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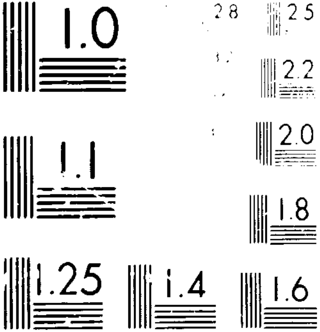
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# LOCAL MANUFACTURE OF MINI HYDRO EQUIPMENT*

by

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## INTRODUCTION

As the energy crisis is getting worse with each passing day and the developed world wanting to hold on to their position of "fair" exchange with the developing world, it is becoming clear to all and sundry that in order to make Mini and Small Hydro Projects feasible, the manufacturing of the mechanical equipment must be done locally.

Local technology as related to Mini Hydro in the developing world would of necessity be of a low grade in order that the program me be successfully implemented. However, this must not be done at the expense of great losses in the efficiency of the manufactured goods which in this case would be Hydro turbines and their accessories.

Local manufacturing of turbines and other equipment such as penstock, valves and track racks would certainly enhance the economic viability of these projects and make them competitive in an energy starved developing world especially the rural areas of the developing world where energy starvation is even more acute.

Energy consumption has a very high correlation with the standard of living of a country, hence when the energy consumption of the developed world is compared to that of the developing world then it is being realized to what extent the inhabitants of the developing countries are fighting for a better place in which to live. It is ironic that it is in developing countries that the great majority of potential energy sources are located. What is sad is that these energy sources remain potential for various reasons. In Mini Hydro Generation the actual equipment costs are prohibitive when purchased from developed countries, hence the need to manufacture the equipment locally.

## MANUFACTURING POTENTIAL

With the exception of very few, all developing countries have the potential of developing their own manufacturing capabilities, with, in most cases, little help from the right quarters.

The most necessary ingredient is the will to succeed, followed by some of the most elementary industrial tools such as the welding torch and a fairly large lathe.

In some of the smaller countries where all the ingredients are not present in any one country, but a group of neighbouring countries have all the ingredients, then the way out is to have a country manufacture that component which it is most capable of manufacturing.

Not only the hardware must be considered in the manufacturing of equipment as being important but also the human skills needed as inputs to the successful conclusion of the whole venture. Towards this end, personnel of the various developing countries must, not only of necessity, but with great haste and utmost urgency, convene a workshop with the sole objective of working out ways and means of disseminating experiences accumulated in the developing world.

## THE MANUFACTURING OF A BANKI TURBINE - 1KW

After a decision was taken to manufacture a Banki Turbine, all literature available on the subject, within reach, was read with great enthusiasm. After the construction, it was realized with hind sight that a much more aestetic product could have been produced. This paper deals with the more aestetic version.

## THE PLAN

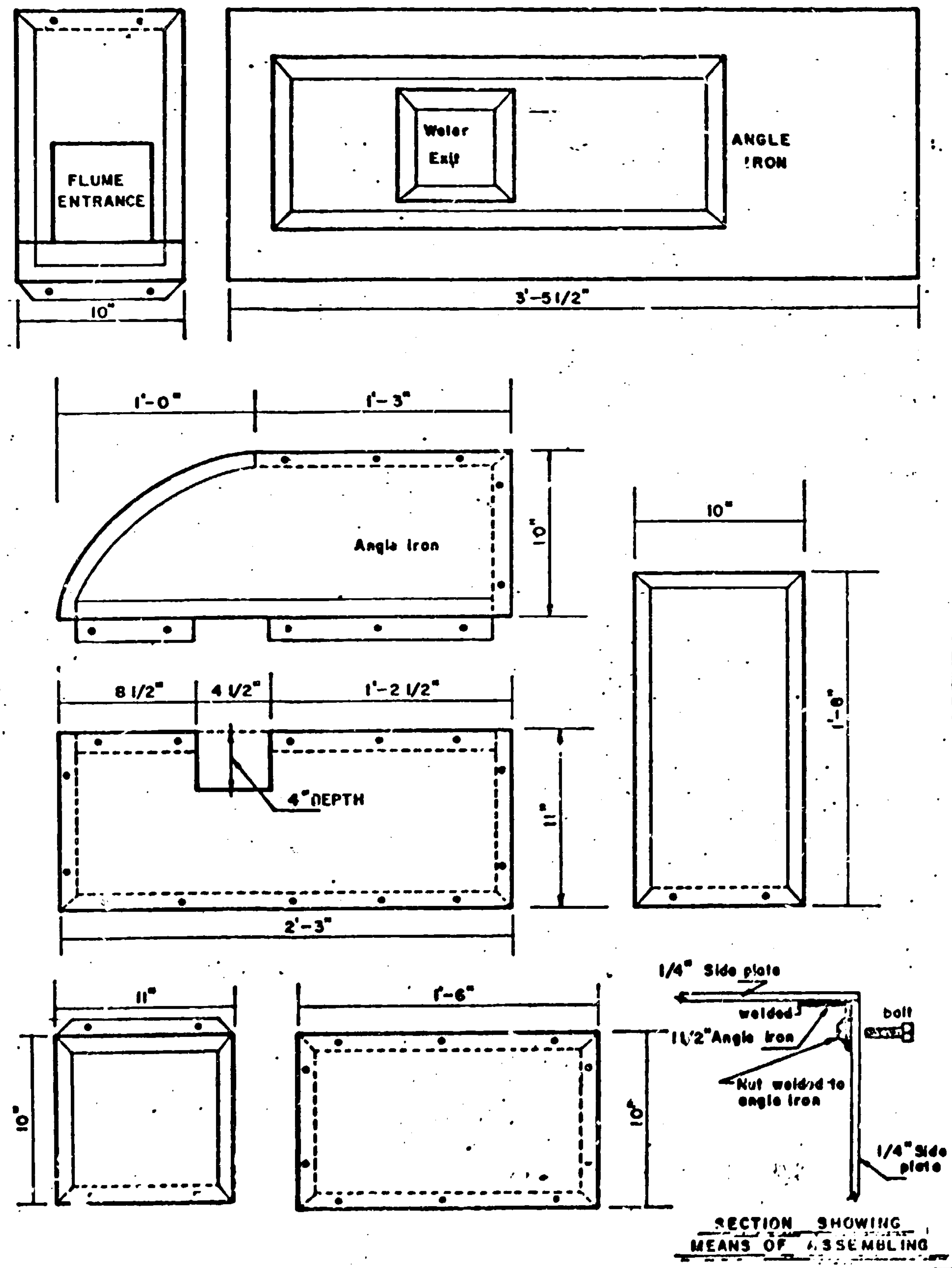
Being conscious that low technology will be used in the manufacturing process, it was decided to first survey the workshop where the turbine would eventually be fabricated taking note of the relevant machinery available there.

The next step was to design the turbine. The working drawings of the turbine was done on a one-to-one scale with the sole purpose of utilizing those drawings as templates during the manufacturing process.

## THE PROCESS

Once the working drawings were made available, the manufacturing process started.
The base of the turbine was first cut from 1/2 inch mild steel plate with a cutting torch (See figure on following page). Into this plate was cut an exit for the spent water to pass from the turbine into the

## BANKI TURBINE — DETAIL OF PARTS



tailrace (see figure on following page). Unto this base plate was welded angle iron correlating to the covering of the turbine.

A feature to be noted by this method is that angle irons which will eventually form the frame are welded onto one plate while bolted onto the adjoining plate. This allows for easy transportation to site. Assembling on site becomes much easier since bolting is the only operation required.

The assembled angle iron framing turbine without the runner is shown in Figure showing "Banki Turbine Framework with Base". It should be noted here that the curved section in front is not absolutely necessary if no bending machines are available. In fact straight angle irons can be substituted. However since it is more aestetic to have it curved perhaps two pieces of iron can be cut and then welded together to form the curved frame.

After assembling the turbine a vibration test was envisaged using compressed air.

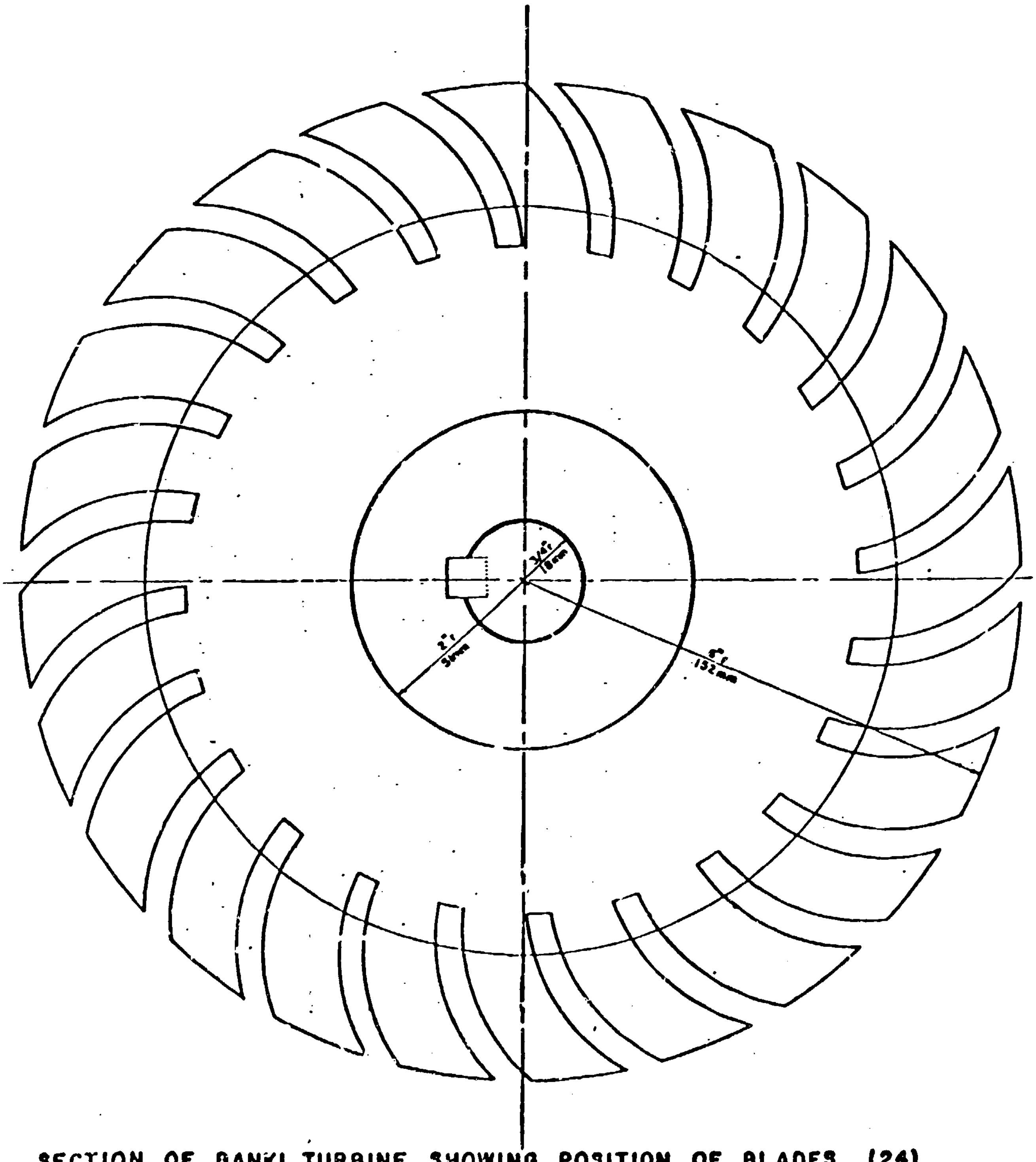
The runner shall be tested for static balance.

## THE RUNNER

By far the most important part of the turbine is the runner. This was made by first cutting out the two side plates with the torch and afterwards placed on the lathe to finish it off according to specification.

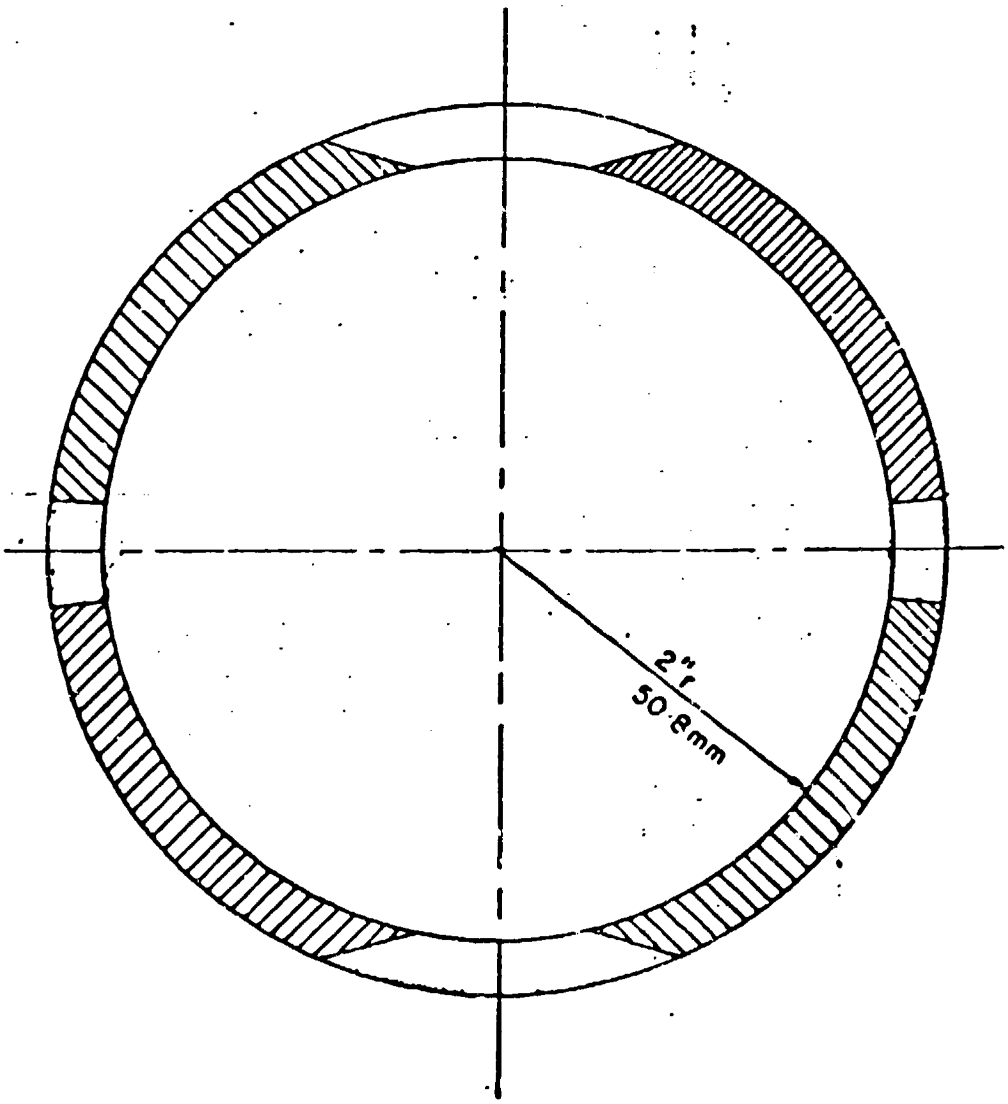
These two end pieces were then tacked on together and a print of the one-to-one drawing (See Figure on next page) now being used as a template was pasted onto one of the end plates and the required curved slots punched on to the metal using the drawing template as a guide.

With the punching completed the next step was to remove the paper template and use the cutting torch to cut out the curved slots as previously punched. These will accept the blades of the runner.




SECTION OF BANKI TURBINE SHOWING POSITION OF BLADES (24)

## METHOD OF CUTTING CIRCULAR TYPE RUNNERS



Note that by tacking both ends together and then using the cutting torch ensures that on both end plates the curved slots shall correspond to each other thus avoiding lots of trouble when fitting in the blades onto the end plates.

For the curvature of the blades a suitable sized galvanized pipe is sought and cut along the axis into four pieces (See Figure on following page). Any one of these pieces will obviously have the designed radius of curvature, thus avoiding the metal bending process which may not be readily available in the developing countries.

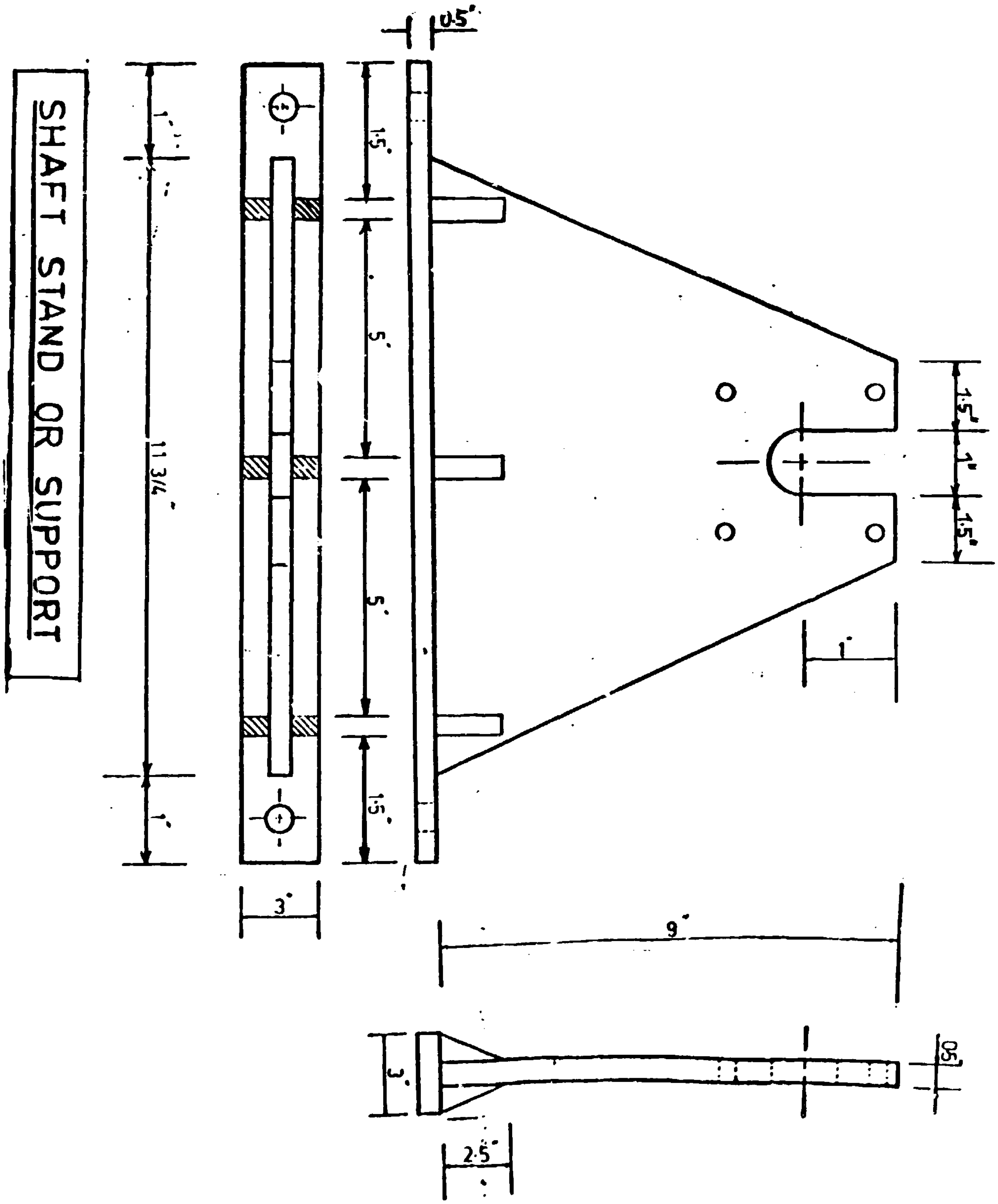
Before breaking the tacks on the end plates, a hole to accommodate the shaft is marked and drilled in the centre of the end plates. This can be done on a lathe or a drilling machine depending upon the size of hole required.

To ensure that the corresponding slots do not get mixed up a mark is made on both end plates while still being tacked up. The tacks are now broken and the shaft placed into the end plates at their correct positions and tacked on to the shaft. At this point one blade is placed into the slots previously cut into the end plates and properly positioned before being tacked. When the first, second and third has been placed approximately 120 degrees apart and tacked, the others are also put into place and welded. Lastly the end plates are also properly welded unto the shaft.

This runner is now ready for the lathe which will cut the blades into shape making a wedge to reduce the resistance to water entering the runner blades.

After machining static balance test was done, it may be noted here that once care is taken at the welding stage to evenly distribute the welding, static balance should not be a problem. However, should the runner not be statically balanced, then balances can readily be welded unto the ends of the runner.

Suitable stands to accommodate the shaft with its bearings within the housing of the turbine was now fabricated, positioned on the base plate and welded (See Figure on following page).


SHAFT STAND OR SUPPORT
11 3/4"
1"
1"
3"
1.5"
5"
5"
1.5"
0.5"
9"
1.5"
1"
1.5"
1"
3"
2.5"
0.5"

## THE FLUME

The flume is that part of the turbine that guides the water unto the runner blades. Care should be taken when designing this piece that the area of the cross-section of the flume remains constant. If this were not so, the water velocity shall be faster at places where the area of the cross-section is smaller and slower in places where the area of the cross-section is greater than the area of the cross-section of the penstock. In passing, let it be noted that a constant volume moving factor shall create a lower pressure, hence the possibility exists that the flume may just fold in should the pressure decrease enough.

The flume was fabricated using the same method as for the runner. After having cut the curved ends using the torch and the drawing as a template, the other two sides were welded so as to follow the contour of curved ends. See Figure showing the "Section of the Flume".

Some amount of heat applied to the front and back plates of the flume and hammered into shape will do the job should the plates appear troublesome to get into shape.

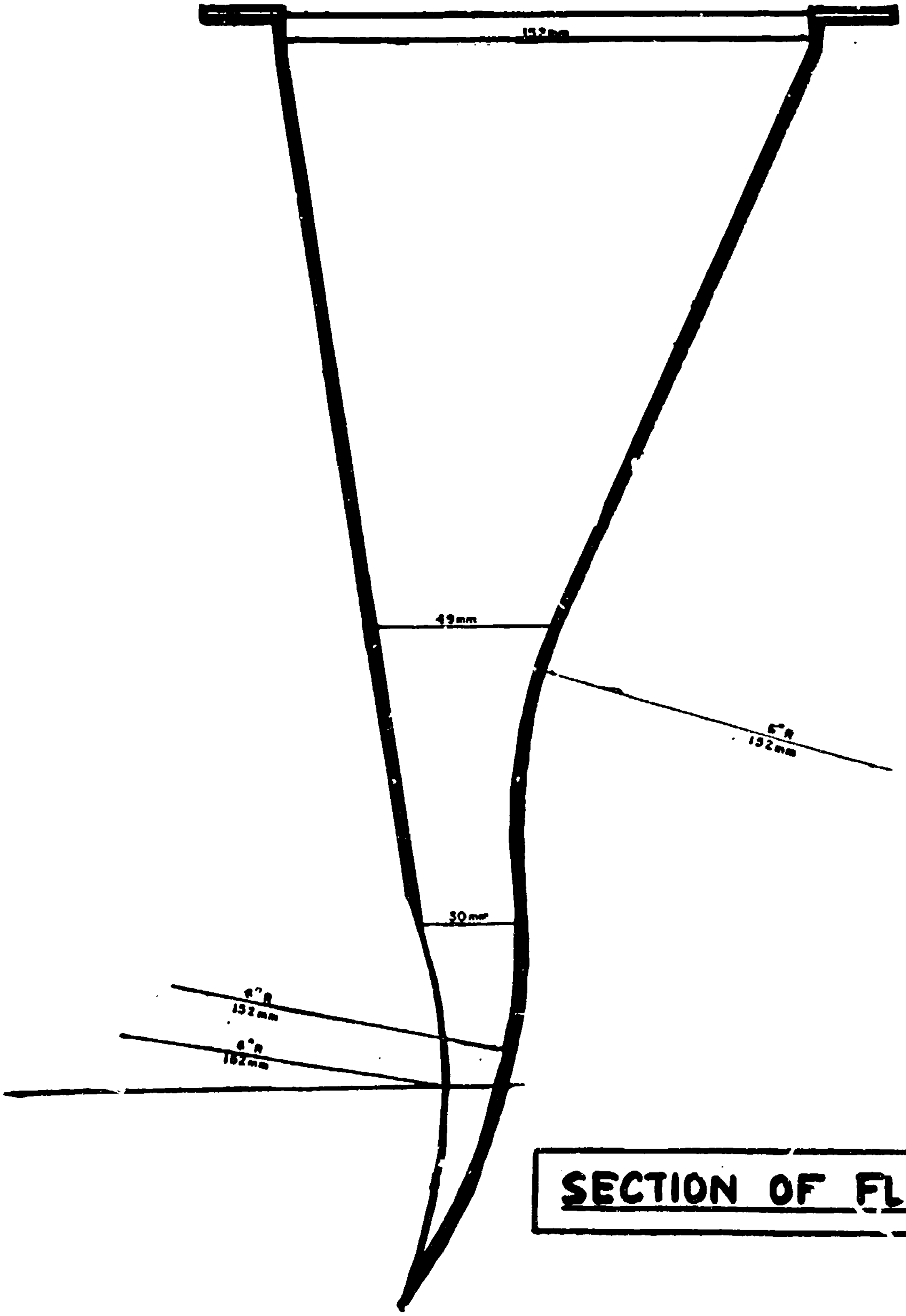
The flume is bolted unto the top pieces of the turbine housing, by means of a plate unto which is welded the flume.

At the back of the flume a brace was introduced to prevent the likelihood of any vibration developing in the flume, thus reducing the efficiency of the turbine. See "Section of Turbine" for the brace.

## THE TRANSITION PIECE

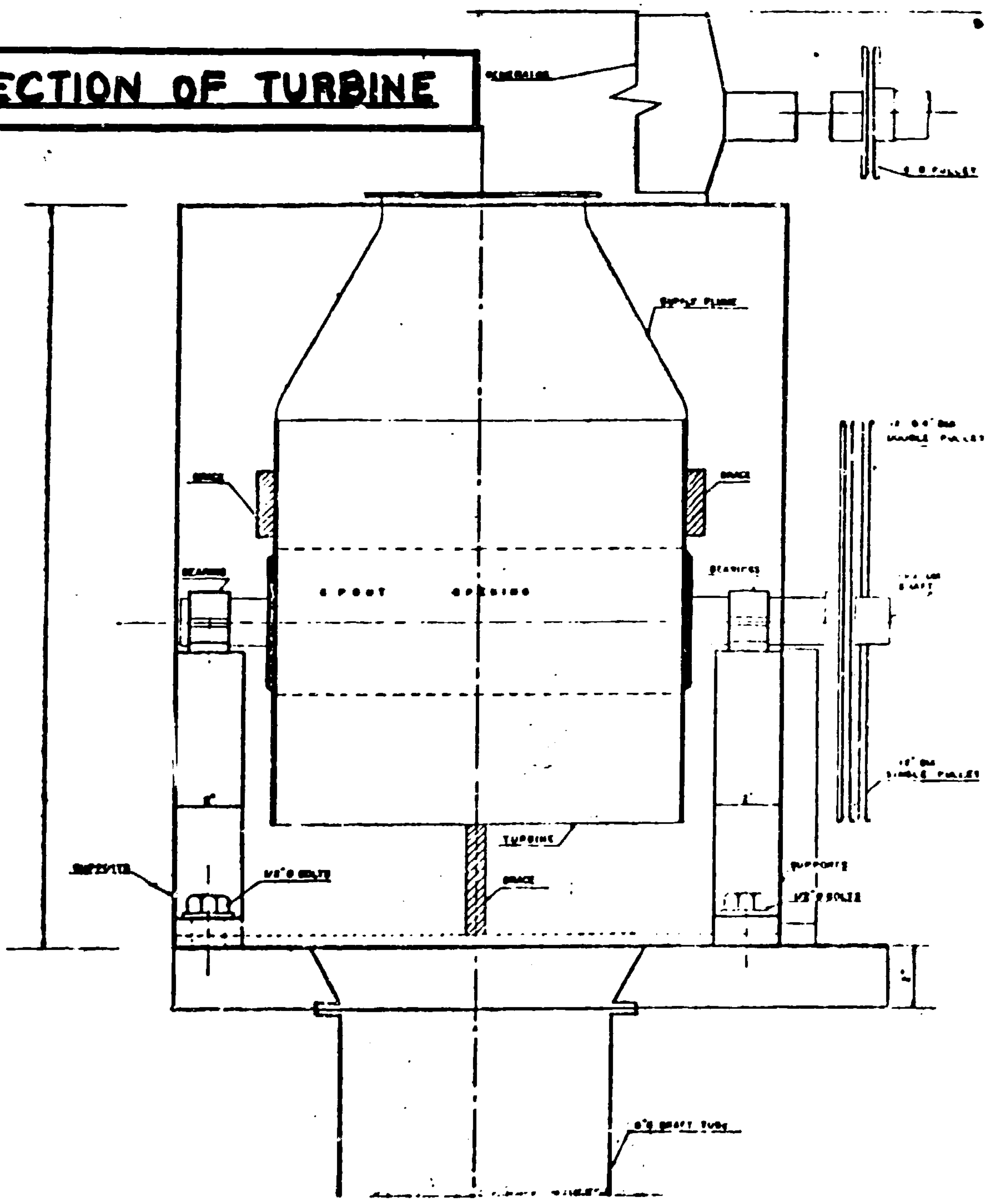
This is the piece that is found between the penstock and the flume. Since the penstock's cross-sectional area is circular in shape and the flume's cross-sectional area is oblong, it would require a transition piece that would gradually change a circular shape into an oblong shape, while maintaining a constant cross-sectional area.

This part was developed on drawing and then cut from metal according to the drawing and then folded to shape. The transition piece is bolted unto the top piece of the turbine housing using a rubber gasket between them. Experience has shown that it is much better to use more but smaller than less and larger bolts, to prevent leaking through the joint.




SECTION OF FLUME

## SECTION OF TURBINE



THE SHAFT STANDS OR SUPPORTS

The supports for both the runner and the intermediate pulleys were made of the same shape and from the same size of material. These supports are fastened unto the base plate by slots into which adjusting bolts are passed and tightened after the necessary adjustments have been made.

These stands shall carry the bearings for both the runner and the intermediate pulleys as shown on the "Side View of Turbine".

THE GENERATOR STAND

This was welded unto its position at the "back" of the turbine. This plate was slotted to allow for adjustments of the pulley belt.

The "open" end of the plate was supported on angle iron tips.

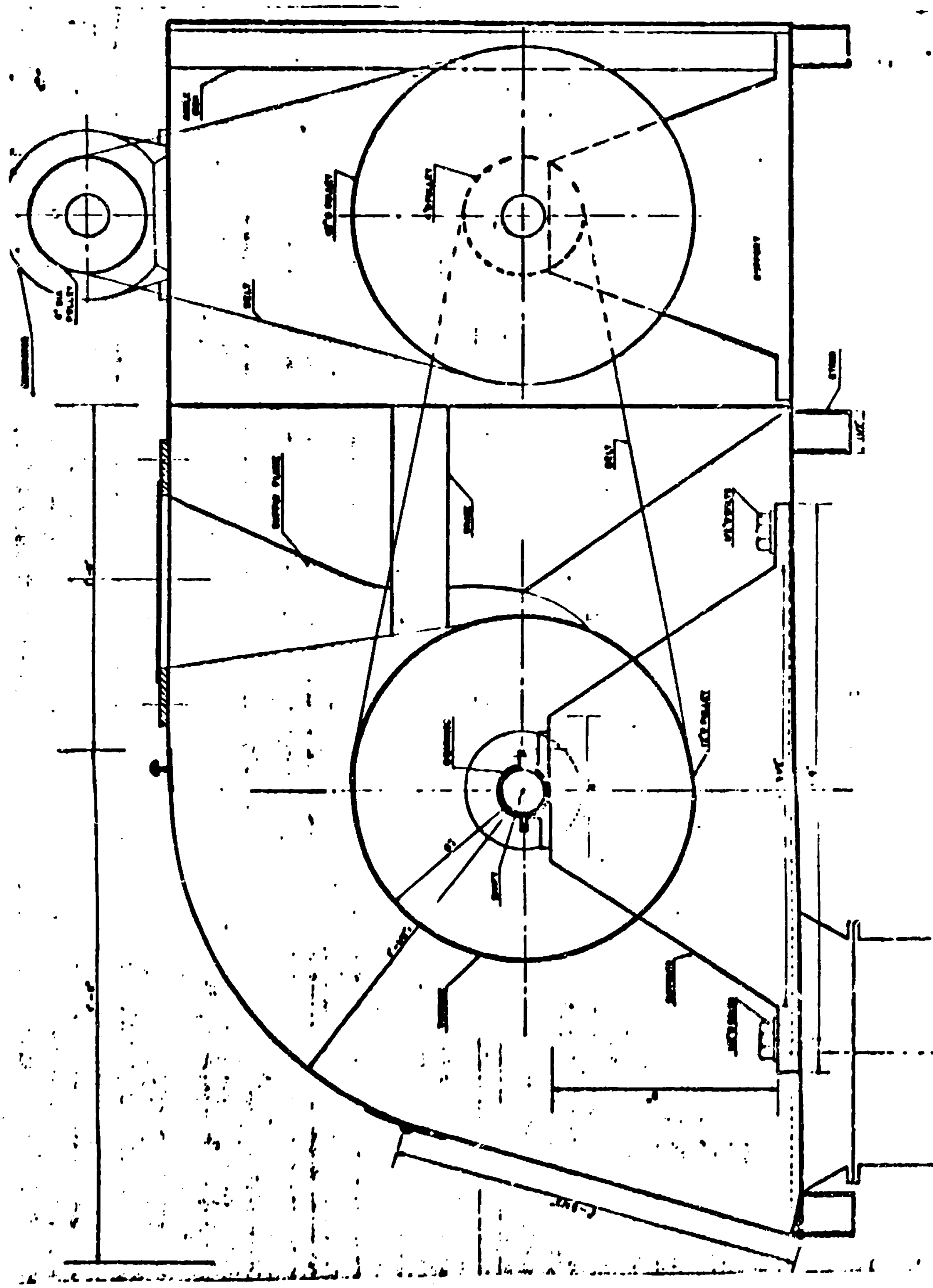
CONCLUSIONS

As can be observed from the foregoing, the Banki Turbine lends itself to a low grade technology.

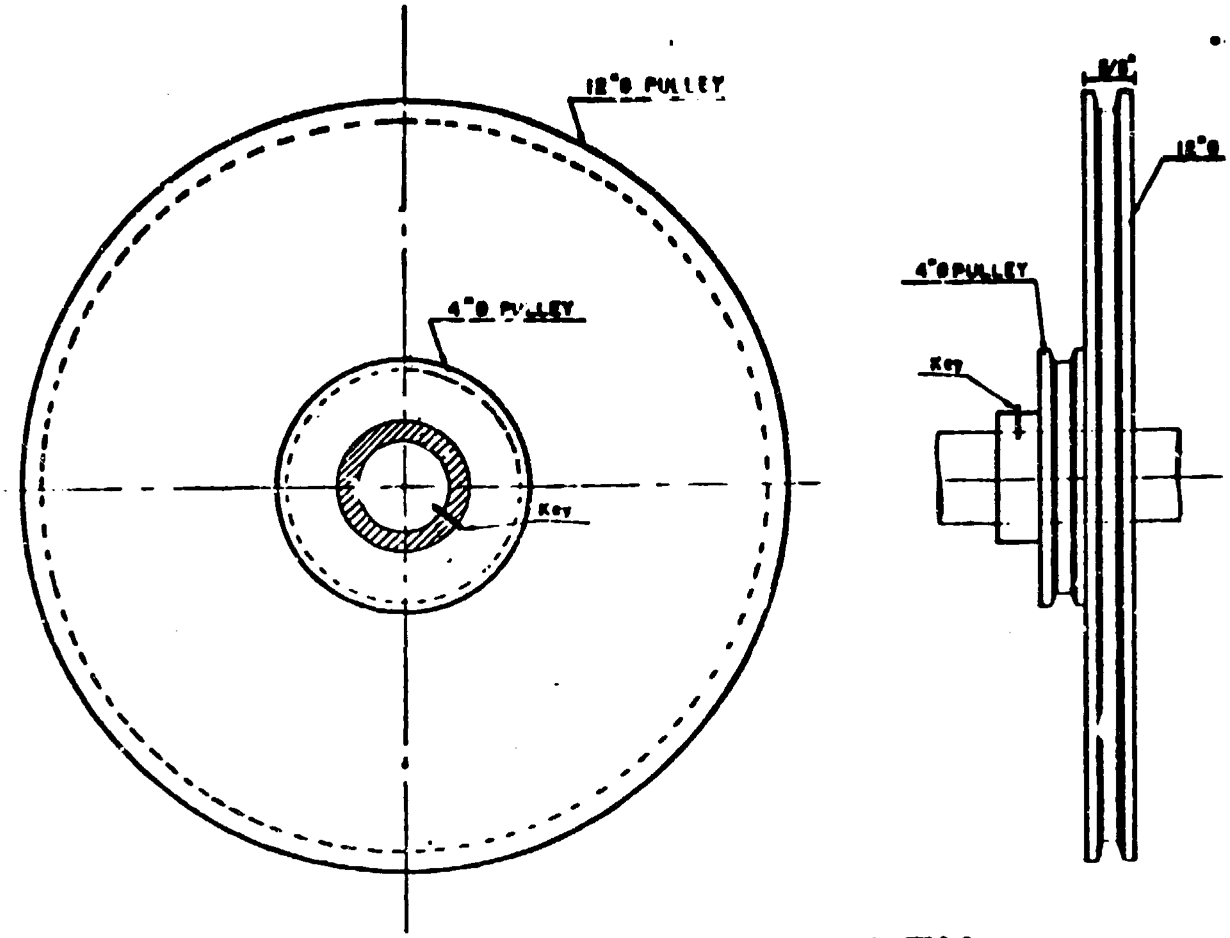
It can be constructed at a central point, transported to site and re-assembled without much doing.

A good grinding stone to cut down edges and welding seams, as well as some paint and a brush will certainly enhance the aestetics of the turbine.

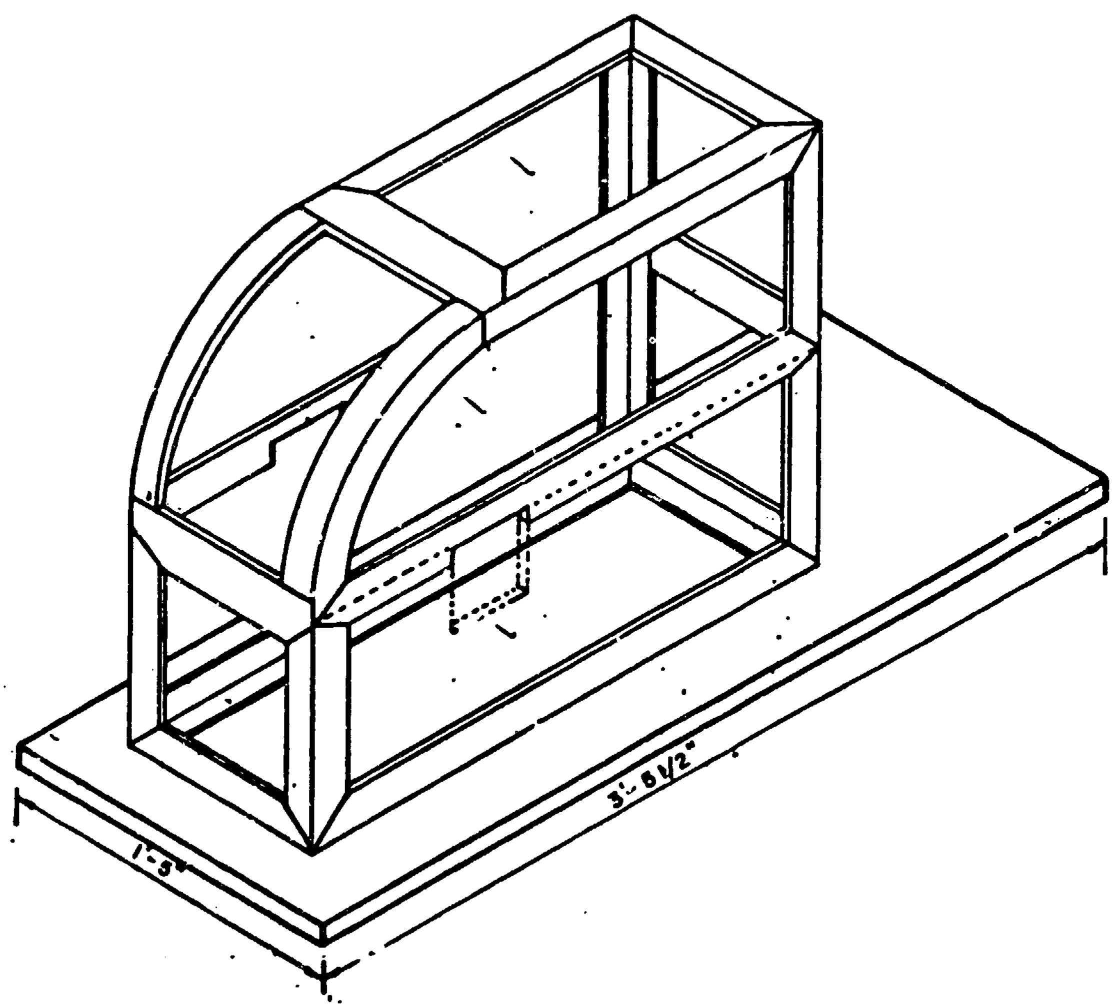
This turbine was designed to be manually operated when necessary as an open loop feed forward electronic control device was envisaged.



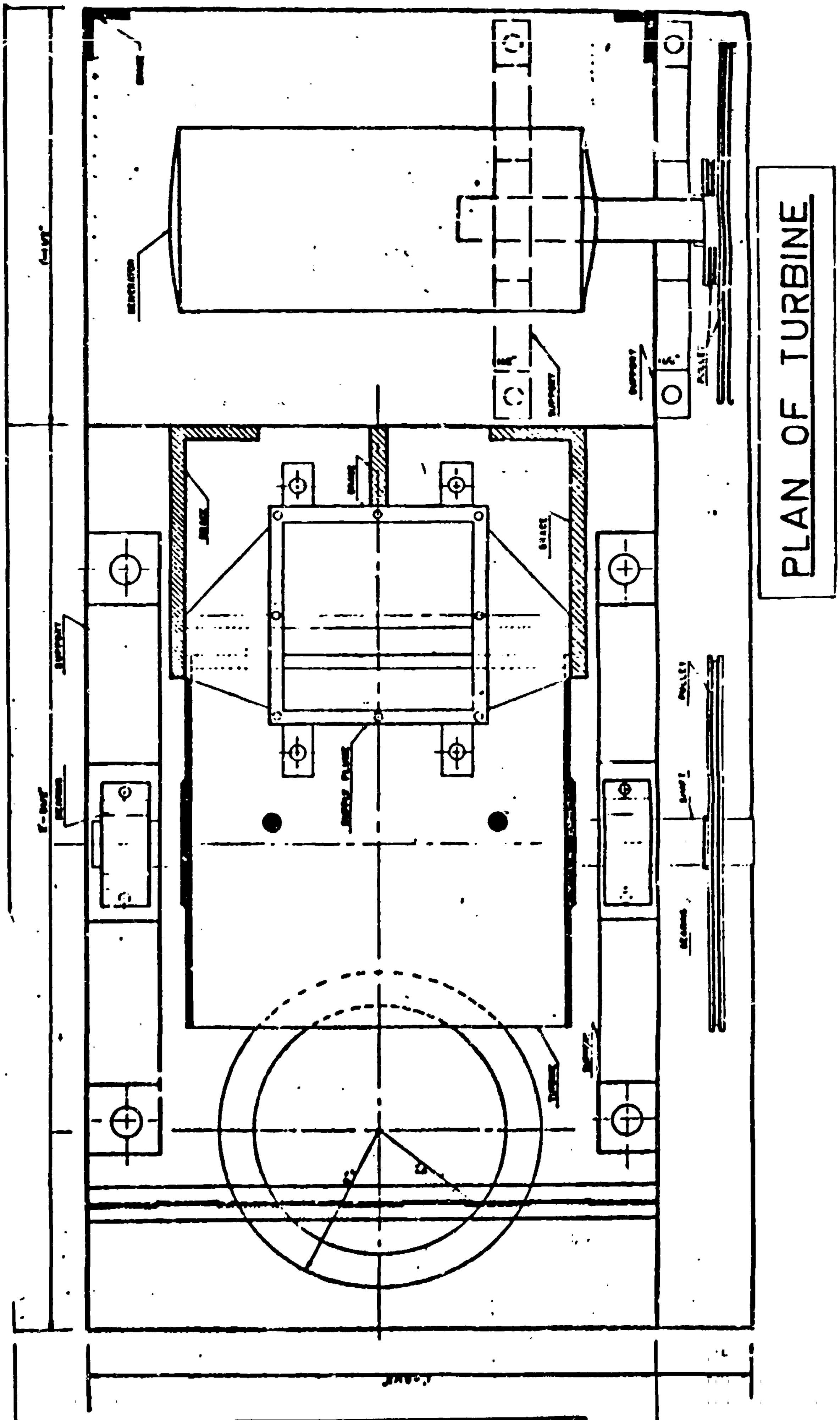
SIDE VIEW OF TURBINE




DETAIL OF DOUBLE PULLEY




BANKI TURBINE
FRAME WORK WITH BASE


PLAN OF TURBINE