart: corn as a grain--even when dried--has more moisture in its kernels than rice and, therefore, corn flour needs to have less moisture added; legumes seem to require a relatively high moisture content.

There are some general guidelines for good experimentation:

- . *Begin with simple cereal flours (not with combinations). Use flours made from maize, wheat, and rice. As a general rule, assume these flours already contain about 12% moisture and should contain 30%. Therefore, to get 30 grams of mixture at 30% moisture requires 6 (6.1) grams of water to 24 (23.9) grams of flour.*
- . *Use approximately 30 grams of material for each test.*
- . *Take careful measurements for each test; note pressure, temperature, time, mixture/moisture.*
- . *Note product results. For simple cereal mixture, a good product will be round, 8cm to 12cm in diameter, flat (5cm thick) and have a crisp texture.*
- . *Go on to other ingredients and textures as good products are obtained and using the machine becomes easier. For high protein mixtures, a general rule is 7 parts cereal to 3 parts legume or oilseed.*

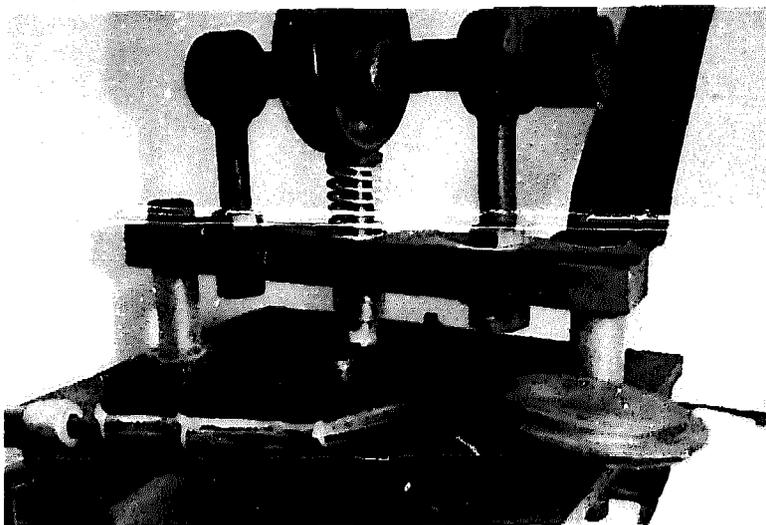
If all the above sounds complicated, it will not be after a short time. As stated earlier, the machine has been used successfully in Korea for a number of years. There, the machine operator controls moisture, temperature, pressure, etc. by experience alone--and does this successfully.

## Standardizing Procedure and Product

Once the operator is familiar with the machine and has examined preliminary test results, the final mixtures can be determined, and the machine set up for standardized operation. Two methods can be used.

Method One. This method is more scientifically accurate, but requires access to equipment which may not be readily available in the field.

- . Make up 1kg of desired mixture.
- . Dry 100g of this flour in oven at 130°C.
- . Weigh flour after one hour. (The amount of weight loss will be the % of moisture in the flour.)
- . Prepare 300g of flour with a 30% moisture content (use the Pearson Square method detailed on page 52).
- . Oil the base plate depression with edible vegetable oil.



A close look  
at the cup  
and lid.

- . Repeat the procedure for samples at different moisture levels, e.g., 25%, 35%, 40%. Run these samples keeping temperature and pressure in the middle of the range. This will save time and effort.
- . Lay out the samples on a grid as they are produced. This will help guide the experimentation.

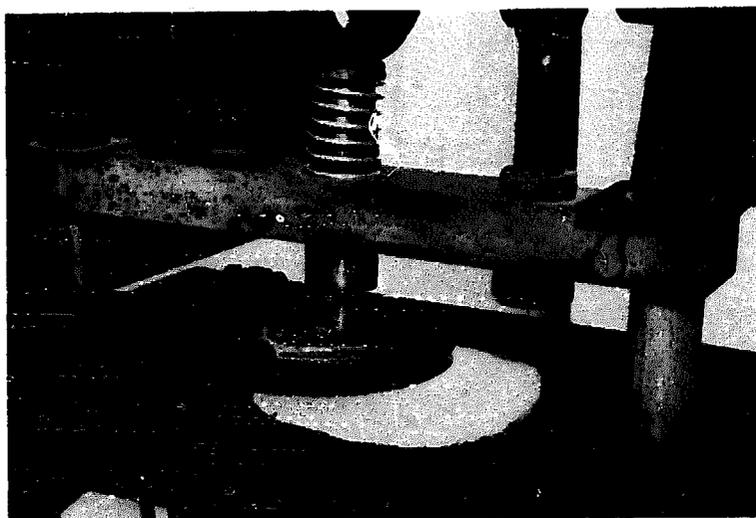
Moisture levels	TOO LOW	Temperature and Pressure in Middle Range				TOO HIGH
	25%	Sample 1	Sample 3			
30%			Sample 4		Sample 9	
35%			Sample 5	Sample 8	Sample 7	
40%				Sample 6		

- . This grid shows the results of the experimentation process. The first sample at 25% tasted "raw", did not seem to expand; the second sample burned. The third sample, also at 25% moisture seemed more acceptable, but it was decided to try a mixture containing 30% moisture content at a slightly higher temperature and pressure. And so on. Sample 8 was finally pronounced most acceptable and was selected for consumer testing.

Method Two. This method is probably more feasible in field situations than the first.

- . Heat the machine.
- . Oil the base plate depression with edible vegetable oil.
- . Test the temperature of the base plate and lid by sprinkling a few drops of water in the depression. If the water sizzles and steam is formed immediately, you are probably ready to run a sample.
- . Try to put the lid in the base plate depression. If the lid sticks, the base plate is too cold or the lid is too hot. Continue to heat the base plate until the lid can be placed and removed easily.
- . Try a few samples using only enough flour to fill the depression. (Fill the depression to level, approximately 60cc.)
- . Start with dry flour each time, adding water in small amounts until acceptable products are obtained. (Water can be sprayed on the mixture.)

- . Heat the base plate and lid of the machine simultaneously. (NOTE: When the lid is cold, it will stick in the depression. As the machine warms, expansion of the base plate and lid will take place. At operating temperature the lid can be placed and removed freely from the base plate.)
- . Try a few samples as the machine is warming.
- . Note the positions of the thermostatic coil and the torque arm as you start to get acceptable products--products which seem to have expanded (puffed). At the beginning of the range where products are acceptable, paint fine lines with enamel paint, place punch marks, or scribe lines on the machine at the points where both the thermostatic coil and torque arm begin to yield acceptable products.



A cooked product after the lid is raised and steam released.

**REMEMBER!! KEEP ALL SAMPLES FOR COMPARISON**

- . Continue to heat the machine and to run samples. When the machine is too hot, a ten-second cook time will either burn the product or make it fly apart upon release of the handle. This point for temperature and pressure will be the upper limit of the production range. Paint a fine line, place a punch mark, or scribe a line, for both temperature and pressure. This step and the preceding one yield an upper and lower range for temperature and pressure for flour with 30% moisture.

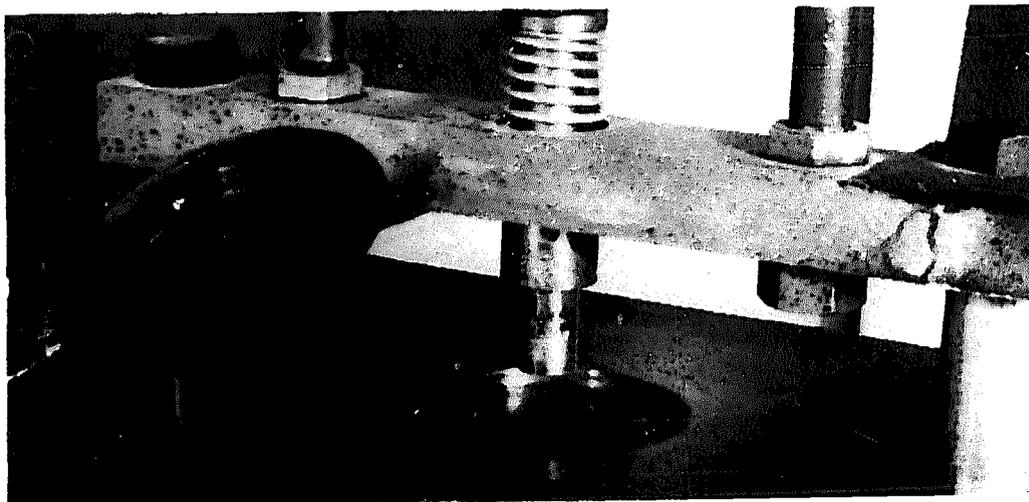
- . Follow the same procedure as detailed in Method One for establishing temperature and pressure ranges.

**REMEMBER!!** If too much water is added, the total % of moisture may be reduced by adding more dry flour.

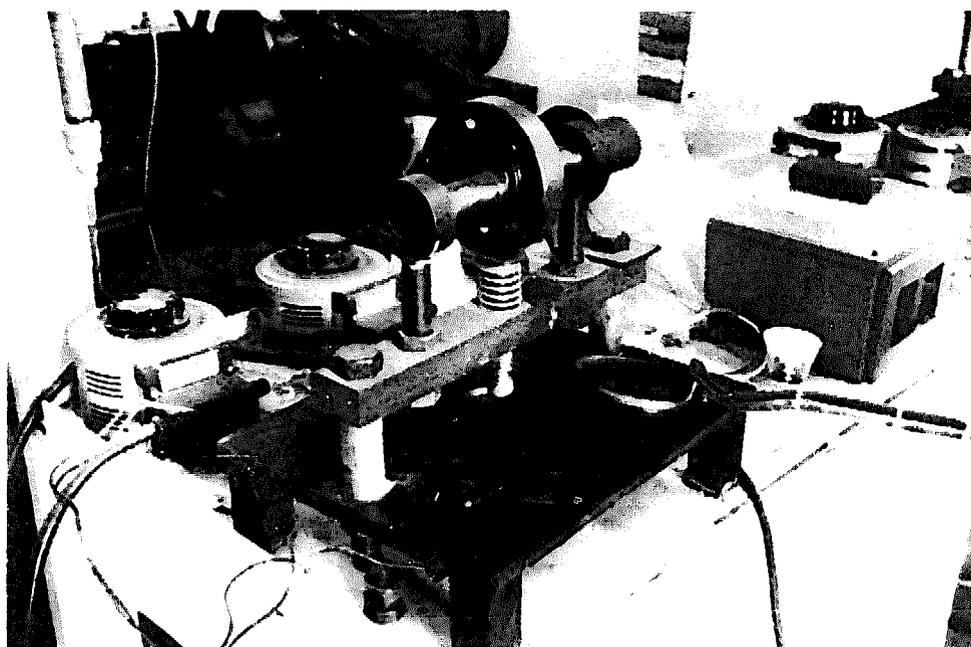
Once the desired mixtures and products have been determined, the machine marked for standard operation, the user should be ready to go. Here is a summary of steps for start up and operation.

### START UP AND OPERATION

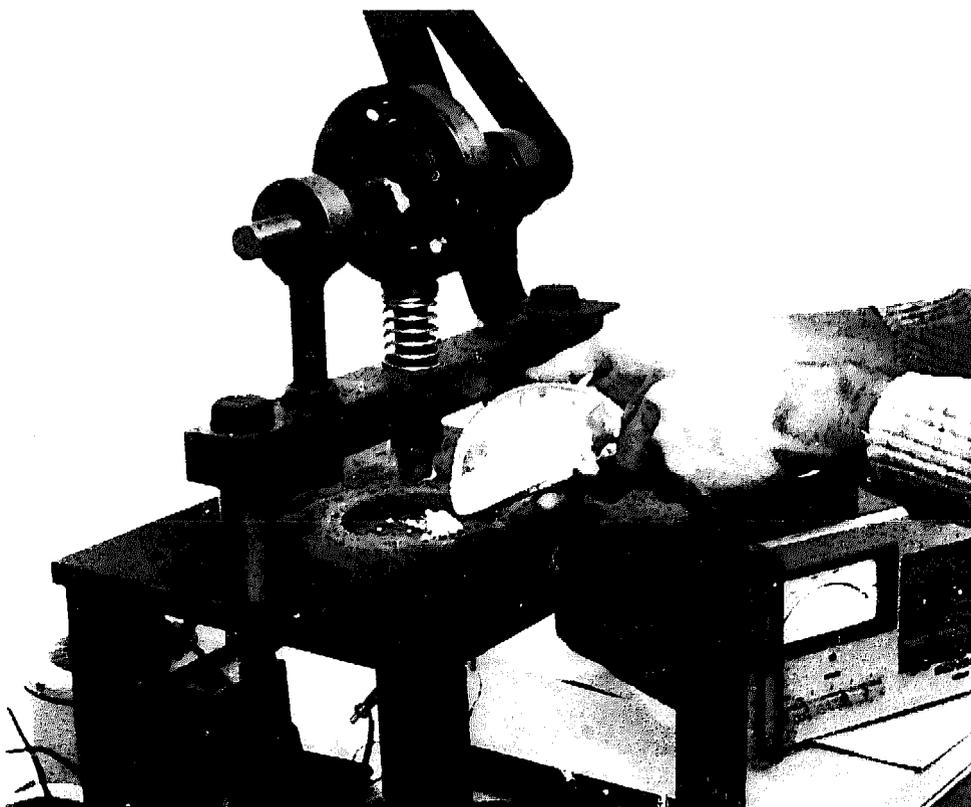
- . Prepare materials.
- . Mix with water. Apply water by spraying if only small amount is to be added. If the product is to be SVP, use material within 48 hours or texturizing ability is lost.



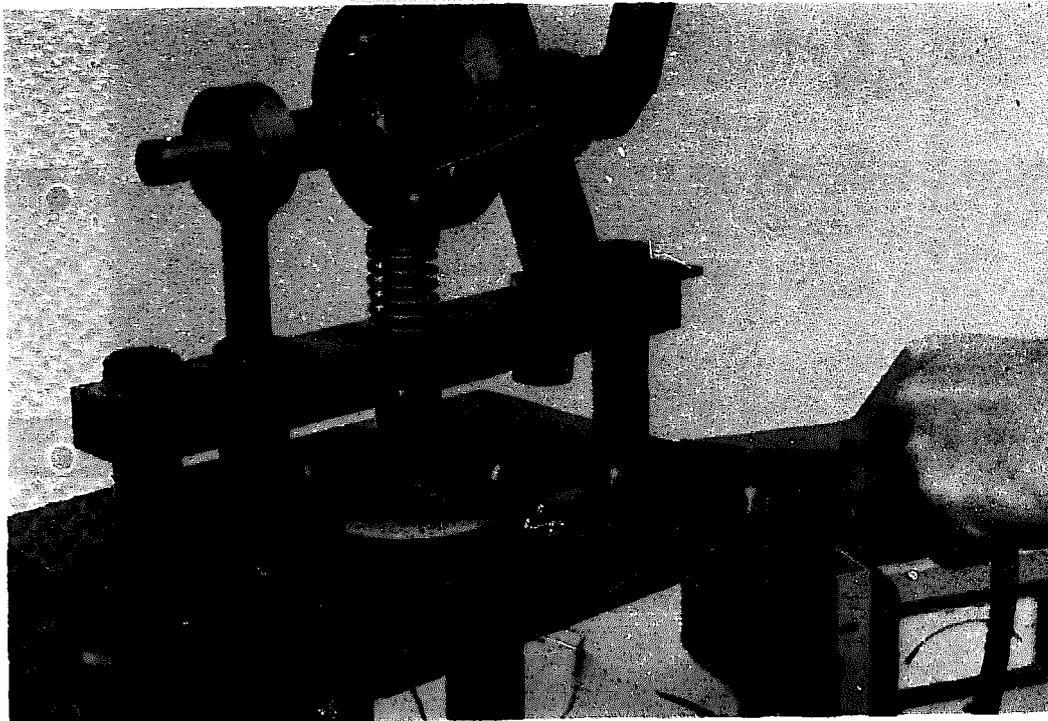
- . Oil machine using available vegetable oil. This must be done after every cycle except when using raw materials with high fat content, e.g., full-fat soy flour, peanut flour, etc.
- . Oil cup and lid using available vegetable oil. This must be done after every cycle except when using raw materials with high fat content, e.g., full-fat soy flour, peanut flour, etc.



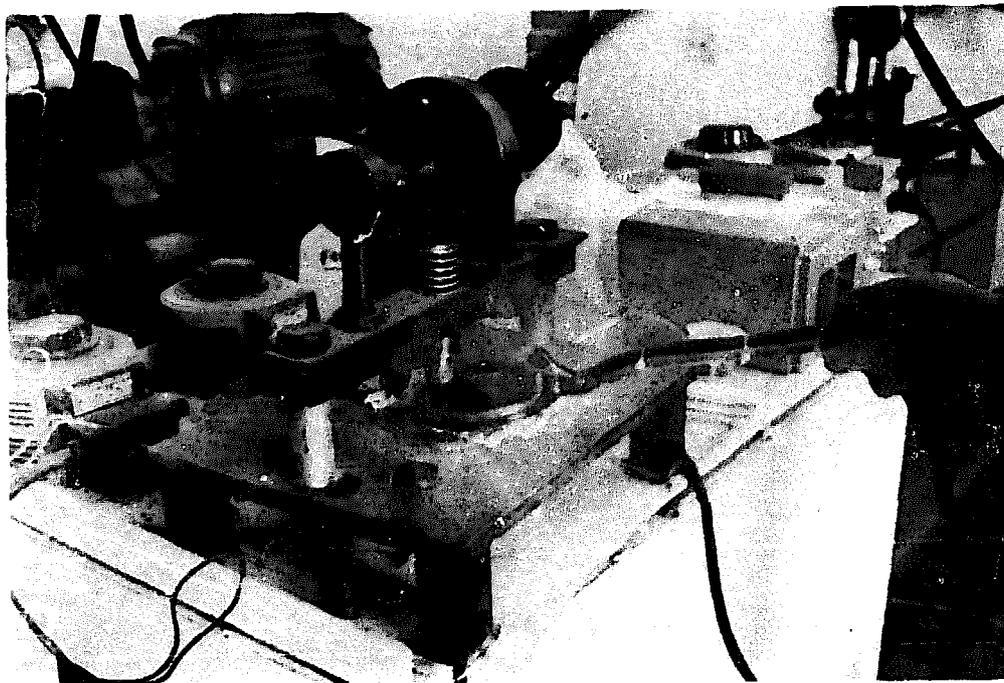
- . Heat base plate to desired setting according to temperature indicator on base plate (heat lid separately). Lid temperature should be equal to that of base plate.



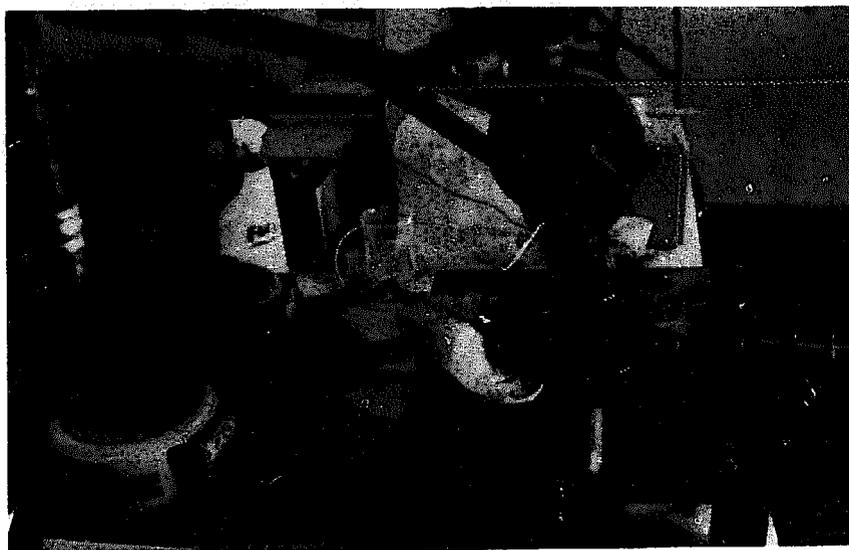
- . Put 60cc of raw material into cup of texturizer.



- Center lid over cup and lower torque arm to compress. Guide lid into cup while lowering torque arm to desired compression.



- Release handle quickly keeping lid in a level position. This will allow maximum expansion obtainable with given parameter but is not always desirable according to product.



*A completed laboratory product.*

## A Word About Flavoring

It is possible to produce a very tasty pure vegetable protein product by using meat flavoring of beef, chicken or veal. Meat flavors are available in liquid, paste or powder forms. During texturization the liquid and paste flavoring should be combined with the water, and the powder flavoring combined with the flour.

A common problem with flavoring is that it evaporates somewhat during texturization. This cannot be avoided, and the operator should not become overly concerned about it.

The easiest and most inexpensive way to obtain flavoring is to purchase it from a commercial source; however, if for some reason it is not available, flavors may be produced by hydrolysis of vegetable and yeast proteins.

For more information on flavoring of products, please write to: *Meals for Millions Foundation, Drawer #680, Santa Monica, California 90406 USA.*

# Appendix A

## Designing a Nutritious Human Food

Many factors must be considered when designing a formula for a nutritious food. First of all, it is necessary to know what part of the total diet a given food is or will be. Under almost all circumstances, any single food item will not be a total diet for humans; however, important staples and basic foods should be as nutritious and complete in themselves as possible.

With these considerations in mind, the user of the texturizer should refer to recommended nutrient intakes, such as that shown on the FAO Table (see the following page), or to the Cameron and Hofvander Table for infants and preschool children (shown below) which is more explicit by age.

Daily nutrient requirement for infants and preschool children (compiled by Cameron and Hofvander 1971).

	Infants (months)			Preschool children (years)			
	0-3	4-6	7-11	1-2	2-3	3-4	4-5
Approx weight (kg)	5	7	9	11.5	13.5	15.5	17.5
Calories	550	770	900	1150	1300	1450	1550
Reference protein (g)	11.5	12.6	12.6	12.2	14.3	16.4	17.0
NDpCal%	8.3	8	NA <sup>b</sup>	7	NA	NA	NA
Iron (mg)	5 <sup>a</sup>	5	7	7	7	7	8
Calcium (mg)	550	550	550	450	450	450	450
Vitamin A (retinol) (mg)	NA	NA	300	250	250	250	300
Thiamine (mg)	0.22	0.31	0.36	0.46	0.52	0.58	0.62
Riboflavin (mg)	0.30	0.42	0.49	0.63	0.72	0.80	0.85
Niacin equivalent (mg)	3.6	5.1	5.9	7.6	8.6	9.6	10.2
Vitamin C (mg)	20	20	20	20	20	20	20

<sup>a</sup> At 2-3 months.

<sup>b</sup> NA = not available.

TABLES AND INSPIRATION FOR APPENDIX OBTAINED  
FROM DCVLO, WILLIAMS & ZVAKA 1976.

Recommended nutrient intake (FAO 1974).

Age	Body weight (kg)	Energy <sup>a</sup> (Kcal)	Energy <sup>a</sup> (MJ)	Protein <sup>a,b</sup> (g)	Vitamin A <sup>c,d</sup> (µg)	Vitamin D <sup>e,f</sup> (µg)	Thiamine <sup>c</sup> (mg)	Riboflavin <sup>c</sup> (mg)	Niacin <sup>c</sup> (mg)	Folic acid <sup>g</sup> (µg)	Vitamin B <sub>12</sub> <sup>g</sup> (µg)	Ascorbic acid <sup>g</sup> (mg)	Calcium <sup>g</sup> (g)	Iron <sup>g,h</sup> (mg)
<b>Children</b>														
1	7.3	820	3.4	14	300	10.0	0.3	0.5	5.4	60	0.3	20	0.5-0.6	5-10
1-3	13.4	1360	5.7	16	250	10.0	0.5	0.8	9.0	100	0.9	20	0.4-0.5	5-10
4-6	20.2	1830	7.6	20	300	10.0	0.7	1.1	12.1	100	1.5	20	0.4-0.5	5-10
7-9	28.1	2190	9.2	25	400	2.5	0.9	1.3	14.5	100	1.5	20	0.4-0.5	5-10
<b>Male adolescents</b>														
10-12	36.9	2600	10.9	30	575	2.5	1.0	1.6	17.2	100	2.0	20	0.6-0.7	5-10
13-15	51.3	2900	12.1	37	725	2.5	1.2	1.7	19.1	200	2.0	30	0.6-0.7	9-18
16-19	62.9	3070	12.8	38	750	2.5	1.2	1.8	20.3	200	2.0	30	0.5-0.6	5-9
<b>Female adolescents</b>														
10-12	38.0	2350	9.8	29	575	2.5	0.9	1.4	15.5	100	2.0	20	0.6-0.7	5-10
13-15	49.9	2490	10.4	31	725	2.5	1.0	1.5	16.4	200	2.0	30	0.6-0.7	12-24
16-19	54.4	2310	9.7	30	750	2.5	0.9	1.4	15.2	200	2.0	30	0.5-0.6	14-28
<b>Adult man</b>														
(moderately active)	65.0	3000	12.6	37	750	2.5	1.2	1.8	19.8	200	2.0	30	0.4-0.5	5-9
<b>Adult woman</b>														
(moderately active)	55.0	2200	9.9	29	750	2.5	0.9	1.3	14.5	200	2.0	30	0.4-0.5	14-28
<b>Pregnancy</b>														
(later half)		+350	+1.5	38	750	10.0	+0.1	+0.2	+2.3	400	3.0	30	1.0-1.2	i
<b>Lactation</b>														
(first 6 months)		+550	+2.3	46	1200	10.0	+0.2	+0.4	+3.7	300	2.5	30	1.0-1.2	i

<sup>a</sup> FAO 1972.

<sup>b</sup> As egg or milk protein.

<sup>c</sup> FAO 1965.

<sup>d</sup> As retinol.

<sup>e</sup> FAO 1970.

<sup>f</sup> As cholecalciferol.

<sup>g</sup> FAO 1961.

<sup>h</sup> On each line the lower value applies when over 25% of the calories in the diet come from animal food. The higher value applies when animal foods represent less than 10% of the calories.

<sup>i</sup> For women whose iron intake has been at the recommended level throughout their life, the daily intake of iron during pregnancy and lactation should be the same as that recommended for nonpregnant, nonlactating women of childbearing age. For women whose iron status is not satisfactory at the beginning of pregnancy, the requirement is increased, and in extreme cases of women with no iron stores, the requirement can probably not be met without supplementation.

Note: kg — kilogram; Kcal — kilocalorie; MJ — megajoule; µg — microgram; mg — milligram; and g — gram.

While this manual does not dwell particularly on other minor nutrients, minerals and vitamins, the user is encouraged to consider alternate sources such as fresh fruits and dark green leafy vegetables for these nutrients. Here, particular emphasis is placed on issues of energy intake and protein content and quality.

To obtain a quality human food protein, it is often necessary to use vegetable protein from two or more sources. For example, starch-rich cereals and root crops can often (but not always) be supplemented by protein-rich foods from animal and vegetable sources.

Double mixes. Protein value of each mix is NDpCal 7-8%. To 100 grams of staple food, add the weight (grams) of the supplementary food shown in this table (Cameron and Hofvander 1971).

	Oats	Wheat	Rice	Sorghum	Pennisetum millet	Maize	Potato	Sweet potato	Yam (fresh)	Taro/Cocoyam	Banana	Plantain	Cassava flour
Egg	10	25	25	25	25	30	5	15	10	10	15	20	55
Dried skim milk	5	5	15	10	10	15	5	10	5	10	10	15	30
Dried whole milk	5	10	25	15	20	30	5	15	10	15	20	25	55
Fresh fish	5	10	20	15	20	25	5	15	10	10	15	20	45
Chicken or lean meat	5	10	25	15	20	25	5	15	10	10	15	20	50
Soybean or equivalent	5	10	20	15	20	25	5	15	10	15	15	20	45
Average legume	10	10	25	25	25	25	25	25	25	25	25	25	Not possible

Note: Approximate caloric values per 100 grams: average of cereal 350; potato 75; sweet potato 115; yam/taro 105; plantain 130; banana 115; and cassava flour 340. Approximate caloric values per 10 grams: average legume 35; soybean 40; chicken or lean meat 15-20; dried skim milk 35; dried whole milk 50; egg 15; and fresh fish 10-15.

Again Cameron and Hofvander show the types of combinations that achieve a Net Dietary Protein to Calories Ratio of 7 to 8 percent (NDpCal\*).

As shown in the text, cereal proteins are relatively deficient in the amino acid, lysine, which is present in relatively high amounts in legumes. Legumes are poor sources of the sulfur-containing amino acids, methionine and cystine, which are adequate in cereals. Therefore, cereals and legumes can often be combined to good advantage.

\*NDpCal% =  $\frac{\text{protein intake}}{\text{caloric intake}} \times 100 \times \text{net protein utilization (operative)}$ .

For an infant it is recommended that 8% of the calories should come from protein which is approximately the same as the value of protein calories in human breast milk. An adult diet requires only 5% of the calories to be derived from protein.

Double mixes adjusted for bulk. Each mix combined with the recommended amount of oil and sugar provides 360 calories with NDpCal 7-8% (Cameron and Hofvander 1971).

	Oats	Wheat	Rice	Pennisetum and sorghum	Maize	Potato	Sweet potato	Yam	Taro, Cocoyam	Banana	Plantain	Cassava flour
Egg	60/20	65/25	60/30	60/30	60/30	300/25	175/45	210/20	190/30	190/40	150/50	55/55
Dried skim milk	60/10	65/10	60/15	60/15	60/15	380/15	175/20	190/20	175/20	160/25	140/25	55/25
Dried whole milk	45/20	50/20	40/30	40/25	35/30	175/25	100/30	100/35	100/30	90/35	70/35	30/55
Fish	65/15	65/20	70/30	70/30	70/35	330/30	210/40	240/35	210/45	210/45	180/50	75/50
Chicken	65/15	65/20	65/30	65/30	60/35	300/30	180/40	210/35	185/45	185/45	155/50	65/50
Soybean	55/15	55/20	50/25	50/25	50/25	240/20	140/30	160/25	140/30	140/30	110/35	45/35
Legume	55/40	100/10	65/35	70/30	50/50	320/35	120/65	160/55	145/55	100/70	80/75	Not possible

The gastric volume of some children is much smaller than others and they must be fed more concentrated forms of calories. This table shows how to make these adjustments and still maintain the protein level required by the child for adequate growth. Using this table a wide variety of local foods can be used to provide a sufficient number of proteins to ensure adequate growth of both infants and young children. Legumes can only be used in double mixes; it is impossible to maintain the protein level and adjust for bulk.

Note: Use the amount of staple and supplement shown (grams) with 10 grams of oil and 10 grams of sugar OR 5 grams of oil and 20 grams of sugar.

In the last table, double mixes are combined and developed to produce lower bulk values, particularly appropriate for small children. For example, a combination such as legumes with rice can be made of 65 grams of rice, 35 grams of legumes, plus 10 grams of oil and 10 grams of sugar, to provide 360 calories. This Table will serve as a guide for making appropriate combinations of several commodities to obtain a nutritious food for a child or infant.

These, of course, are general guidelines only. For those who wish to do more extensive work on defining nutrition needs and designing appropriate foods, the bibliography appearing at the end of this manual should be most helpful.

# Appendix B

## Use of the Village Texturizer in a Small Business

### A Hypothetical Example

Profitability for an enterprise using the Village Texturizer must be considered. In the worksheet which follows, most, if not all, of the items that could be important for such an enterprise are outlined. To help the user understand the exercise, an example of a hypothetical operation follows:

For purposes of this example it will be assumed that the Village Texturizer operation will produce 320 products each day for five days a week. One person will be hired to operate the facility and sell the product as it is made. The owner of the facility pays wages and provides limited supervision and training of the operator.

The product will be made from defatted soy flour which is conditioned with moisture to an appropriate degree. Once texturized, the soy patties are soaked in a preparation of hydrolyzed proteins available from a great variety of sources (preparations like soy sauce, fermented fish sauce and the like). After absorbing flavor and moisture from the hydrolyzed protein preparation, the patties are fried in oil and sold.

*Each patty consists of:*

- 1. A 30% moisture-conditioned blend of defatted soy flour (10% moisture originally) and water. Thus a one ounce (28.3g) charge will contain:*

*22.0g of defatted soy flour  
6.3ml of water*

- 2. A 1:2 blend of the hydrolyzed protein with water absorbed on an equivalent weight basis into the texturized patty such that each patty contains:*

*9.4ml of hydrolyzed protein sauce  
18.8ml of water (dilution)*

- 3. An additional one half ounce of soy oil will be absorbed in frying while moisture previously absorbed will evaporate. Thus 14.2g of soy oil.*

It cannot be expected that full recovery of ingredients will be represented in the product sold. Shrinkage will occur due to failure to use all of the conditioned blend, or through losses, or through improper processing of product in any portion of the operation. Thus it is essential to consider shrinkage losses. The following additional amounts of ingredients are added in consideration of shrinkages:

6.3g of defatted soy flour  
 .94ml of hydrolyzed protein preparation  
 (10% shrinkage)  
 25.2ml of water

Total ingredient use for a week of operation producing 1600 products is as follows:

45400g (45.4kg) of defatted soy flour  
 80500ml (80.5 liters) of process water  
 16550ml (16.55 liter) of hydrolyzed protein preparation  
 29400g (29.4kg) of soy oil.

Each patty will weigh from 45 to 60gr as sold. It will be assumed that the product can sell for 10¢ each.

Financial operating statement for a single week of operation for the hypothetical case follows:

**A. SALES**

1600 patties @ \$0.10	=	\$160.00	
	Revenue from sales		\$160.00

**B. COST OF GOODS SOLD**

1. 45.4kg of defatted soy flour			
@ \$21.07/cwt	=	21.07	
1 cwt = 45.4kg			
2. 80.5 liters of process water (3 cu ft)			
@ \$ .35/100 cu ft	=	0.01	
3. 16.55 liters of hydrolyzed protein preparation			
@ \$ .03/ounce	=	17.58	
4. 29.4kg of soy oil			
@ \$ .035/ounce	=	<u>36.40</u>	
(\$1.20/kg)			
TOTAL COST OF GOODS SOLD			75.06

**C. GROSS MARGIN**

84.94

D. OPERATING EXPENSE		
Production Costs		
Wages 40 hrs X \$1.25/hr	=	50.00
Electricity 96.5KWH*		
@ 4.74/KWH	=	4.10
Maintenance and Cleaning		
materials	=	1.00
Rental of Facility	=	10.00
Administration Supvr.		
& Training	=	<u>12.50</u>
TOTAL OPERATING COSTS		77.60
E. NET INCOME FROM OPERATIONS		7.34
F. DEPRECIATION		
Assume \$260 equipment and facility investment** to be depreciated over 5 years. This for 1 week.		1.00
G. INTEREST		
Short term money for expenses B & D above (\$75.06 + 77.60 @ 10% per annum (per week)		.29
H. PROFIT (E minus F minus G)		6.05
On investment of \$260 of equipment		
Return on investment (ROI) = 121%		

## NOTES:

\*Electrical usage based on 1100 watts indicated for warmup and intermittent operation are inflated by 2.5 times for continuous operation and additional frying heat. It is assumed that demand will be 7 hours per day only.

\*\*In addition to the cost of fabricating the Village Texturizer (estimated to cost \$50), other equipment for preparing flour blends, soaking patties and frying the patties are lumped into the \$260 estimate.

It must be emphasized that the potential user of this processing approach must determine which costs are appropriate for his own situation. This is only a hypothetical example.



Depreciation<sup>5/</sup> on Capital Equipment and Structures<sup>1/</sup>

Production Equipment \_\_\_\_\_  
 Office Equipment (if any) \_\_\_\_\_  
 Buildings owned (if any) \_\_\_\_\_

Total Depreciation \_\_\_\_\_ (F)

Debt Service (Interest)<sup>1/</sup>

Interest on Short Term Debt<sup>6/</sup> \_\_\_\_\_  
 Interest on Long Term Debt<sup>7/</sup> \_\_\_\_\_

Total Interest \_\_\_\_\_ (G)

Net Income (Profit or Loss) (E minus F minus G) \_\_\_\_\_ (H)

## FOOTNOTES:

1/ Commonly the period of statement is one year but other time periods may be considered. Whatever period is chosen for this projection, consistent estimates to match the time period should be identified for sales volume, quantities of ingredients purchased, all operating expenses, depreciating and interest costs. For periods other than one year, estimates of monetary values should be prorated from figures customarily determined on a yearly basis.

2/ Revenues from sales and costs for ingredients can be extended to the necessary detail to identify each product and each ingredient used.

3/ Alternative estimates for cost of goods sold may be determined by beginning value of inventory plus purchases less ending inventory value. Although less sophisticated, the above approach serves to outline a procedure of estimating cost of goods sold.

NOTE: To relate quantity of each ingredient to volume of goods sold, the purchase quantity should be inflated to account for the shrinkage during operation.

For example:

$$Q_i = \sum_{j=1}^N V_j \frac{100\%}{100\% - S_j} \times F_{ij} \frac{W_j}{100\% - S_{ij}}$$

Where:  $Q_i$  = quantity of ingredient  $i$ ;  $i$  may be 1,2,3 and more for each ingredient;

$\sum_{j=1}^N$  = is a summation operator to sum together each use of ingredient  $i$  by the  $N$  products  $j = 1,2,3$  to  $N$ .

$V_j$  = Volume of sales of product  $j$  (number of items)

$S_j$  = Percent of shrinkage of finished product  $j$  (i.e. product completed but not sold because of standard quality of other loss).

$F_{ij}$  = Formula percent of ingredient  $i$  in product  $j$ .  
 $W_j$  = Target net weight of single item of product  $j$ .  
 $S_{ij}$  = Percent of shrinkage of ingredient  $i$  in production of product  $j$  (i.e. loss of ingredient weight due to removal of foreign material, moisture, by product, and waste in production).

4/ If products are packaged, packaging material costs should be inflated similar to quantity of ingredients purchased to account for any losses or shrinkage of materials in the operation.

5/ Cash costs for capital items are not charged against single operating periods, but since the cost of the capital item must be considered over a generally much longer period, depreciation charges are the costs of item distributed over the expected lifetime of the item. The procedure is to charge a yearly depreciation against each item (i.e. the purchase price divided by the expected life of the item) or some other scheme, until the item is fully depreciated or disposed. When each item is acquired, either a cash outlay from a reserve is made for its purchase or debt is obtained to be retired over an extended period of operation.

6/ Short term debt is often necessary to pay for operations until revenue can be realized from the sale of goods. It is expected to be liquidated when the revenues are realized.

7/ Long term debt is used to finance a portion of the capitalization of the enterprise. It may be retired over several years of operation and may have a period of grace in the initial year or two of operation.

## MEALS FOR MILLIONS

Meals For Millions is a non-profit, non-sectarian philanthropic foundation that assists communities in developing countries and in the United States in self-help projects to prevent hunger and malnutrition. MFM's program includes:

- Technical and material assistance to help countries develop low-cost, high nutrition food.

- Training of food technologists and nutritionists at MFM's International Institute of Protein Food Technology.

- Research and development to increase food resources and to test and develop high-protein food derived from low-cost vegetable and oilseed sources.

- Nutrition education.

Founded in 1946 by Clifford E. Clinton, MFM has offices in New York City and Santa Monica, California.

**Meals for Millions Foundation**

**1800 Olympic Boulevard**

**P.O. Box 680**

**Santa Monica, California 90406**

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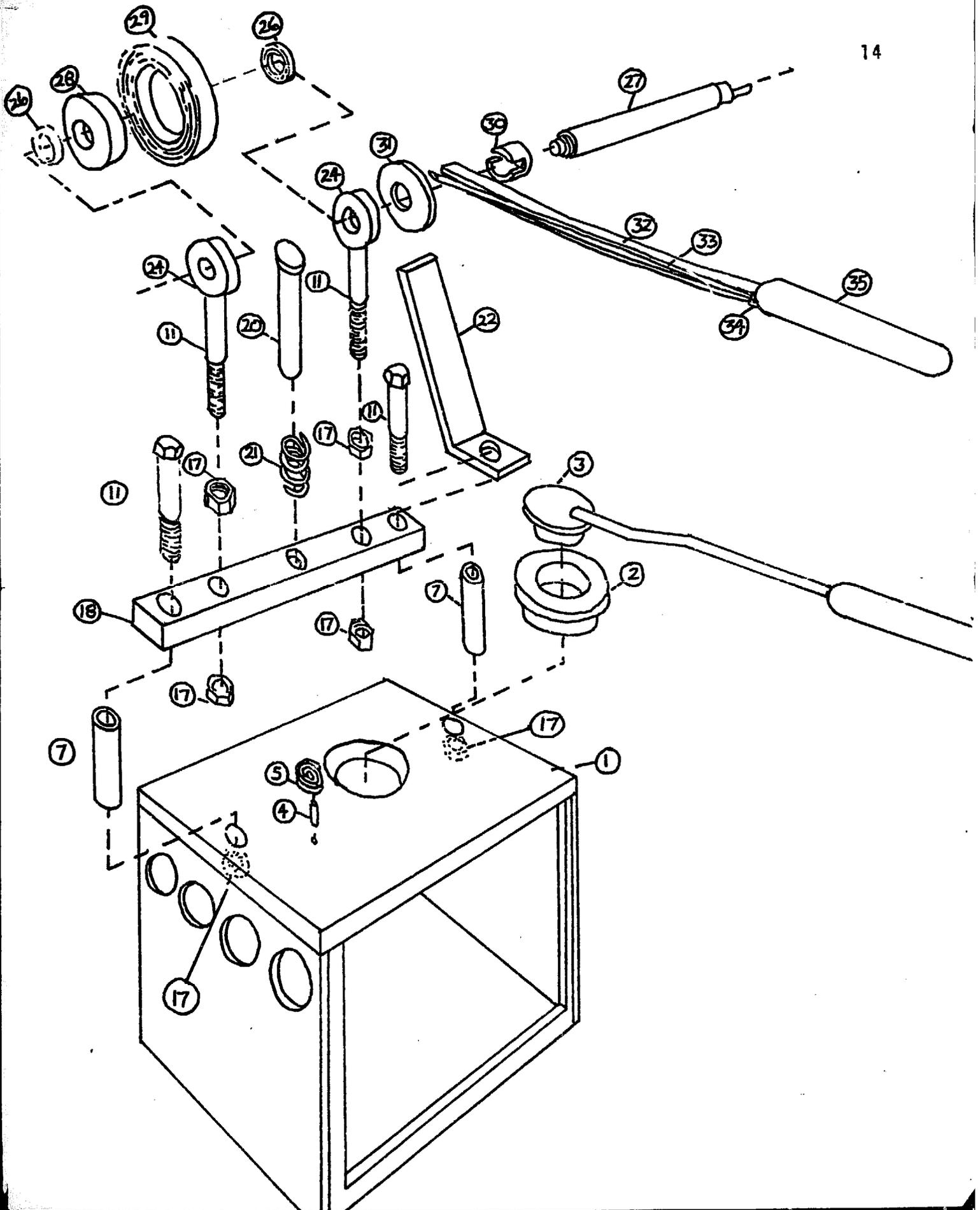
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Self-Help for a Hungry World  
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**VITA**  
**VOLUNTEERS  
IN TECHNICAL  
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Mt Rainier, Maryland, USA 20822



TOP VIEW

HANDLE

SHIM

POINTER

TORQUE ARM

BEARING

CAM

SHAFT

BEARING HOUSING

STOP

TORQUE READOUT

BOLT

BOLT

SUPPORT

NUT

SLEEVE

LID

CUP

BASE PLATE

COIL

FRONT VIEW

SIDE VIEW

