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New Himalayan Water Wheels

by A. Bachmann and Akkal Man Nakarmi

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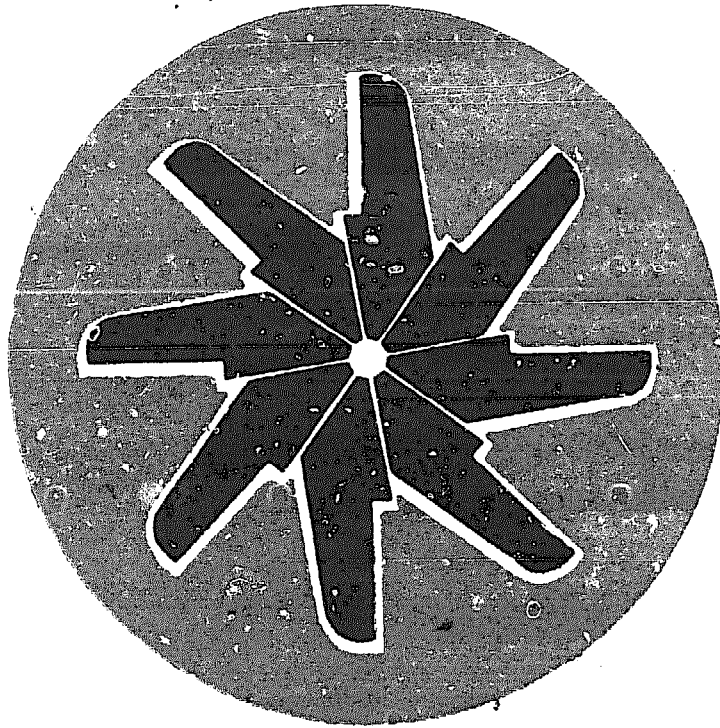
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**NEW HIMALAYAN
WATER WHEELS**



**A. BACHMANN
A.M. NAKARMI**

NEW HIMALAYAN
WATER WHEELS

ANDREAS BACHMANN
AND
AKKAL MAN NAKARMI

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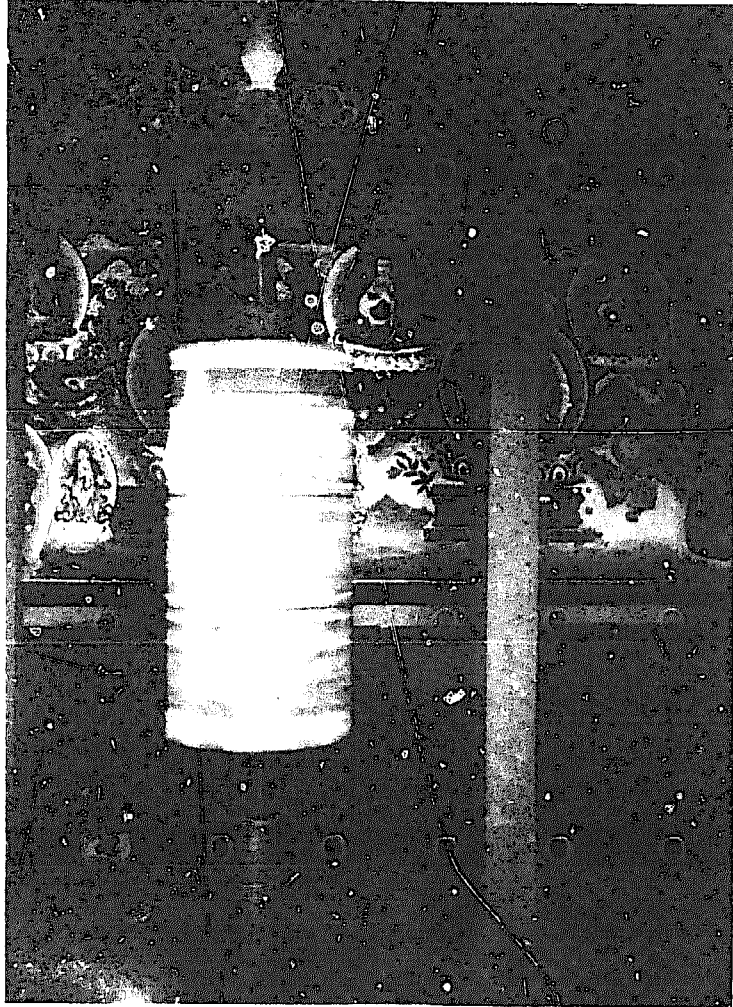
The improvement of traditional mills is a story in itself. Some of the first trials were considered, for example, by late Rev. B.R. Saubolle. We are also grateful to many people, especially to the farmers for their interest and cooperation, Jürgen Steiger (W.-Germany), Corneille Jest (France), Fritz Maurer (Bhutan) and organizations: the Agricultural Development Bank/Nepal, UNICEF, and others for their generous, steady support.

A very good incentive for continuing the search for alternative means of utilizing mini hydro power was provided by UNESCO and the German Nepal Help Association. UNESCO agreed to assist the implementation of a mini hydro project proposal, and the German Nepal Help Association is assisting pilot mill installations. We believe that such contributions are very useful for many people.

We are also thankful to Mr. Gerry Neville for his valuable assistance to improve this booklet.

We are grateful for this assistance in our search for alternative means of utilizing small scale hydro power. We believe that such efforts can have far reaching impact provided that the knowledge and experiences gained are widely disseminated, so that it reaches even the remote corners in developing countries, for we believe that it is people in these situations who stand in greatest need of help to make their lives easier.

Andreas Bachmann
Akkal Man Nakarmi



Water-powered prayer wheel
in the Himalaya.

FOREWORD

Water power is a recognized natural resource in Nepal. There are thousands of traditional water mills still in operation. Interesting enough, the same types of water mills were widespread in medieval Europe and played an important role in the earliest stages of industrialization.

Over the past, much effort has been experienced to improve the efficiency with which water power is used and modern turbines have been developed for farmers, or on large scale, water power for today's industrial needs.

On the other hand, until recent times, little effort has been made to improve the smallest scale water wheels which, even today, are the most widely dispersed means of using hydro power. This may have been due to uncertainty about the usefulness of such improvements. Until recent times efforts at improving mini hydro power systems have been hindered by lack of engineering expertise, and also by a scarcity of information on the subject.

The basic idea in developing alternative hydro power systems is to find ways to keep these small power sources useful and within the reach of rural people. Yet it is obvious that improvements such as faster grinding and the capacity to run additional machines, are often needed.

The designs presented in this paper show certain achievements, gained through mainly a practical approach. It is hoped that quite a bit proves useful for further design developments, and also for the actual construction of many more small scale power systems in the Himalayan mountains, and wherever else there is potential for such

power systems. It is not claimed however, that these first results are the final word on the subject. This recognises that much more work is necessary. It is hoped however, that this booklet will encourage further effort for the improvement of mini hydro power systems, and with stimulates the dissemination of information on these efforts.

INTRODUCTION

The utilization of water power for the grinding of wheat with horizontal water mills is an old tradition in Nepal. These mills, made locally in many parts of the Himalaya still serve a good part of the population, especially in the more remote areas. It is estimated there are between 25,000 and 40,000 still operating in Nepal alone, but reliable data are not available.

The people in the hills depend upon agriculture for their survival. They live scattered all over the country and are largely self-reliant. They do not yet have easy access to kerosene for lighting, and it will take quite some time before many of these villagers will have the chance to be connected to any central power supply.

Until recently the traditional technology of horizontal water wheels for agriculture processing was quite adequate for the needs of rural people. Now, however, with the increase in population the traditional patterns are changing. These days the limitations of the traditional mills -their low productivity and their capacity to only grind grain- are being more keenly felt. People often have to walk for hours to reach the nearest water mill. They have to wait for hours until their turn comes, then wait again to have their grain ground. After that, is the long walk back home. At home, other work will be waiting: oil expelling, rice hulling, food preparation, etc.

Their situation is becoming more critical: increasing population places greater strain upon traditional technologies; more and more time must be spent collecting firewood, family members have to wait longer and longer at

traditional mill sites. This demand for higher productivity has led some entrepreneurs to the conclusion that diesel motors, which are more productive, can therefore be more profitable. However, for these engines fuel must be imported, thus establishing dependency upon foreign suppliers. Precious foreign exchange is drained away from the country to pay for these imports.

DEVELOPMENT OF MODERN WATER MILLS AND MINI TURBINES

New water powered devices were introduced some two or three decades ago. Firstly the undershot wheel was developed, made of wood, and copied by various mill sites. With these larger water wheels more power could be made available for agricultural processes such as: grinding, oil expelling, rice hulling, rice flattening. These wheels were quite heavy, require much material for their construction and needed replacement every six to eight years or so. They also had a limited power production of approx. three to eight horse power.

Almost twenty years ago another type of turbine was developed at BYS: the propeller turbine. A few were made, but the idea did not really catch on and the production ceased.

A few individuals or small workshops developed their own designs, for example Overshot and Undershot Water Wheels, made of metal, etc. As they were a private initiative they did not become well known.^{1/}

In 1973/1974 a new attempt was launched, again at BYS. At first a cross flow turbine was developed and then installed at Baglung ^{2/}. Soon after the Butwal Technical Institute adopted the same type of turbine and other manufacturers followed ^{3/}. Nowadays approx. 150 of these are functioning all over the country. They are used for agro processing through belt-driven systems, and in ranges of 10 to 15 h.p.

Some efforts were also made with existing traditional water mills. There were trials with simple improvements on the lifting/lowering device of the grinding stone;

a power take-off derived from the upper stone; adding a small dynamo for lighting purposes, etc.

However, the ideas did not spread and this possibly for several reasons; for example, the trials were not successful enough, and specialists and organizations active in the field of hydro power did not, at that time, support the idea of such mini hydro power devices.

Then, in 1979 a Seminar-Workshop on Mini Hydro Electric Generation was held in Kathmandu. On this occasion Jean Gimpel brought several models with him. One of them demonstrated the principle of a "Bulgarian Water Mill" (which is quite similar to the present Nepalese design, but with some improved features on it. His idea was to use models as tools for technology transfer to rural areas. Though the improvement of traditional water mills was not really a new one he was successful in motivating people in Kathmandu to think over the existing, traditional water mills.^{5/}

Then in Godavari two sites were selected for pilot plant installations:

- 1) One version was made of wood for grinding purposes, which could also run a bicycle dynamo.^{6/}
- 2) At the other site was installed an early version of the Multi-Purpose Power-Unit (MPPU). This was made of metal and could grind, drive a rice huller, an oil expeller and a car dynamo. ^{7/; 8/}

Significant attention was given to these prototypes^{10/; 11/}
 At the Workshop-Seminar of Renewable Energy Resources in Kathmandu, 1981, the questionnaire filled in by the

participants showed clearly the interest and priority given to it. ^{12/}

CONVENTIONAL MINI HYDRO TURBINES

Traditional Water Mills no longer always meet the daily needs of rural people. The growing population demands more from machines than ever before. The traditional water mills have many advantages: the people are able to make these mills in their own surroundings. Wood and stones are the materials mainly used. A few iron parts are added: the bottom pieces, the upper part of the vertical axle, and the top key - which turns the upper stone. The hammers used to redress the stones are made of steel also.

As people can use materials from their rural surroundings the cost is almost nil. Work can be done anywhere in the fields: the grinding stones cut from a larger rock; the open chute cut from a nearby tree. Repairs are no real difficulty; local skills can maintain these machines.

Modern Metal Turbines: Developments have originated mainly from larger workshops. These workshops have the necessary machines for welding, turning, etc., whatever is required for precision and durable workmanship. The products reach a quite high standard and enable greater production in a relatively short time: identical turbines can be made in an assembly line.

Modern technology, often imported from the Western Hemisphere, can be much more productive. The constructions need often to be redesigned to suit local conditions. Almost all of the materials are imported (steel, bearings,

axles, etc.), well trained machanics produce the required turbines, and specialized fitters will install them at the sites. To run these machines a operator will need to be trained. Such installations are interesting where there is sufficient water and a good market for the processed goods are available. The initial costs are quite high.

Recognising the fact that rural people are in need of more productive water mills, preferably with multiple applications, alternative designs had to be considered.

THE MULTI - PURPOSE POWER - UNIT

The MPPU was developed to be an alternative to the existing traditional water wheel and to be an alternative also to the modern water turbines (above approx. 8 h.p.) Nowadays many have been installed, with heads ranging from 2.4 mtr to 30.0 mtr.^{13/}

With this concept farmers can have more efficient grinding and multiple application for other mechanical processing needs, at lower costs than previously known. Once such a installation proves to be too small for the increasing market, then the MPPU could be removed quite easily to another suitable site (say further up the Hills) and again be useful for many more years to the rural population.

The MPPU is a device constructed entirely by skilled people in a metal workshop. The installation is a matter of some days, done by specialized fitters of the manufacturing company. The rural people then need some training and experience on how to operate, maintain and repair

these new devices (MPPU, rice huller, oil expeller, small dynamo, etc.) ^{14/}

The MPPU requires, as other modern turbines, imported components, it is - as every thing comes from the mechanical workshop - fairly heavy and at its costs. These considerations specify the number of sites that are suitable for the MPPU: it is best suited where it can be quite productive.

From the various MPPU pilot installations the following were found:

- it was possible to use modern, but already available grinding devices and drive them with a simple turbine.
- a locally-made inexpensive model was feasible. Based on a modular design and built in standard sizes with portable components it proved suitable even for remote areas.
- it was possible, with better design, to upgrade existing traditional technology, resulting in a device readily understood by the people and easily installed at sites used for traditional machines.

The farmers reacted positively and with the further support of ADB/N and UNICEF (through their agreement to incorporate such devices in their assistance schemes) ^{15/} and also with the interest of Nepalese firms, the MPPU became quite popular and is being steadily improved. Within approx. 2 1/2 years over 75 units were ordered and produced.

Preliminary calculations on economy have shown promise for larger scale application ^{16/}, ^{17/}, ^{18/}, others doubt it ^{19/} though a thorough evaluation is still needed.

ALTERNATIVE DESIGNS FOR RURAL PEOPLE

Encouraged with the first results of the Multi-Purpose Power-Unit thoughts were given to a possible larger-scale production. People in rural areas are keen to improve their devices, as this gives them the opportunity using several devices and of increasing capacity. It is recognized that rural people may not have access to components made in workshops, and that they would also have difficulty in paying for them.

The main difference in an alternative device to the MPPU had to be that farmers and their skills would be involved actively in construction, thus minimising the cash cost. This also necessitates the use of as many materials from their local surroundings as possible (wood for structures, grinding stones, etc.). Installation would be done mainly at already existing, traditional water mill sites - as the existing infrastructure would enable quite fast installation.

Besides the locally available materials, items such as metal axles, bushes, dynamo, turbine runner and rice huller, produced in workshops are found beneficial. They improve performance, extended durability and increase the flexibility of the modified traditional device.

This lead to several devices having a "material - mix" (parts from both workshops and local surrounding).

Finally a construction kit for farmers / rural craftsmen was produced ^{20/}.

UNESCO accepted a small proposal on "Alternative Mini Hydro Power Development" ^{21/}. This consisted of the development of various devices. With this support, and in combination with other assistance from our side various small water wheels and turbines were developed:

- Cross Flow Turbine (wood)
- "Metal Pelton" (Low-Head)
- Water Wheel, with horizontal axle (wood)
- New Nepali Water Mills

WOODEN CROSS FLOW TURBINE

This was to investigate if a construction made of wood (with metal axle) is practicable and worthwhile copying. The results revealed considerable skill, and that the nozzle was quite difficult to make according to specification.

The test runs were with an open chute (to keep costs low), but the power output was not considered to be good enough and therefore this type of turbine, made of wood and used with an open chute, is not recommended.

"METAL PELTON" - LOW HEAD

Quite often horizontal axles are preferable. This type was made to determine its usefulness. The same spoon-shaped blades as the MPPU turbine wheel are used. The difference to the MPPU is the horizontal axle, thus

resulting in a "Metal Pelton". These spoons are welded to a metal hub and reinforced by a metal rim fixed to the outer sides.

The test runs were made with a metal penstock, with a nozzle at its lower end. The turbine gives quite stable r.p.m. and produces a useful amount of power at quite low cost.

WOODEN WATER WHEEL - WITH HORIZONTAL AXLE

In Bhutan numerous simple water wheels with horizontal axles serve the rural population very well. These water wheels are driven by water delivered by open chutes.

It was recognised that with some changes in the design, efficiency could be improved. Based on a picture of a medieval European design different parts of wood were assembled ^{22/}. These formed the "spokes" to hold the curved blades made of wood (or if required also made of thin metal), and also to house the metal horizontal axle.

The curved blades were cut by a carpenter and bolted to the wheel. The design was tested in Namseling, near Thimphu in Bhutan. Even with the traditional, open chute, the power output - measured by the production of a rice huller - was about doubled, compared to the traditional, horizontal-axle water wheel.

The new assembly proves advantageous over the traditional design for reasons of its efficiency and the ease of construction (no central hub is required).

This device is useful where power requirement is quite low, where wood is readily available and preferably in non-freezing areas, since wood is damaged when it absorbed water freezes.

NEW NEPALI WATER MILLS

The results of many previous field trials led to the development of the "New Nepali Water Mills".

Firstly, based on the MPPU-experience, other ideas were tested. Using the same runner, but in a "door frame" construction an installation was made at Naubise. The grinding is done with a set of local grinding stones. The open chute made of wood was replaced by a metal pipe (the miller insisted on it). Previously it was believed that a penstock (pipe), bearings and "synthetic" stones (emery) are essential parts for improvement of performance.

This unit grinds easily three to four times more and can also run a small dynamo. The problem of running conveniently a rice huller was not solved (the upper stone would have to be lifted -respectively removed- so to enable the power take-off from the main pulley). The miller did not show sufficient interest in hulling so the unit turns as it is. This problem could be solved: a) by having a simple stone-lifting device (as seen in illustrations of European mills ^{23/}) or b) by incorporating a simple shaft-coupling.

The next development was that the grinding part was kept separate from the water turbine, being connected with a

belt. This has several advantages: the speed of the belt-driven machines can be adjusted by using different-sized pulleys (quite slow grinding is required for good tasting flour and by using natural stones which are just laid on each another). More importantly, the water power can easily be used for hulling, etc., (as the grinding part can easily be "cut-off" by simply releasing the belt from the pulleys). Also, the speed of the belt-driven machines can be adjusted by using different-sized pulleys.

Attention was paid to keep such "New Nepali Water Mills" within the reach of rural people: using local skills and materials for the structures, the supply of local grinding stones and the water chute made of wood. For the improvement of efficiency and durability and very practicable technology-transfer, consisting of all metal parts. Where such samples are constructed, also in remote areas, the patterns and kits of metal parts are provided, the technology-transfer is very likely.

CONCLUSION

Recognizing the potential of tens of thousands of water mills it is certainly worthwhile to upgrade traditional expertise by incorporating new experiences. This will give rural people:

- quicker improvements in their own, decentralized technology
- faster grinding
- income raising through cottage industry
- small sources of light
- etc.

Our latest findings show that it is possible to improve the grinding efficiency by several times, even with the traditional grinding stones and the open water chute. In addition people can hull their rice and have a small light.

Much of the improved water mills can be made by rural craftsmen , and with materials from their local surroundings. They may need a supply of some metal parts and small machines, such as a rice huller, dynamo, etc.

Utilization of Nepal's vast resources of hydro power potential is receiving more emphasis. Electricity is readily thought as a means of supplying power needs. There is no question that electricity is a very versatile energy source. With extensive distribution grids energy for manufacturing and household needs can be supplied to many people, provided they live near these

grids, and can afford the cost of a mains connection. Electricity from the mains, useful as it is, will for many years to come, be available for urban settlements and a few centres, but not for the remote villages - which represent the large majority of the population.

Water power has been most highly developed in the West and ideas from there have been adapted to suit local requirements, and several small turbines can be produced within the country. It is normally assumed that what is more efficient will produce more, and this is true when the raw materials are available and the products saleable. The following definitely are very important:

- time factor (survey, installation time)
- existing infrastructure (trad. mills, market patterns, irrigation, etc.).
- low initial investment (less security required to receive bank loans, less risk, faster return)
- simple designs that can be run by traditional millers and also easily be maintained and repaired.

Water power can be used very efficiently to directly run machines by belts, or even more simply by turning grinding stones directly through a vertical shaft. The latter has been done in the Himalayas for centuries and is still the most common use of hydro power - in many thousands of water mills.

Low cost water mills have been made for a long time. The rate of horse power production by the traditional type

is low compared to the modern metal one. Significant contributions to upgrade traditional mills can further be developed by the country's own mechanics and engineers. However, a prospective manufacturer of these low-cost small turbines cannot expect to make a living out of it, as most of the work is done by the rural people themselves. This is probably one of the reasons why very few manufacturers are willing to assist in developing such small devices. Here comes possibly the question of enthusiasm and possible incentives to be provided.

With the demand of more productive units new thoughts are necessary to increase not only the capacity of grinding, but also the multiple application of even small-scale hydro power. For improvement of efficiency the common criteria are the low-head and low-cost. Also very active involvement of rural people for construction is essential (and the extreme dependency on metal workshop for the entire settings - as known from modern turbine sites - needs to be drastically reduced). Moreover, where such "home-made" devices are installed people in rural areas will most probably be able to maintain and repair these installations.

With these first successes technology transfer to and within rural areas has been initiated. What is required is demonstration of these improvements to local people so they might be encouraged to adopt them.

Water-powered devices are only one of several possibilities for overcoming the growing shortages of power in remote areas. Animal power, improved utilization of biomass &c., are other energy sources that may help. All should meet the two criteria: low cost and applicability largely without dependence on outside inputs.

Enthusiasm and skill; education; dissemination of information and other support is essential for wide-spread application consequent increase in self reliance of rural people.

TRADITIONAL WATER POWER UTILIZATION

Horizontal water wheel
for grinding.



Water-powered prayer
wheel

Wood works, powered by
a horizontal-axle wheel.

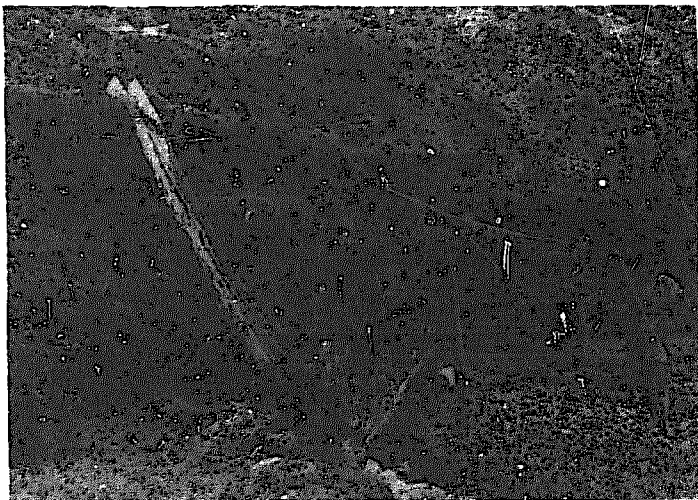
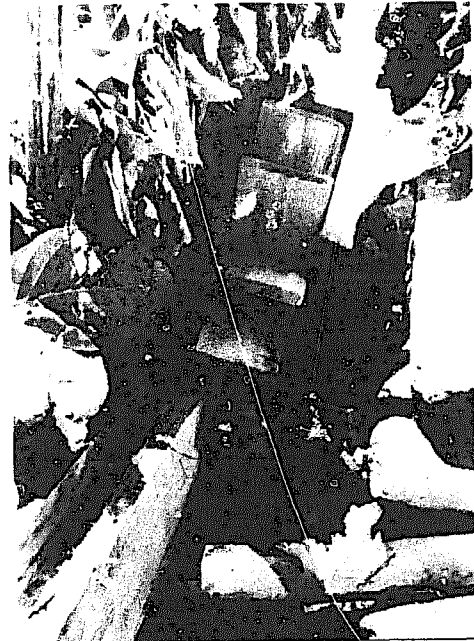


TRADITIONAL WATER POWER UTILIZATION



Wood turning with a simple water wheel. The small wheel is on the same axle and fitted directly behind the leaves.

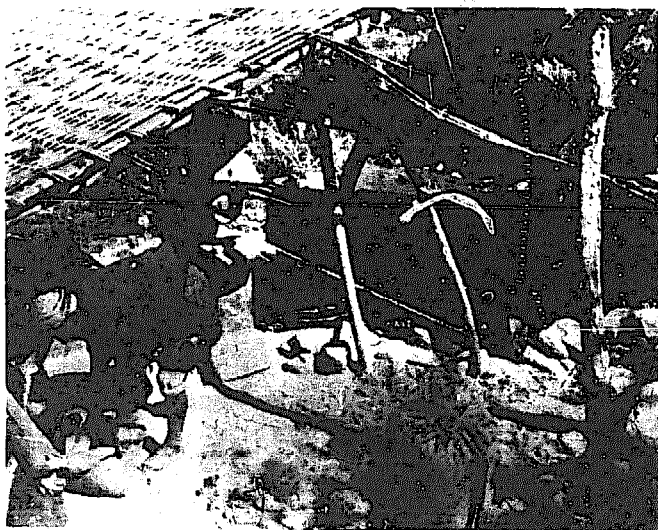
The water wheel with the horizontal axle (seen from above). The shaft is extended to house the wooden cylinder for turning on the other side.



The rural workshop for wood turning. Water is taken from a small irrigation canal, the small water wheel is fitted at the lower end of the open chute.

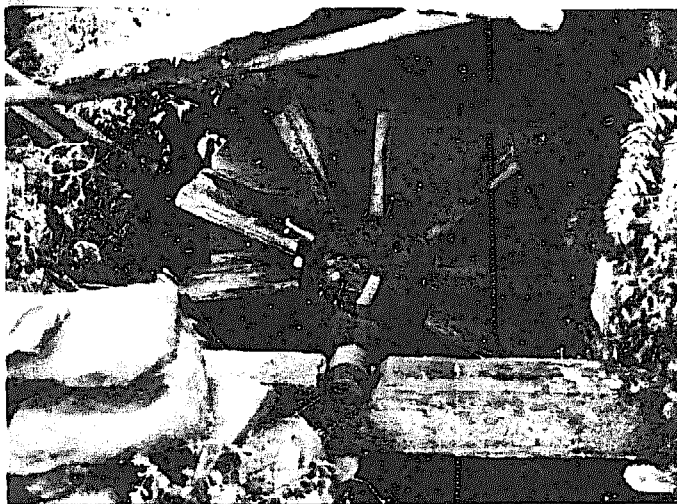
TRADITIONAL WATER POWER UTILIZATION

A small installation for rice hulling. Water is directed to the small water wheel, through an open, wooden chute. The horizontal axle is extended through the wall, where the pulley is fitted.



The rice huller (on the stand) is connected to the pulley, made of wood, by a flat belt.

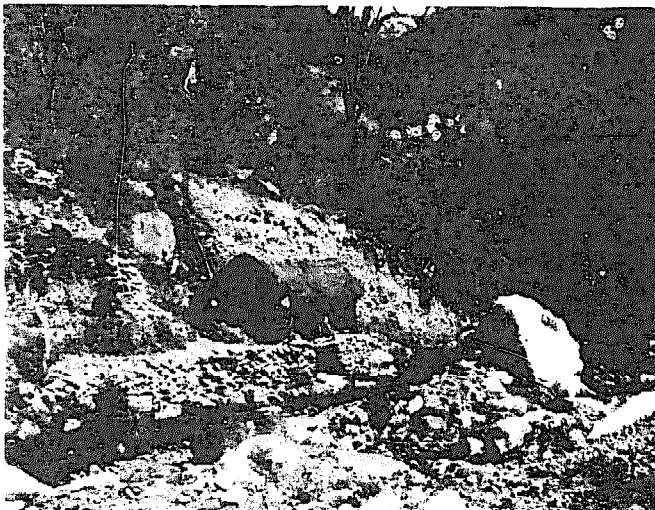
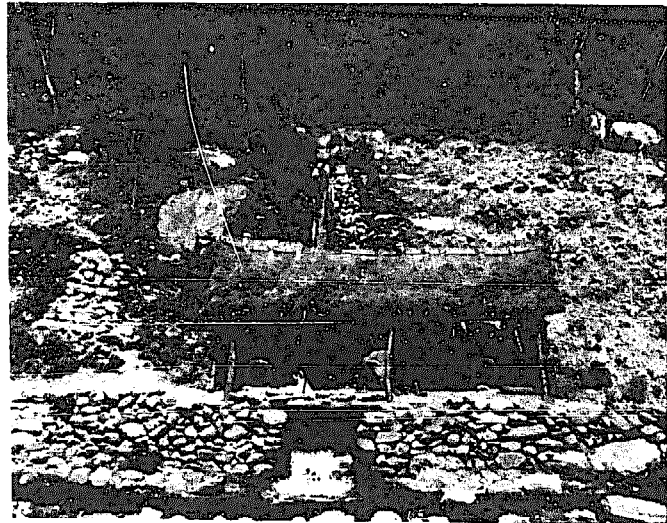
A simple small water wheel, with horizontal axle (made of wood). The open chute on the left.



TRADITIONAL WATER POWER UTILIZATION

Horizontal water wheels are being used traditionally for many centuries. There are still many thousands in operation.

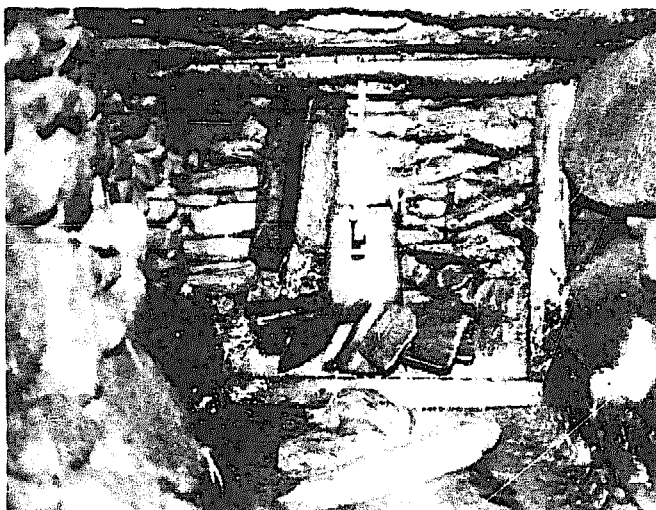
A simple grinding place, water wheel is below the floor level.



Side view; water is directed to the water wheel through an open chute made of wood.

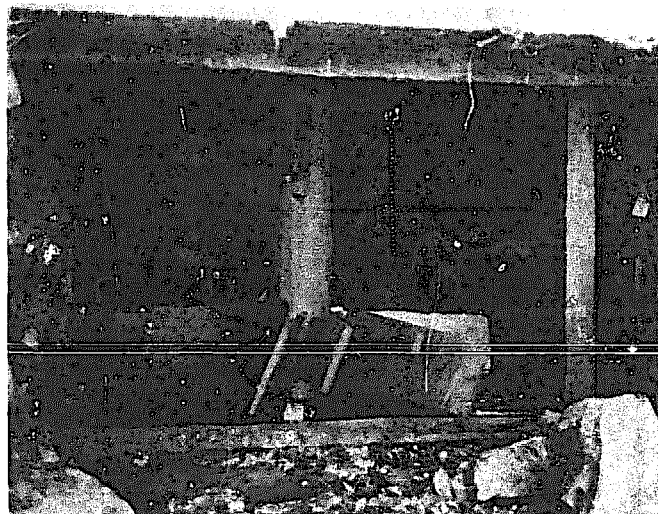
TRADITIONAL WATER POWER UTILIZATION

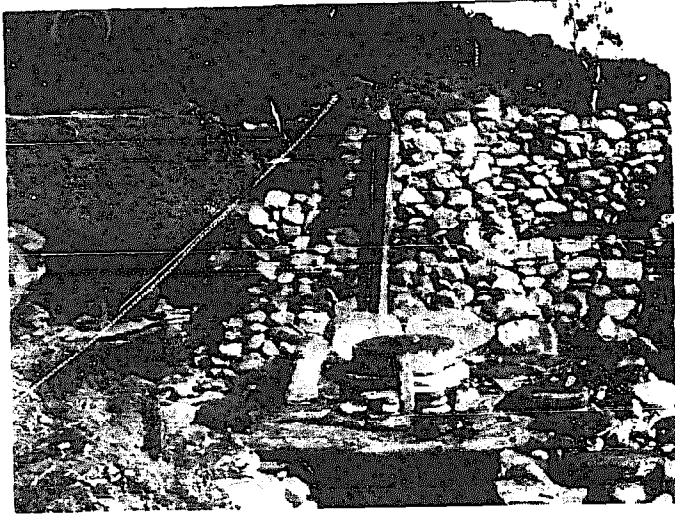
Horizontal water wheel with vertical axle. The bottom pin rests on a lever arm. This arm can be lifted from above and enables adjustment of gap between the two grinding stones. Open chute on the left, behind the wheel.



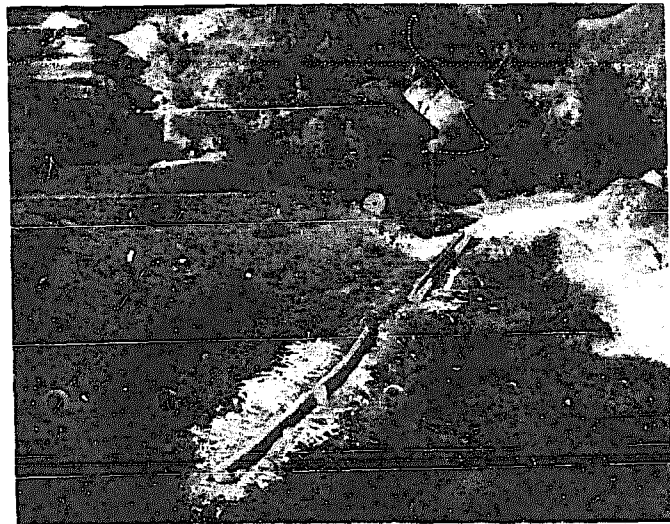
A horizontal water wheel of good quality. Stones and freezing climate is harmful to such devices.

In very remote areas some millers still use stones at the bottom of the vertical axle as a pin.



TRADITIONAL WATER POWER UTILIZATION

A construction site of a traditional water mill. Note the open chute with its lower end becoming narrower. The lever arm (lifting device for stone) can be seen in front of the grinding stones.



The open chute, made of wood, can be cut near the mill site.



Grinding stones are cut from rocks nearby. They may last for two to five years, depending on hours of operation.

TRADITIONAL WATER POWER UTILIZATION

The upper stone is the rotating one. Here the miller cuts the slot required for the forged iron key.



Father and son are working on the adjustment of the upper stone (stone seen from below). The iron key has to sit properly in the stone.

A miller dresses the upper stone; the lower stone is in the floor just in front of the man. This may need to be done every few weeks (or days) depending on working hours and on the quality of the stones.

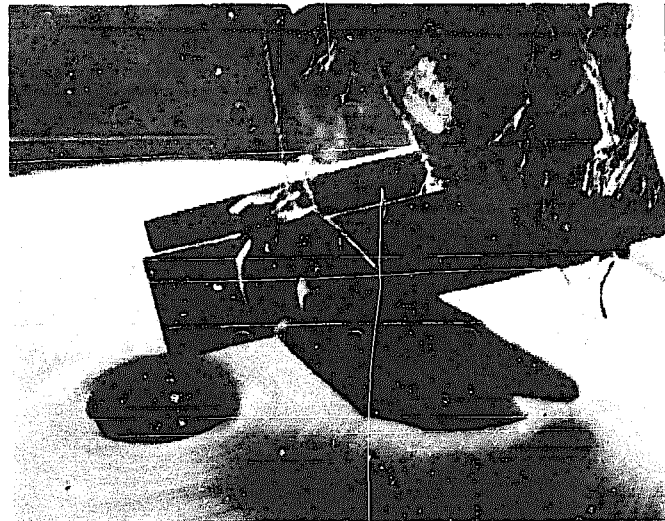


TRADITIONAL WATER POWER UTILIZATION



A mill house at high altitude. Here the grinding stones have grooves.

A "bird" (wooden piece) is loosely fitted to the grain feeder canal; the lower part rests on the grinding stone. The rough surface of the rotating stone keeps the hopper in motion.

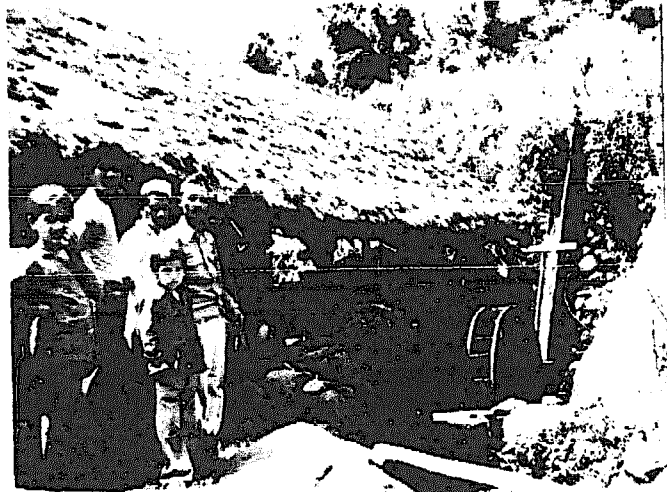


The upper stone is the rotating one, in counter-clock direction (seen from above). The flow of grain into the centre hole can be adjusted by lifting or lowering of the grain feeder canal: a string is fixed to a small stick.



TRADITIONAL WATER POWER UTILIZATION

Undershot water wheels, made of wood, can often be seen in rural areas.

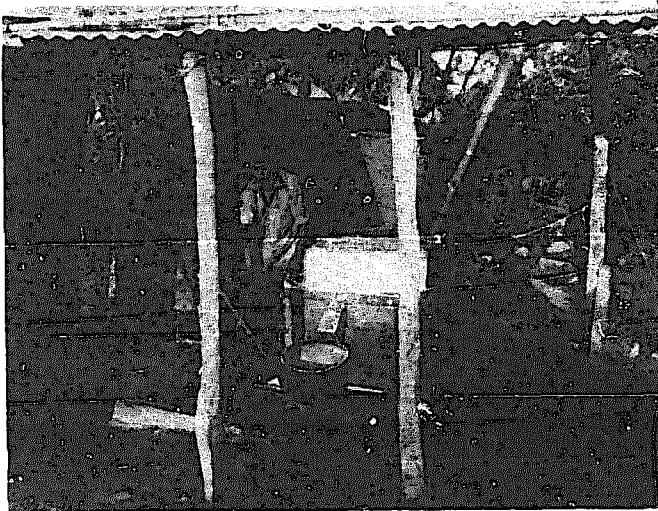


This one drives a grinder, a rice huller and a small crusher.

Nowadays these devices are losing the interest of millers and are sometimes replaced by modern turbines.

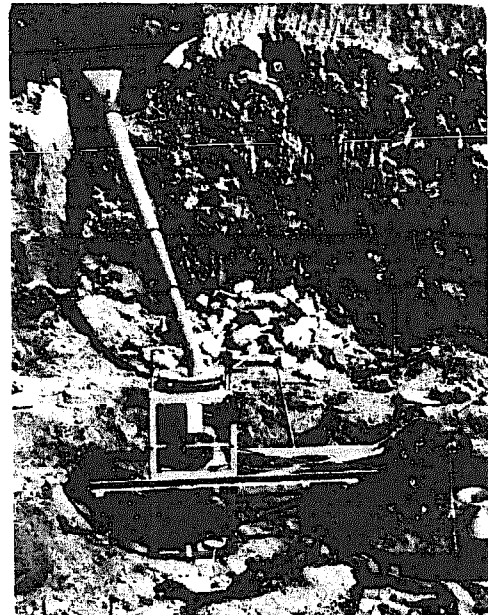


MULTI - PURPOSE POWER - UNIT (MPPU)



The first Multi-Purpose Power-Unit (MPPU) on a test run in Godavari, September 1980. The operator is busy with a small rice huller driven by the MPPU.

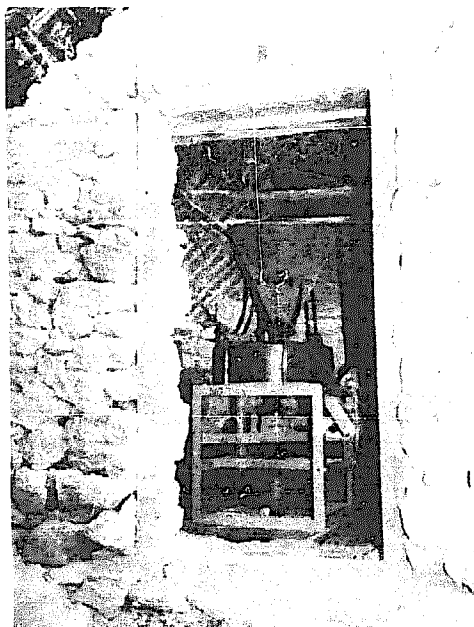
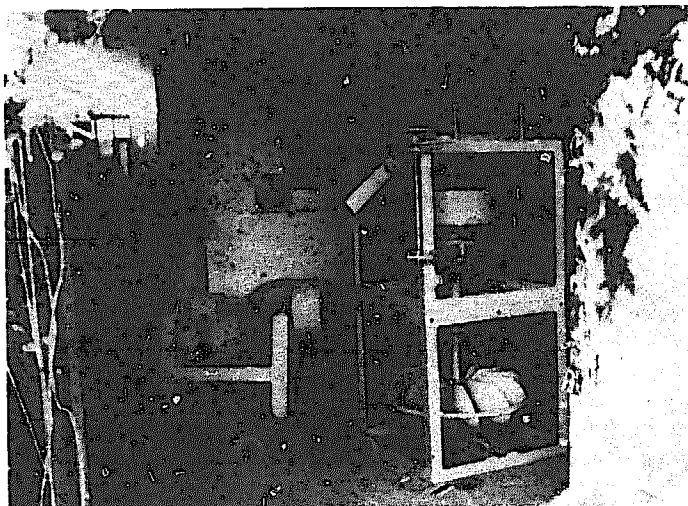
A site of a MPPU installation. It could drive different machines after five days.



A new, small mill house with a MPPU in the hills. The low head requirements enables the installations at traditional mill sites.

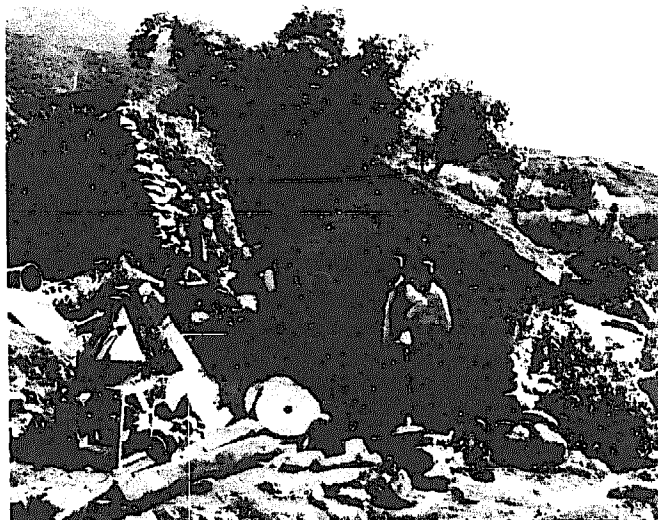
MULTI - PURPOSE POWER - UNIT (MPPU)

A MPPU at the workshop ready for dispatch.



MPPU fit in existing small mill houses, with low head. They enable higher productivity and multiple application.

A traditional mill has been removed and was replaced by a MPPU. It is now a community-owned mill, under the "Small Farm Family Programme" of ADB/N and UNICEF.



MULTI - PURPOSE POWER - UNIT (MPPU)



MPPU grinding wheat. The small dynamo (12V-DC) provides little electricity sufficient for few lights.

This set drives the grinder, a small rice huller and a dynamo.



The MPPU is designed as a modul and in standard sizes. The parts are in porterable loads and can be easily assembled at the site.

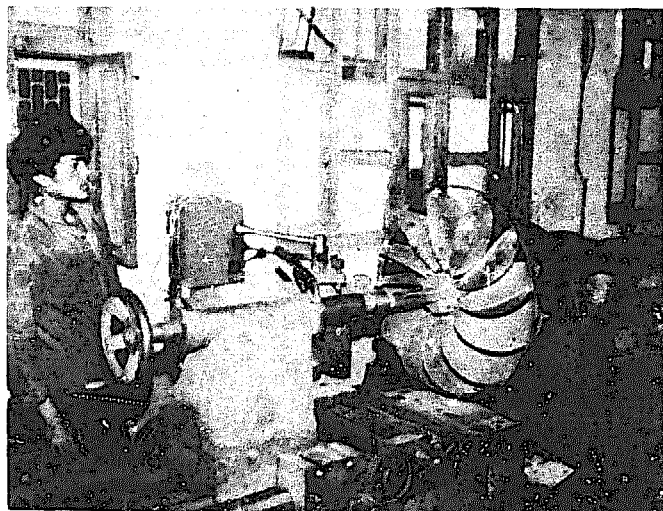
MULTI - PURPOSE POWER - UNIT (MPPU)

The spoon-shaped blades for the turbine runner are forged into a mould (the same runner is used for the MPPU).

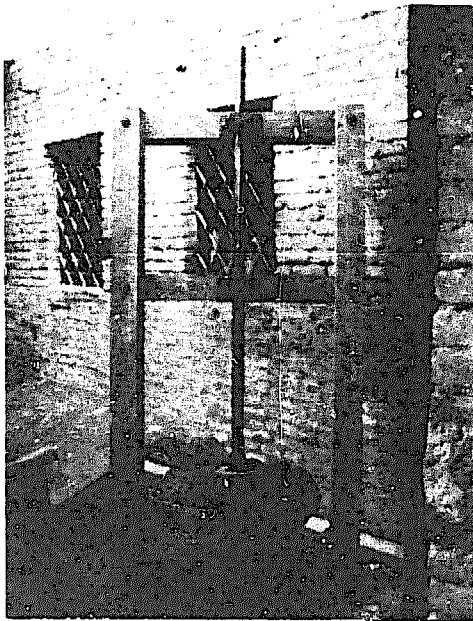


Turbine runner being assembled at the workshop.

Final adjustment on the lathe.

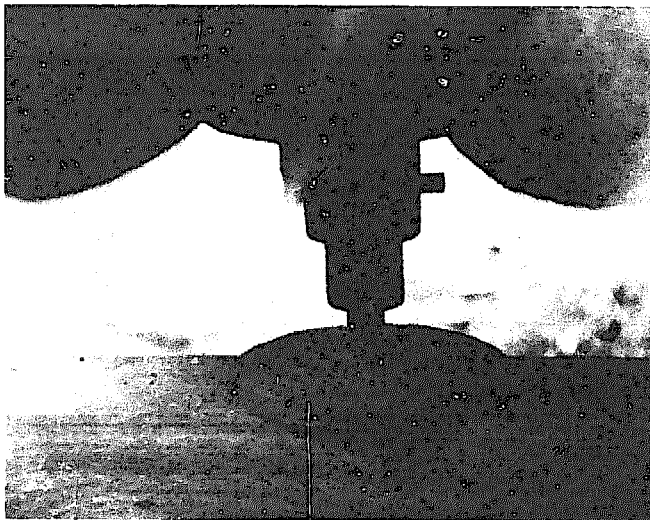
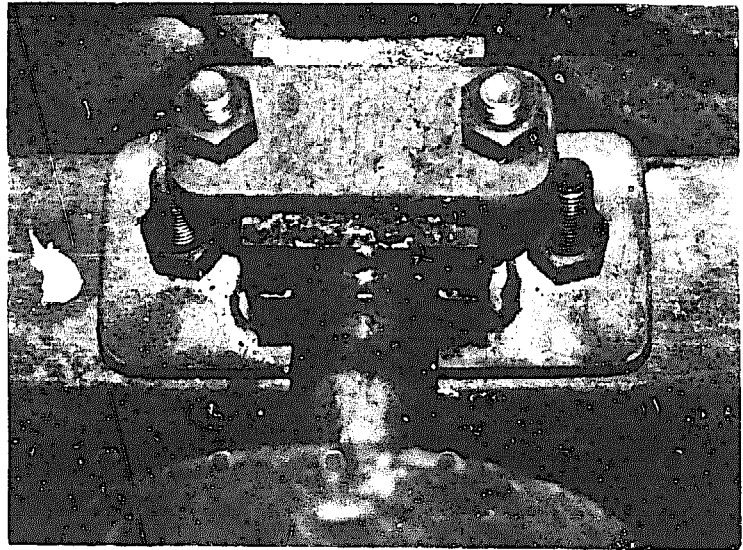


NEW NEPALI WATER MILLS



A "New Nepali Water Mill", fitted in a door frame, ready for installation. The metal parts are made in the workshop (runner, axle, bushes). The wooden frame can be made by people in remote areas.

A prototype of a newly developed bronze-bush and holder. The bronze-bush could be replaced by a good quality oil-soaked wooden block.



The bottom pin of both axles, that of the turbine runner and that of the grinding part can easily be removed for replacement. The bottom plate, of cast iron, can simply be shifted to the next small cone, when worn-out.

NEW NEPALI WATER MILLS

"Door-frame" constructions enable easy entering through the small doors.

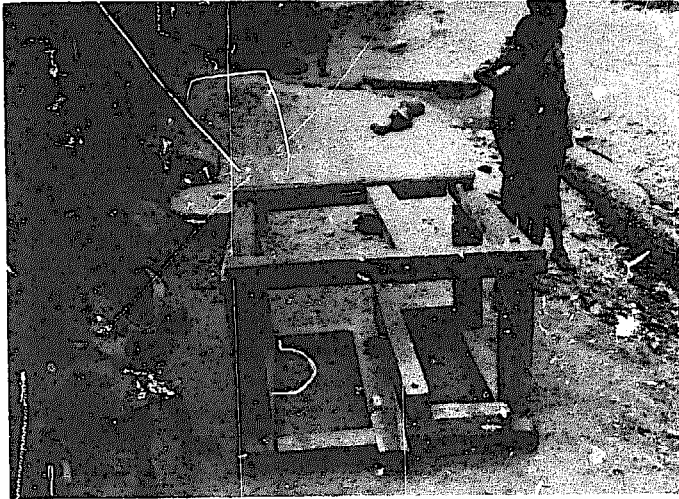


A New Nepali Water Mill, fitted at an old site, using the traditional stones, with a metal runner beneath, and a metal penstock. The grinding capacity has been increased from one to three, approximately.

A locally-made dust-cover fitted over the faster turning grinding stones.

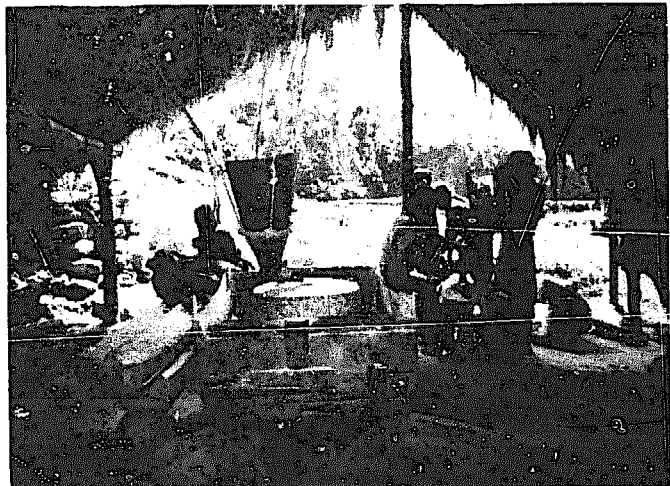


NEW NEPALI WATER MILLS



Wooden stand for grinding stones nearing completion. The miller has been provided with the metal parts and the instructions on how to make the wooden framework.

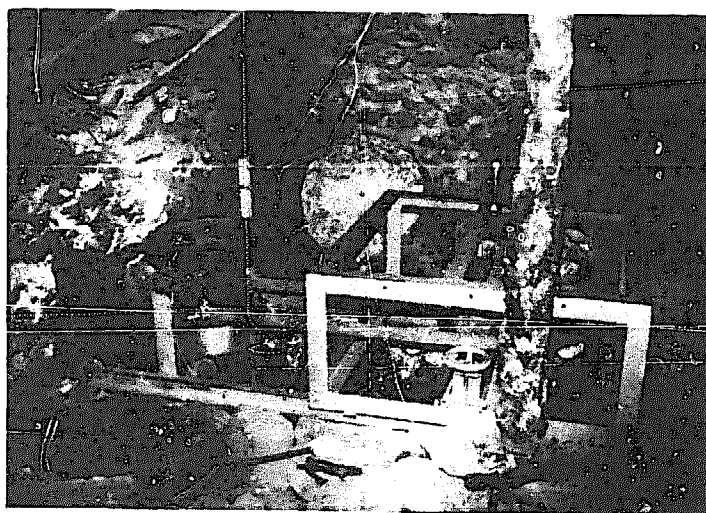
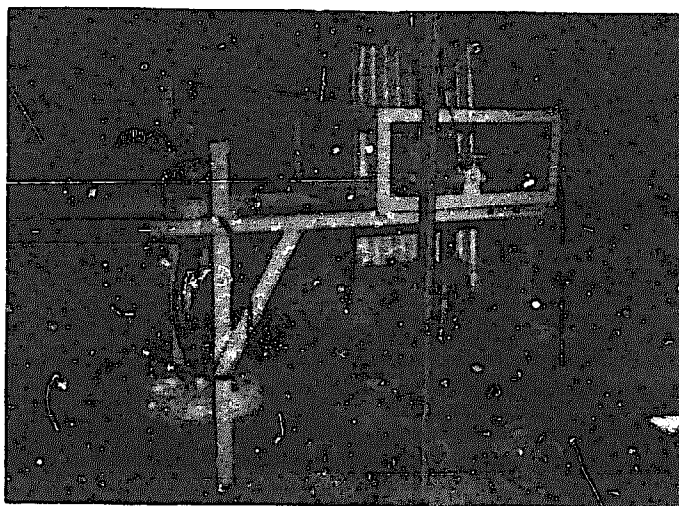
The grinder made with the "material-mix": grinding stones and frame from nearby available materials; the metal parts supplied as a "construction kit" from the mechanical workshop. The operator handles a small rice huller run from a New Nepali Water Mill.



Front view of the same installation: the power take-off (axle with three pulleys) transfers the power of the turbine (top most pulley) to the rice huller and/or grinder.

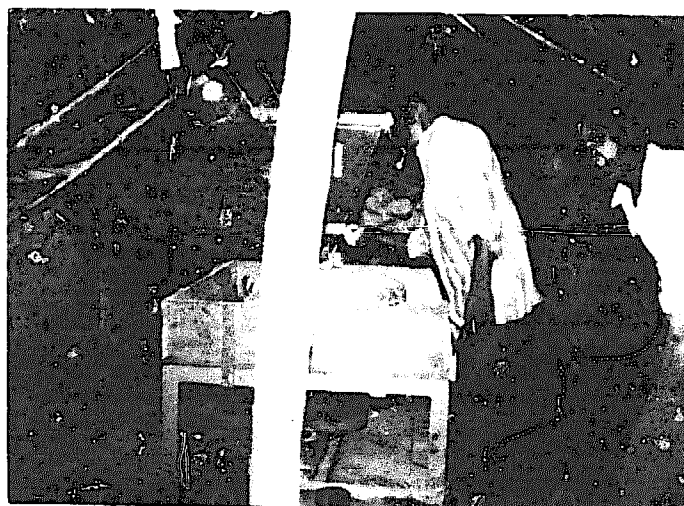
NEW NEPALI WATER MILLS

A prototype of a New Nepali Water Mill under construction. Here the grinding unit is separate being connected with a flat belt.

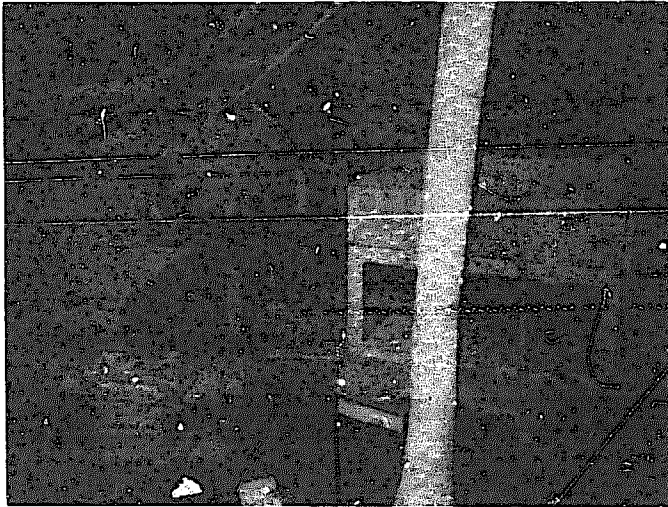


The unit under installation.

A test run for grinding and small electricity generation (note the light).

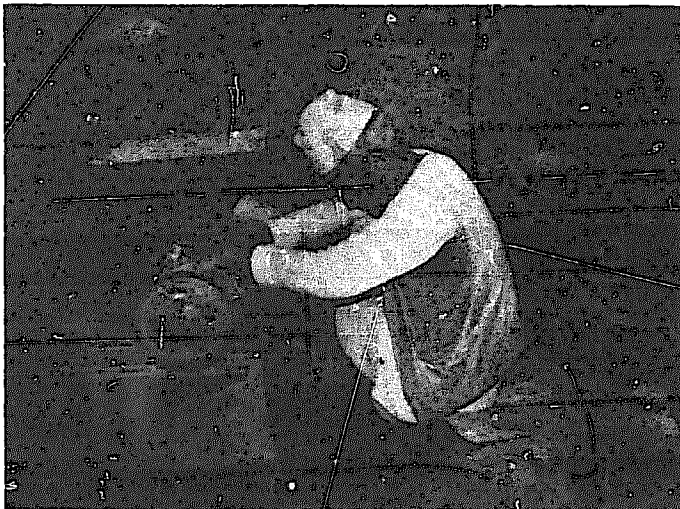
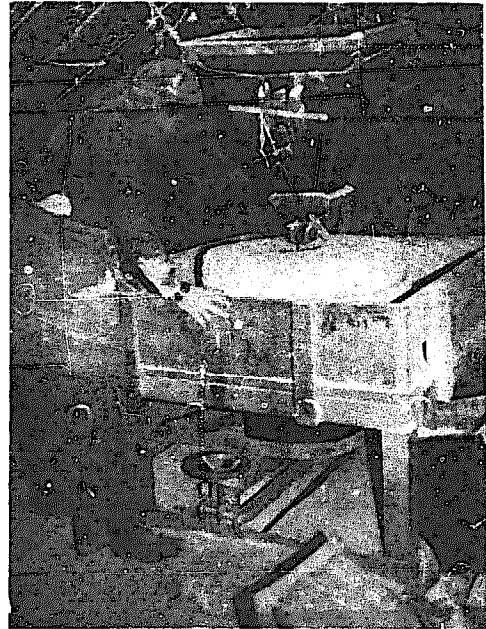


NEW NEPALI WATER MILLS



The setting of a New Nepali Water Mill. The turbine runner is below the flywheel (middle, behind).

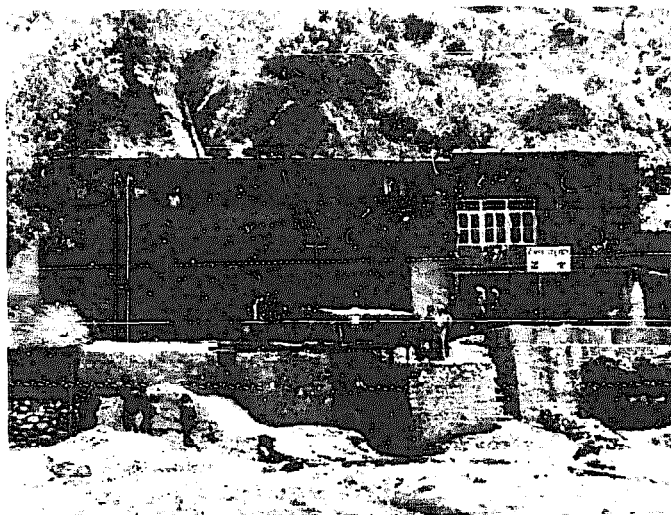
Increased productivity with local grinding stones, with the same head and open chute.



Rice hulling as multiple application (the grinder can be "cut-off" by simple removing of the belt).

NEW NEPALI WATER MILLS

A water-powered processing center at Malekhu.



The clever miller realized that he could use also the remaining three meters head (tailrace of a larger turbine) and fitted a MPPU-turbine, with extended shaft.

This small turbine drives a 1 kW - 220V alternator and with this the nearby bazaar receives electricity for 25 lamps!

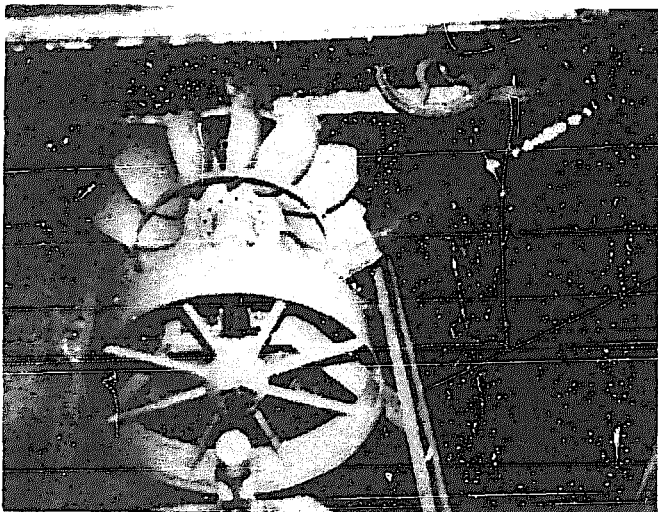


NEW NEPALI WATER MILLS



A horizontal-axle "Metal Pelton" being assembled. It is made for low-head application; using the same spoon-shaped blades as the MPPU.

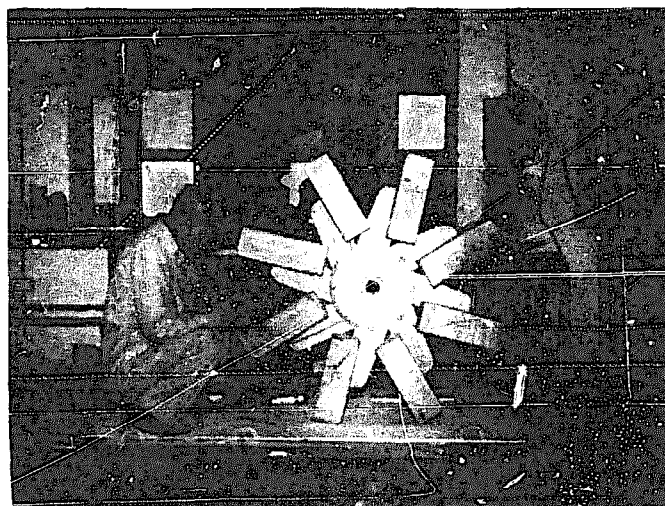
The installation of a prototype at the site.



Test-run of such a low-head "Metal Pelton", which can drive rice hullers, etc.

NEW NEPALI WATER MILLS

A prototype assembly of a small water wheel with horizontal axle. This construction has curved blades for increased efficiency. It is designed to enable rural craftsmen to make more efficient devices by themselves.



The small water wheel, made of wood, at the test site in Namseling, Bhutan. The first test showed that the efficiency (rice hulling) could be about doubled as compared with the previous design with flat paddles.

Namseling, the site of the wooden water wheel with horizontal axle. The wooden chute directs the water to the wheel below (left)

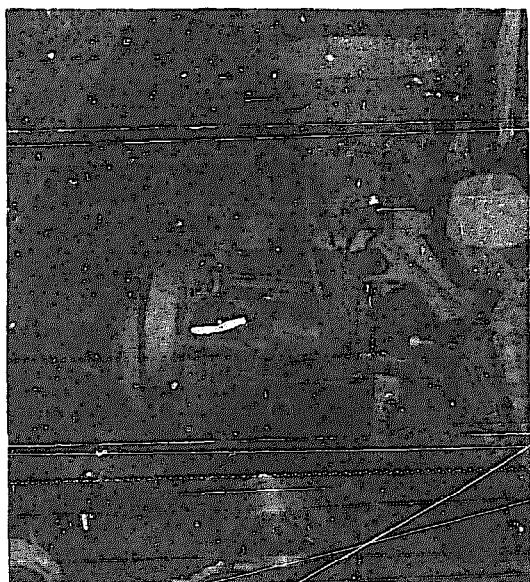
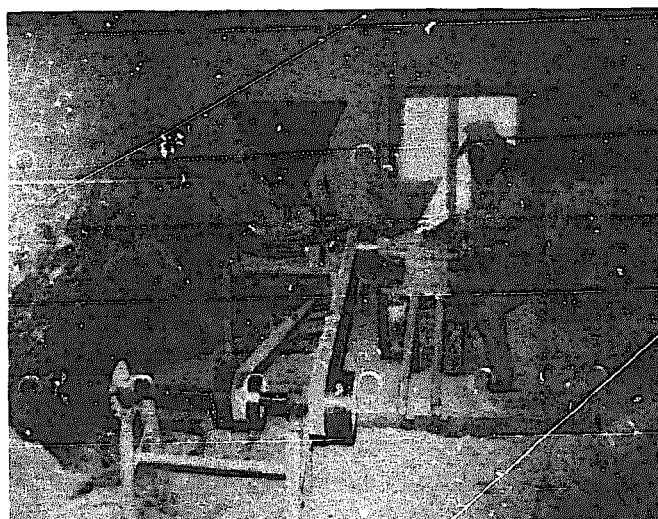


NEW NEPALI WATER MILLS



Efficient grinding at sites of traditional water mills, with multiple application.

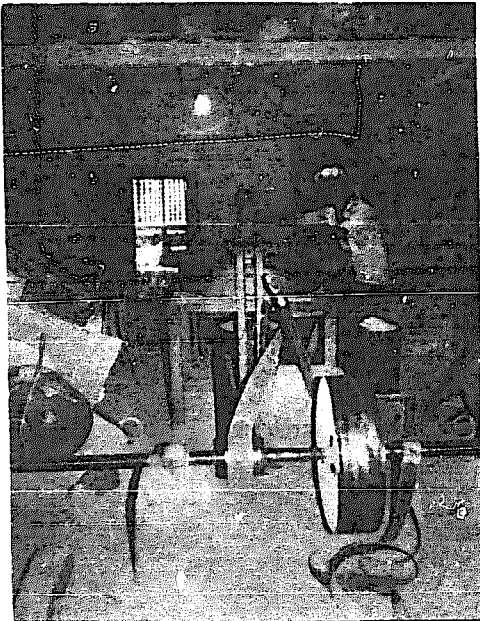
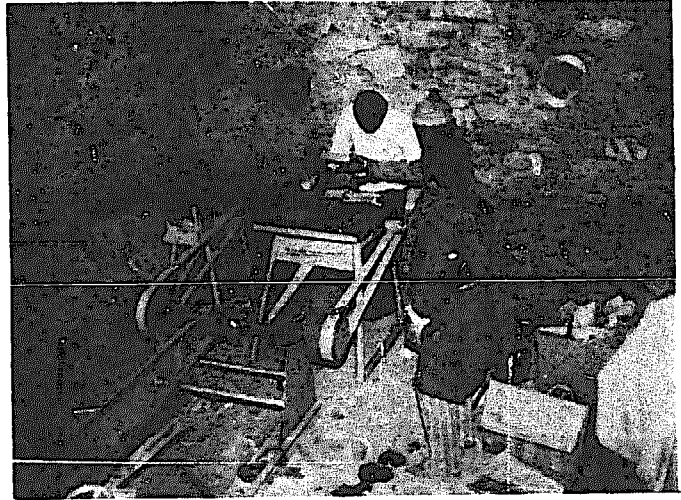
Rice hulling with low-head water power.



Baby-size oil expeller, driven by a MPPU.

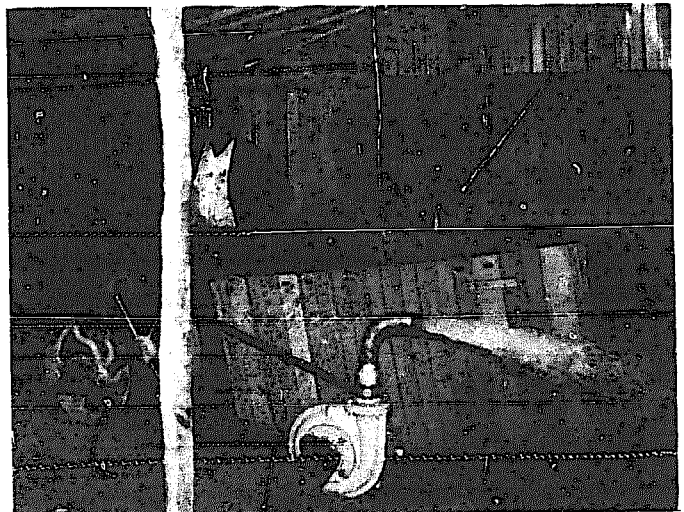
APPLICATIONS

Demonstration of a belt-driven wood planer and of a circular saw.

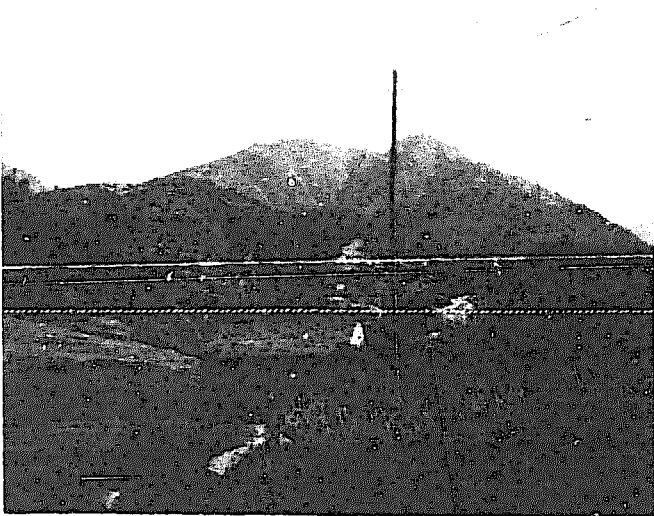


Rice flattener, belt-driven

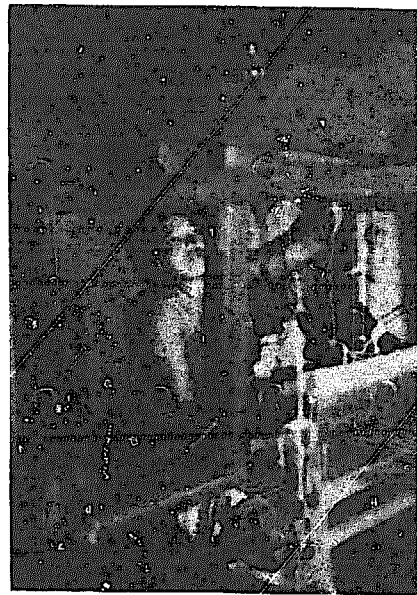
Small-scale irrigation



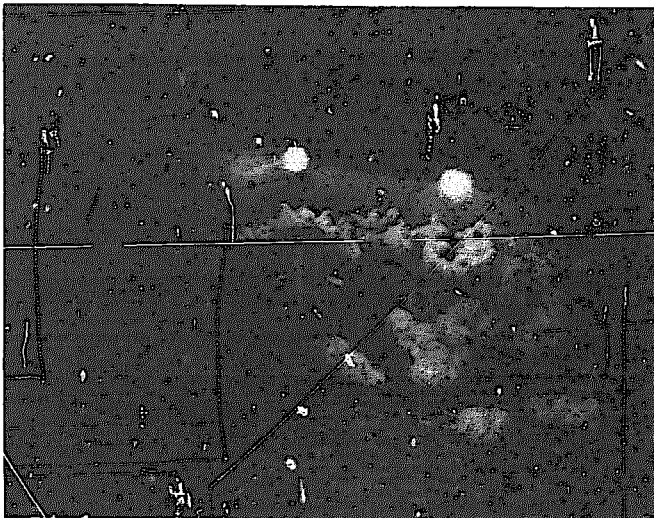
APPLICATIONS



Small water turbines can generate electricity for nearby users.



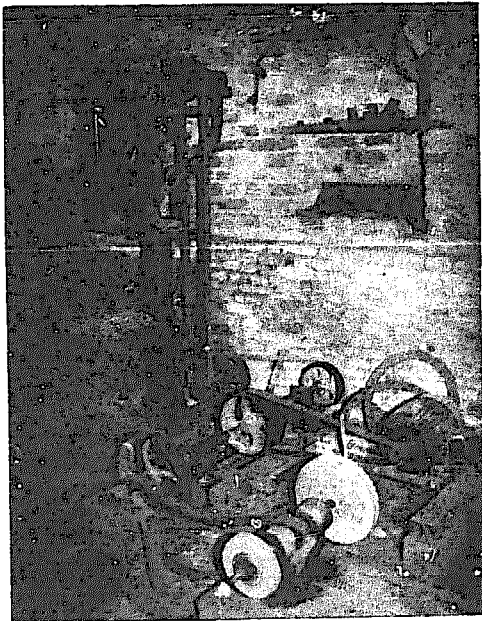
Electric light does improve working conditions for cottage industries.



Small electric lights can prove useful, for example for chicken raising, etc.

APPLICATIONS

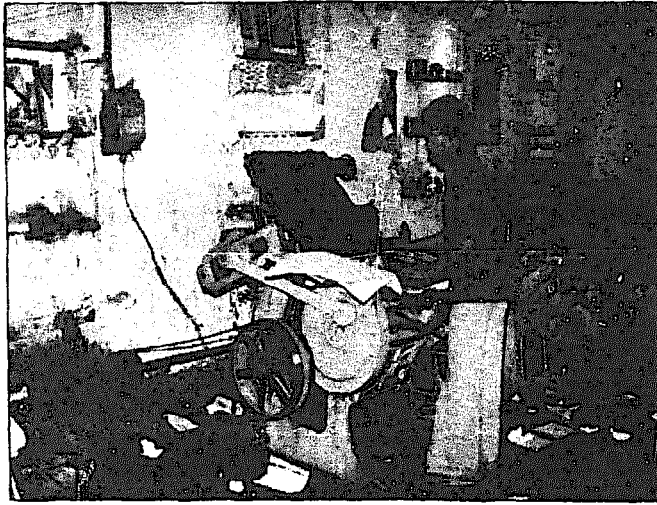
Threshing machine, driven
by a small water turbine.



Drilling machine with
belt-drive (here shown
with electric motor).

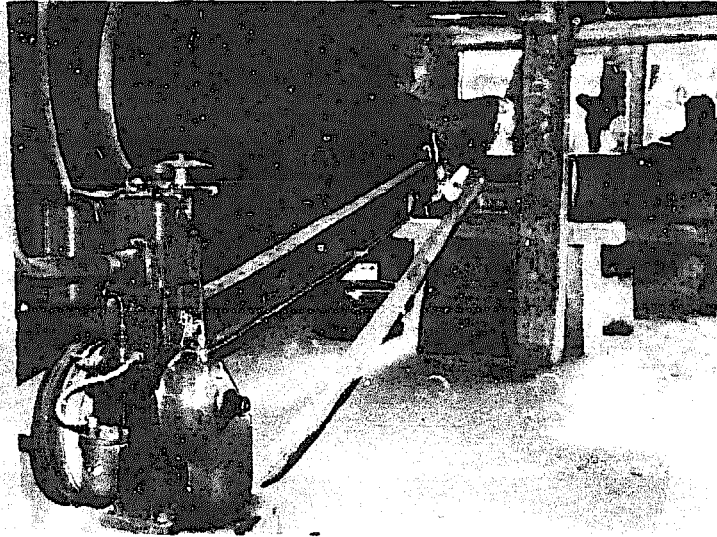
A belt-driven lathe,
(shown with electric
motor).



APPLICATIONS

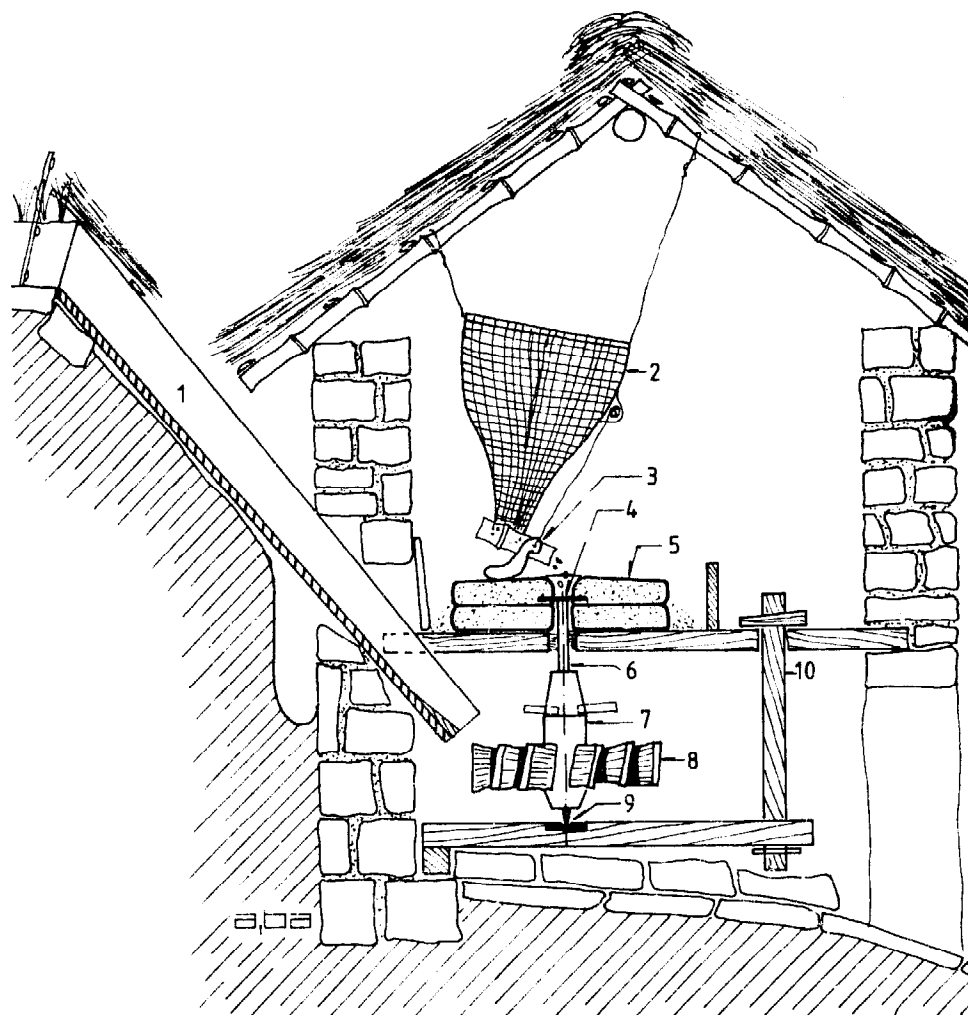
Printing-Press with belt drive - could be run by a small water wheel.

Modern times require often improved efficiency. Sometimes this is achieved by simply buying diesel motors - with this currency is exported to buy the fuel!



Some traditional mills are out of function for several reasons. With the upgrading of the traditionally-proven technology many can be kept alive for future services of people in rural areas.

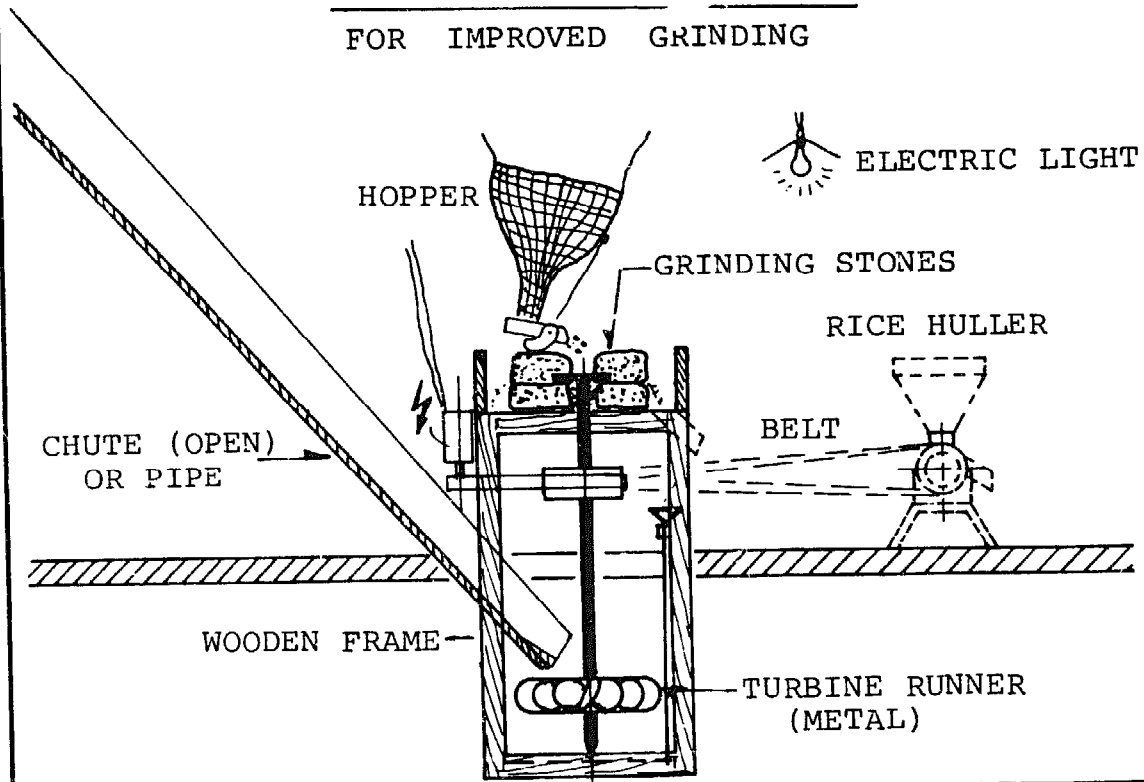
TRADITIONAL HORIZONTAL WATER MILL



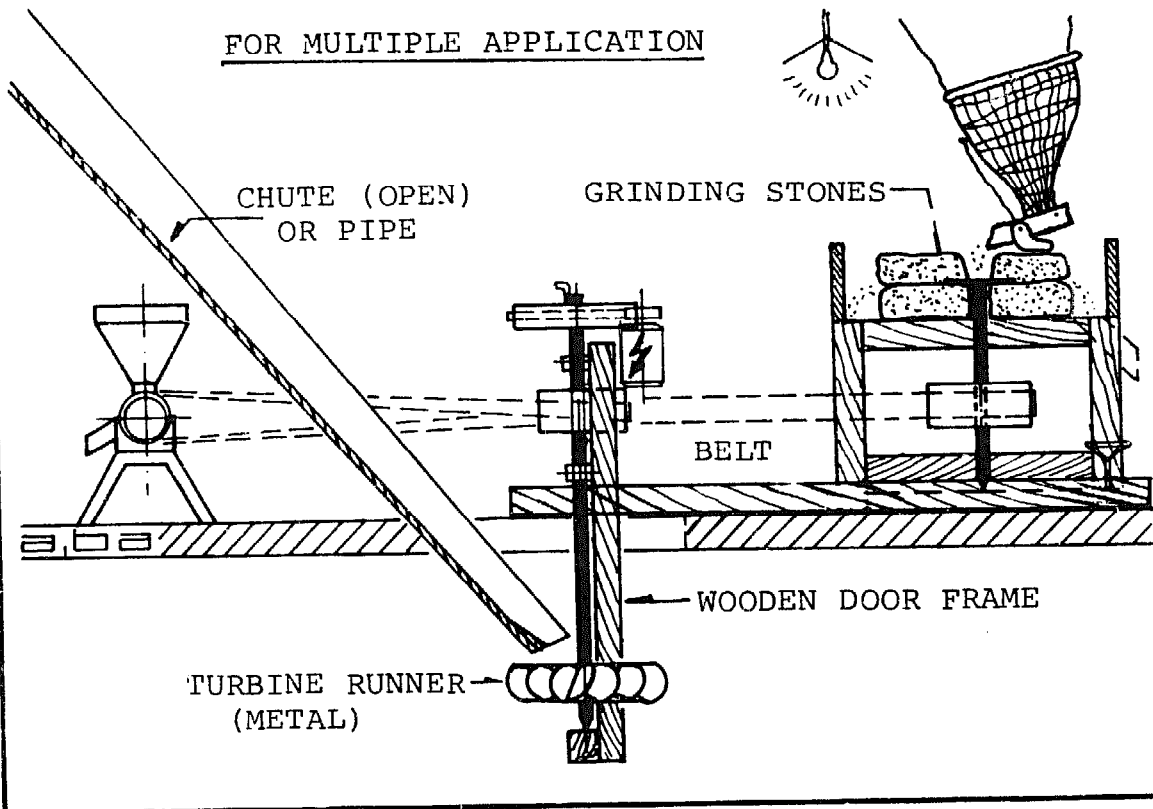
- | | | | |
|---|--|----|--|
| 1 | Chute, delivering the water to the side of the wheel behind the shaft. | 6 | Shaft, metal |
| 2 | Hopper (basket) | 7 | Hub, wood (thick shaft) |
| 3 | Bird (Vibrator) to keep the grain moving | 8 | Wheel or tirl, with obliquely set paddles on thick shaft |
| 4 | Rynd (forged metal piece) | 9 | Metal pin and bottom piece |
| 5 | Grinding stones | 10 | Lever, lifting device to adjust gap between grinding stones. |

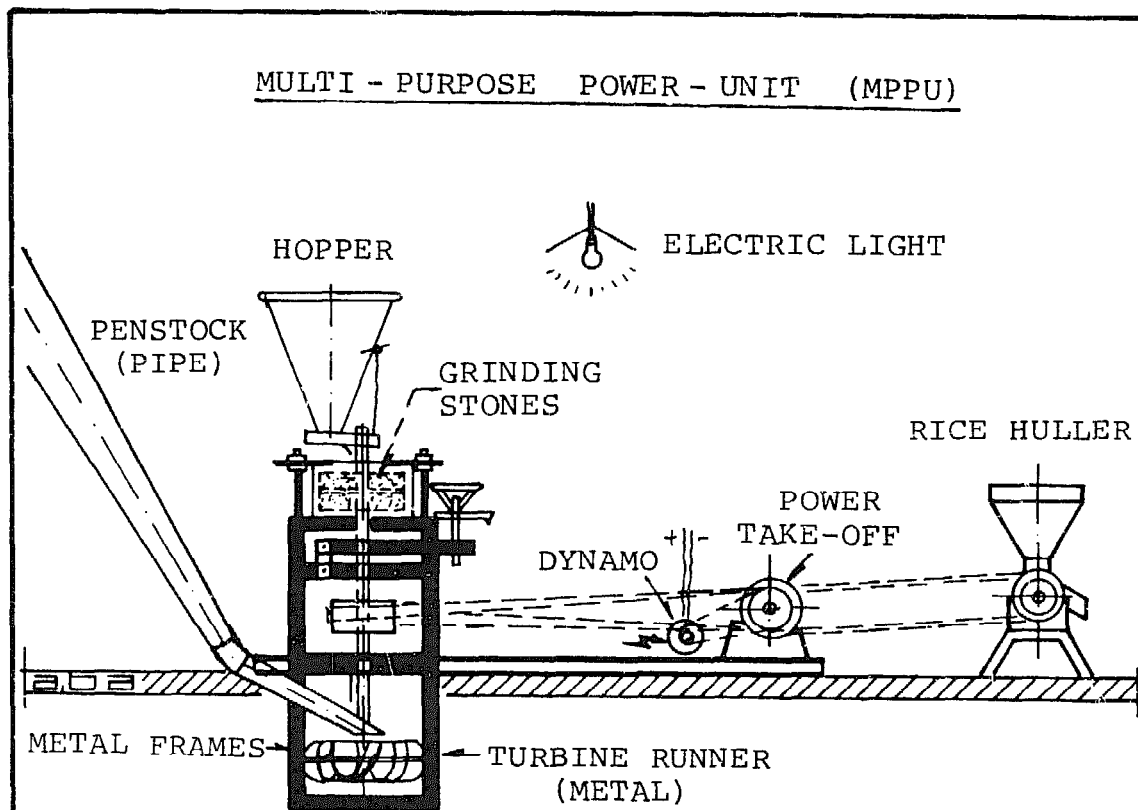
(Ref: Mini Technology I, by B.R. Saubolle and A. Bachmann, 1978 Sahayogi Press, Kathmandu)

NEW NEPALI WATER MILLS (2 SAMPLES)
FOR IMPROVED GRINDING



FOR MULTIPLE APPLICATION





The MPPU is a concept to improve existing traditional water mills, as well to bring new, small scale water power application to the reach of the rural people, even to remote areas.

The unit is constructed of metal and comprises of three detachable segments portable to distant places in the hills. Besides doing two or three jobs at one time, the MPPU grinds grain much quicker than the old mills. The increase both speed and power is attributable to the improved blade design of the water wheel and to the use of a penstock and bearings.

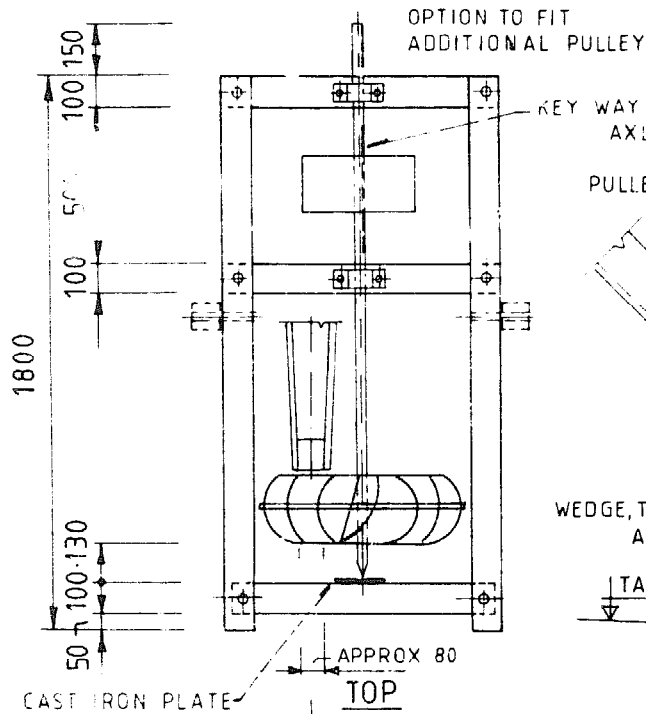
Depending on head and water quantity the power output can range from 2 to 5, 10 h.p., and machines can easily be fitted, such as rice huller, oil expeller, dynamo 12V-DC or 220V-AC (1 kW). The small scale cottage industry can run wood saw, planer, looms, etc.

The MPPU can be used as a complete set: turbine, mill and power take-off, and also with its separate pieces:

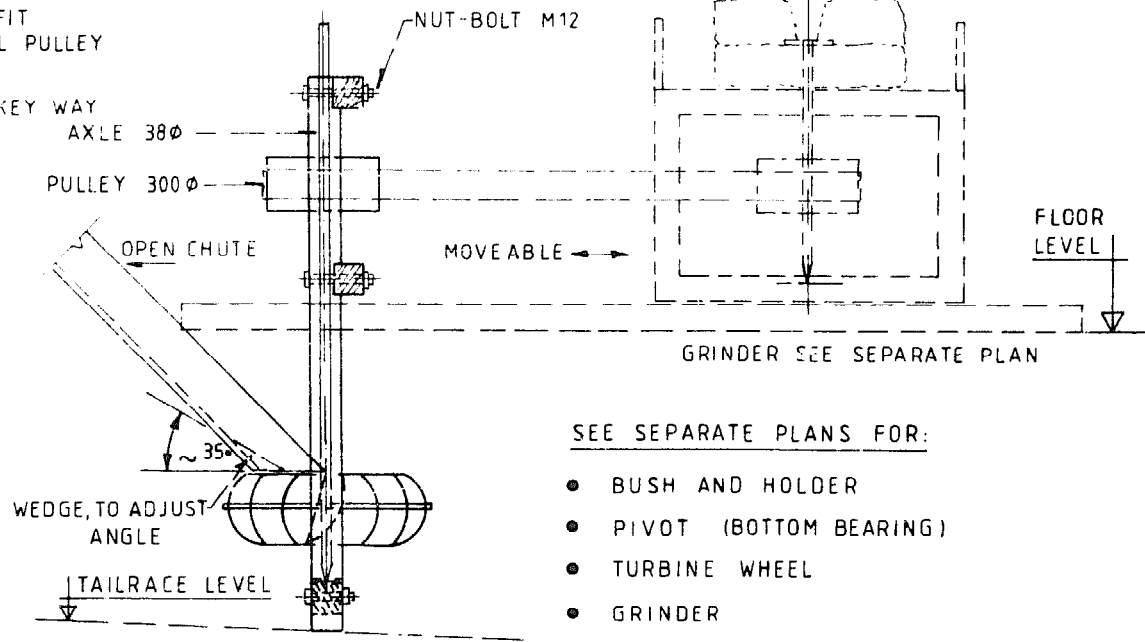
- turbine only (for example for a small dynamo only)
- mill only (to be run by conventional engines; or by animal power or wind power).

(More information can be obtained from the authors' booklet: Multi-Purpose Power-Unit with horizontal water turbine, 1982)

FRONT



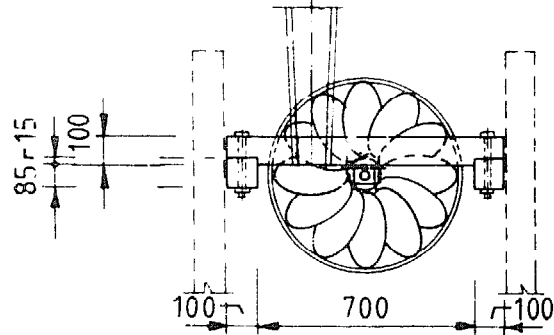
SIDE



SEE SEPARATE PLANS FOR:

- BUSH AND HOLDER
- PIVOT (BOTTOM BEARING)
- TURBINE WHEEL
- GRINDER

RPM APPROX 220

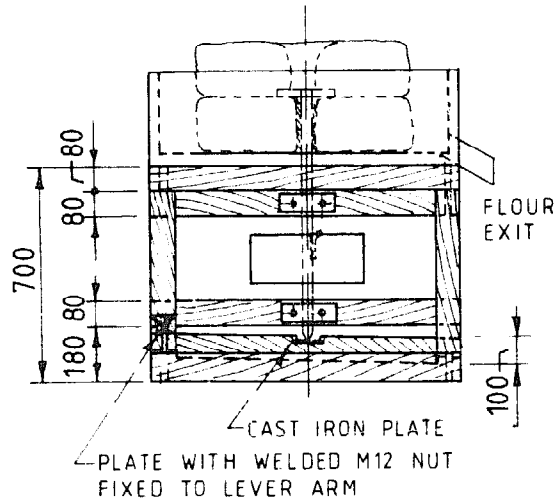


MEASUREMENTS IN MM
B.D.B

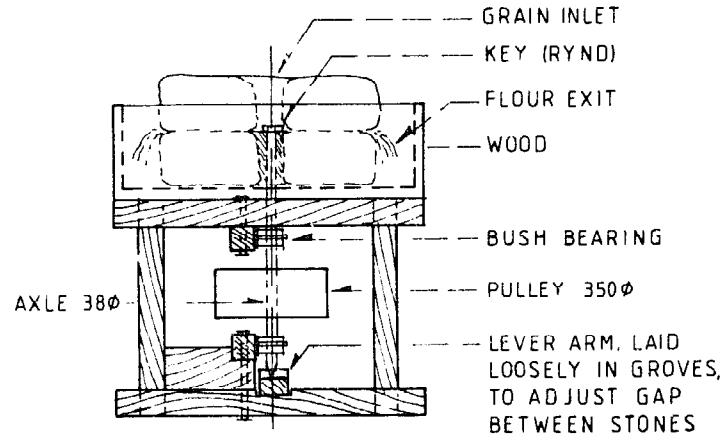
NEW NEPALI WATER MILL
 WOODEN CONSTRUCTION
FRAME FOR TURBINE

GRINDER

FRONT

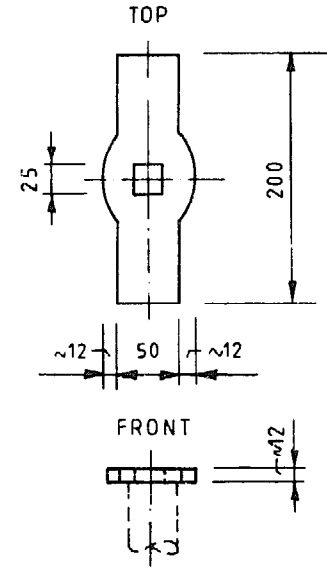


SIDE

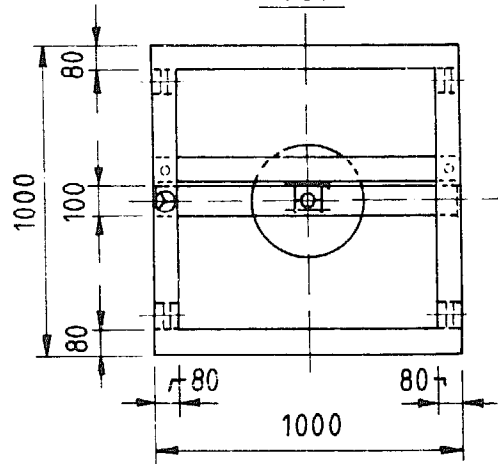


KEY (RYND)

FORGED IRON



TOP



SEE SEPARATE PLANS FOR:

- BUSH AND HOLDER
- PIVOT (BOTTOM BEARING)
- HOPPER (GRAIN FEEDER)

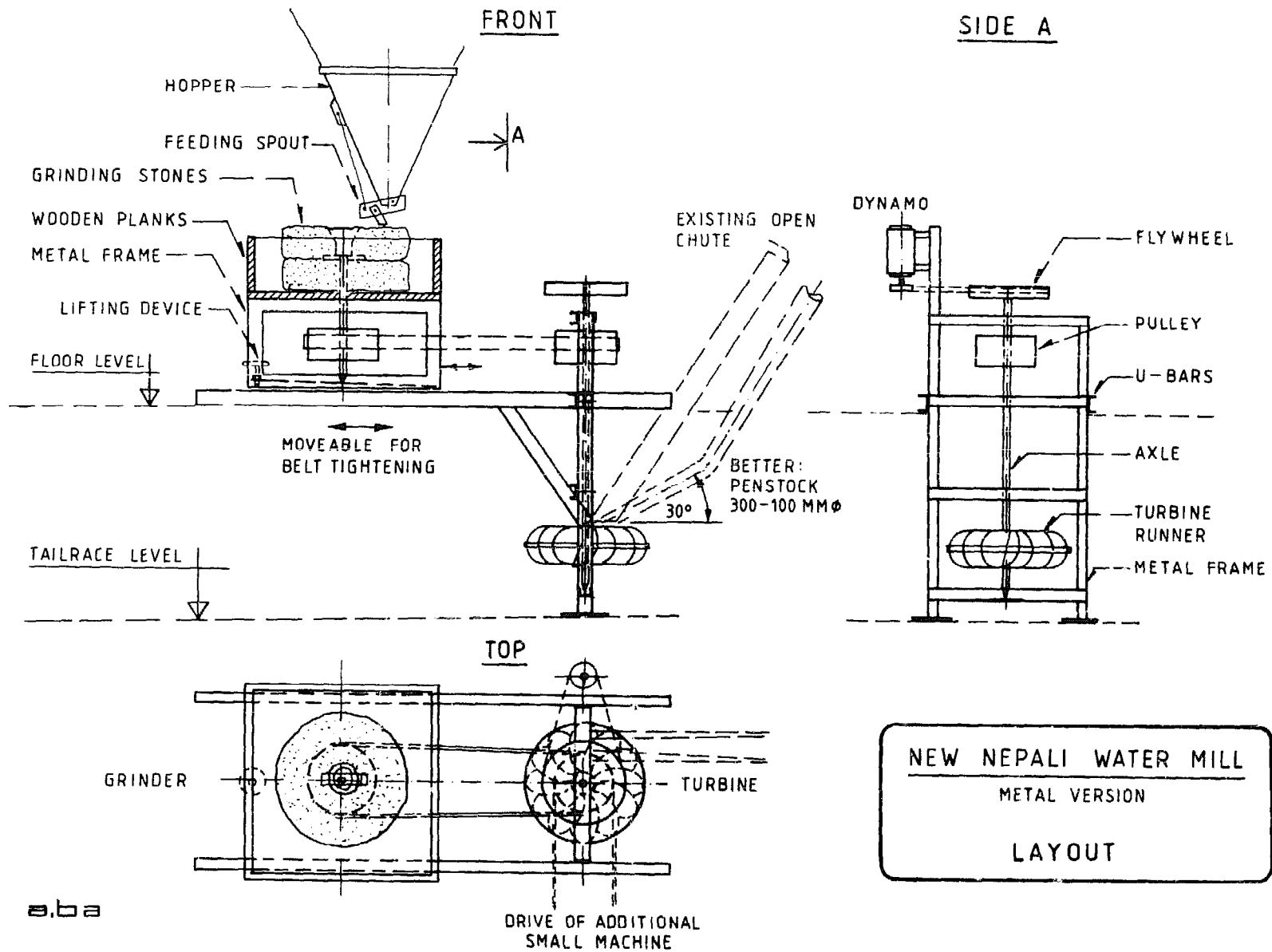
RPM OF STONE APPROX. 100-150

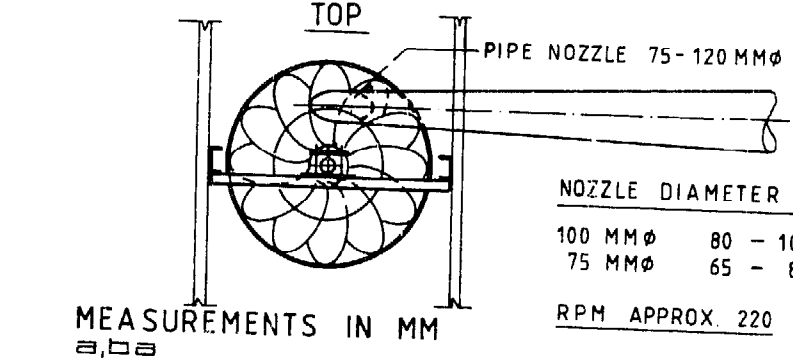
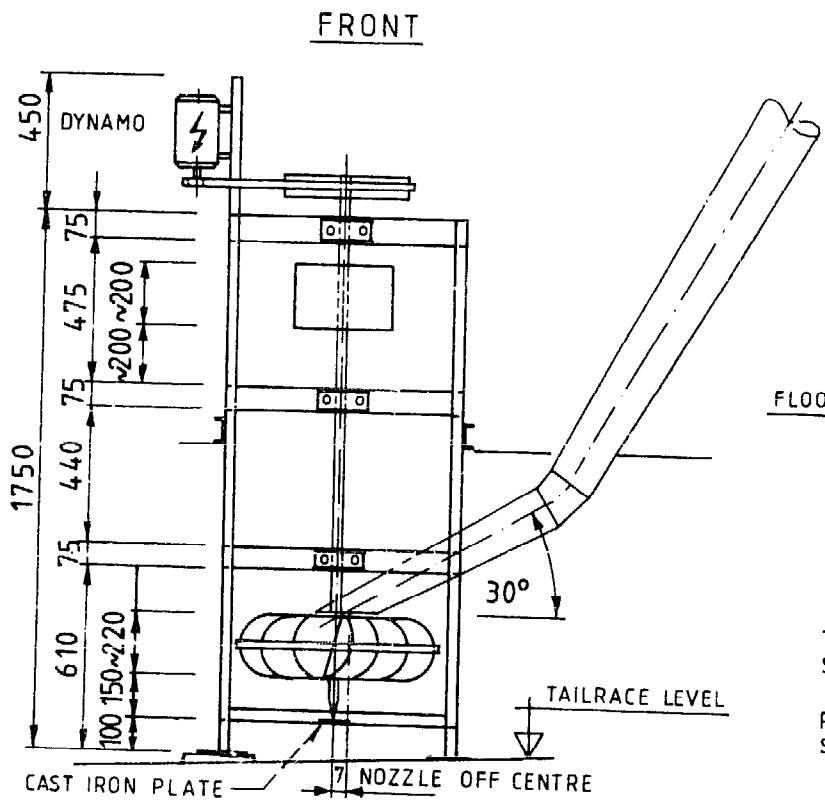
NEW NEPALI WATER MILL

WOODEN CONSTRUCTION

GRINDER

MEASUREMENTS IN MM
8.8.3

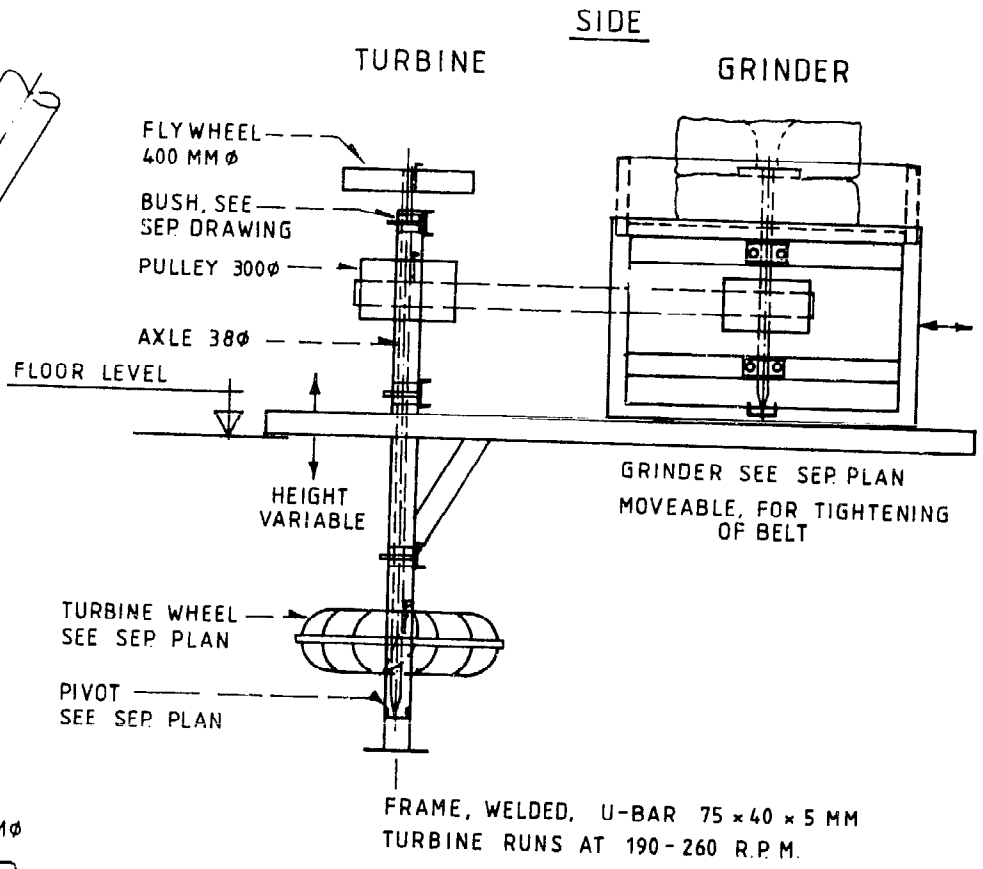




NOZZLE DIAMETER (4 MTR HEAD)

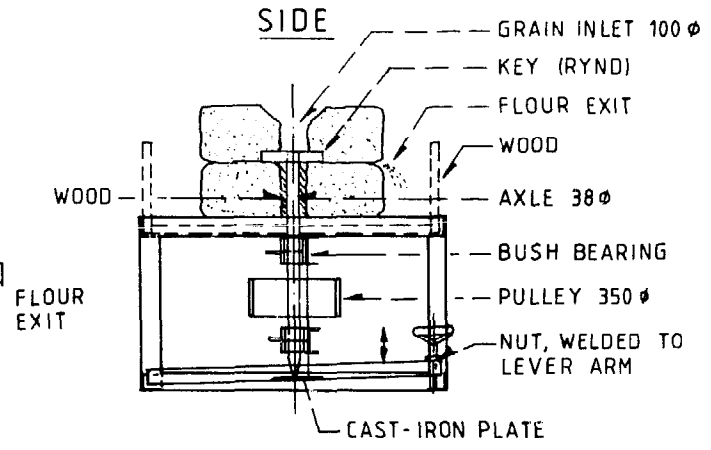
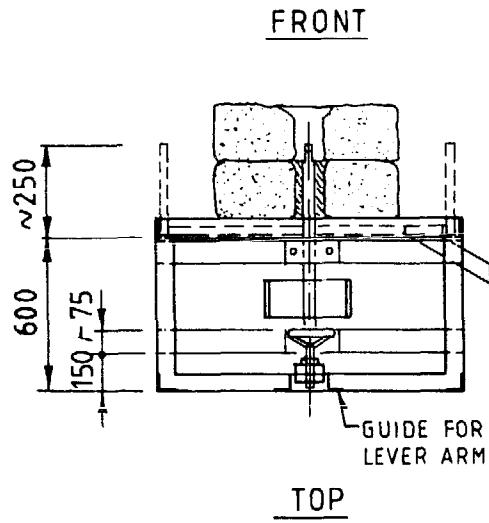
100 MM Ø	80 - 100 LTR / SEC
75 MM Ø	65 - 80 LTR / SEC

RPM APPROX. 220

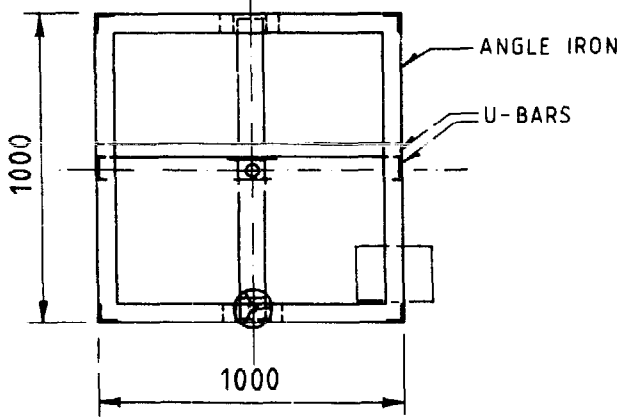
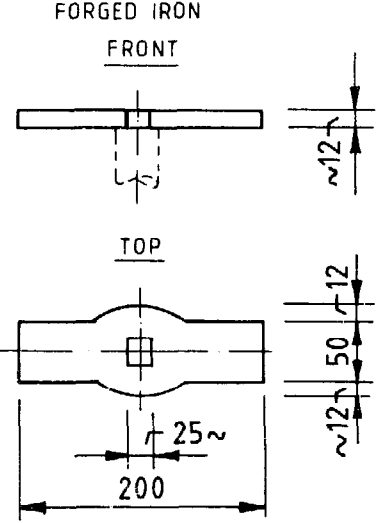


NEW NEPALI WATER MILL
METAL VERSION
FRAME FOR TURBINE

GRINDER



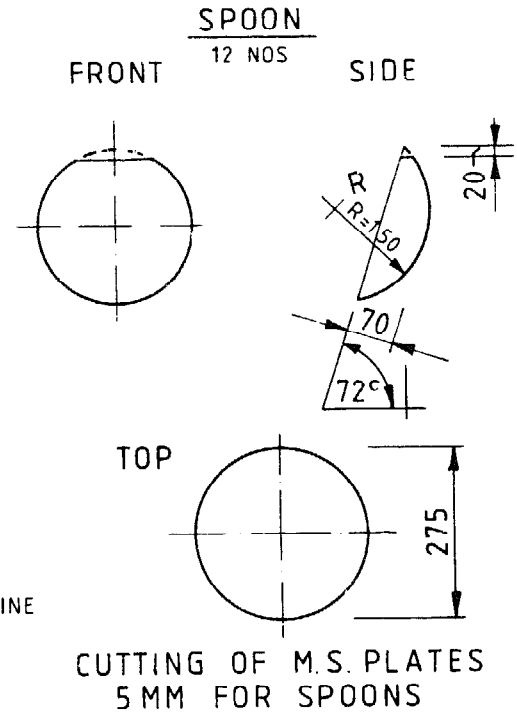
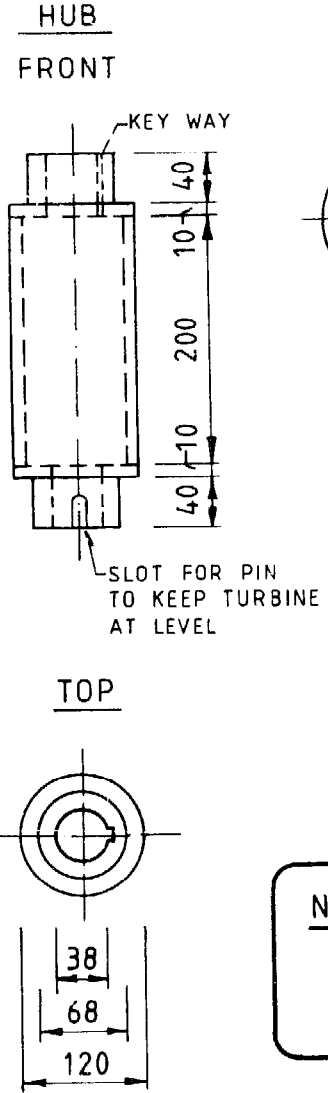
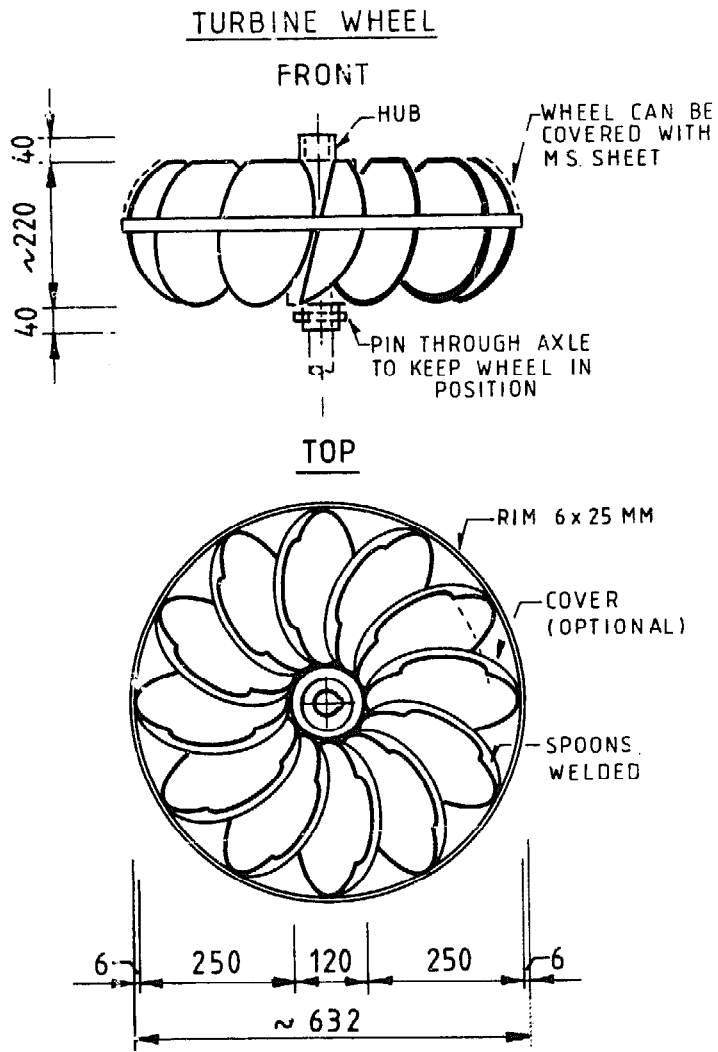
RYND (KEY)



- R.P.M OF STONE APPROX 100 - 150
- MATERIALS:
 - U-BAR 75 x 40 x 5 mm
 - ANGLE-IRON 65 x 65 x 6 mm
 - BUSH & BOTTOM PIVOT → SEP SHEET

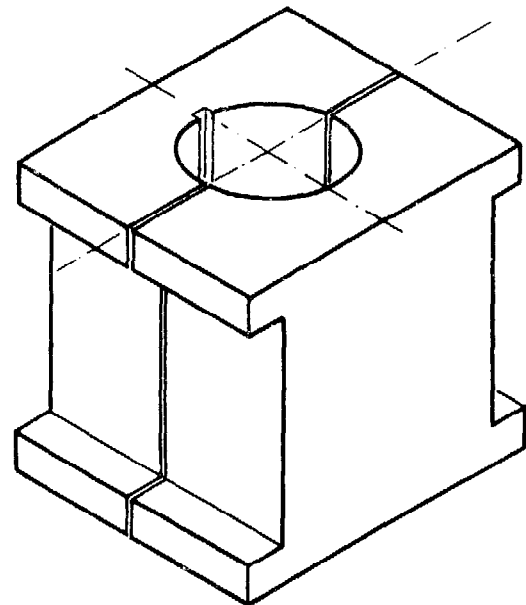
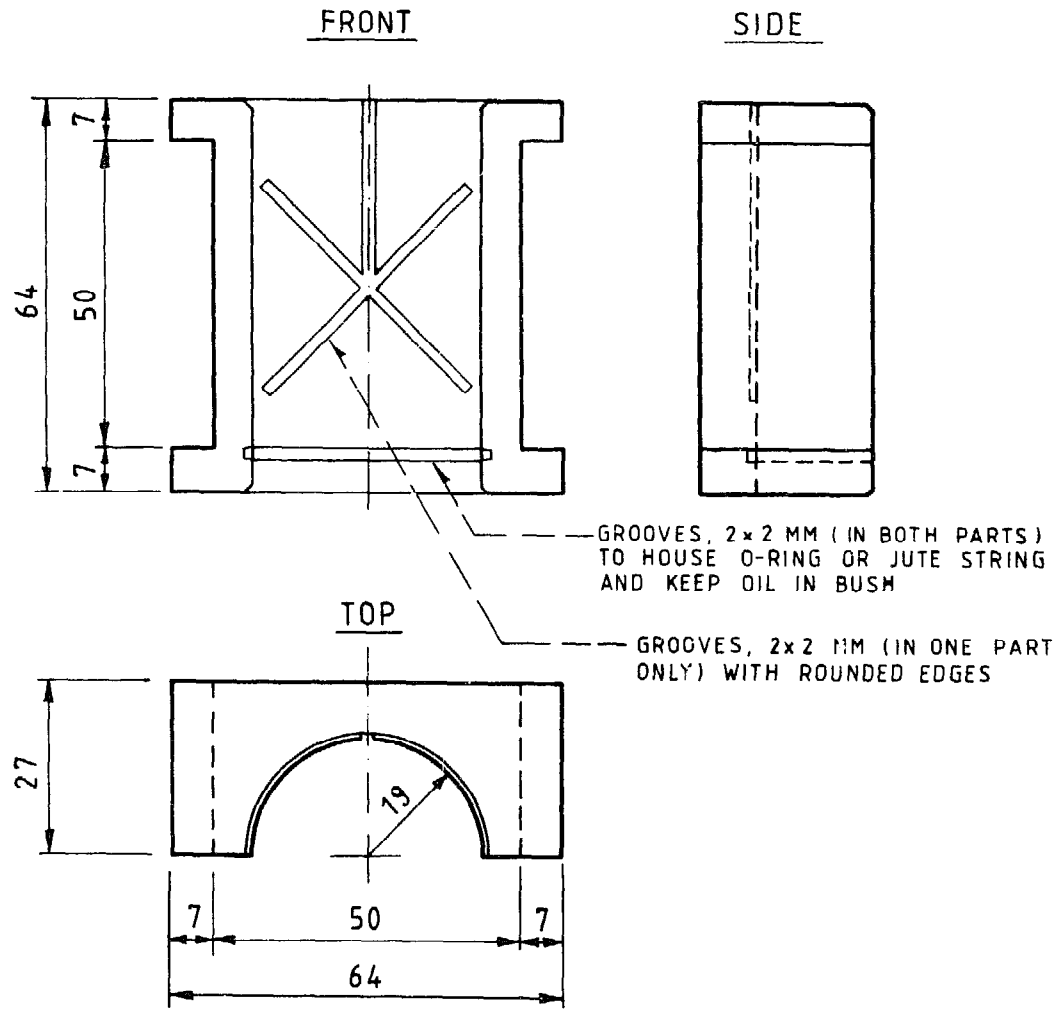
MEASUREMENTS IN MM
8.8.8

NEW NEPALI WATER MILL
 METAL VERSION
 GRINDER



NEW NEPALI WATER MILL

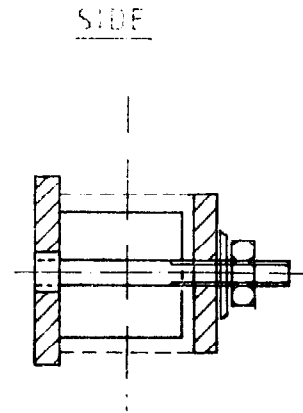
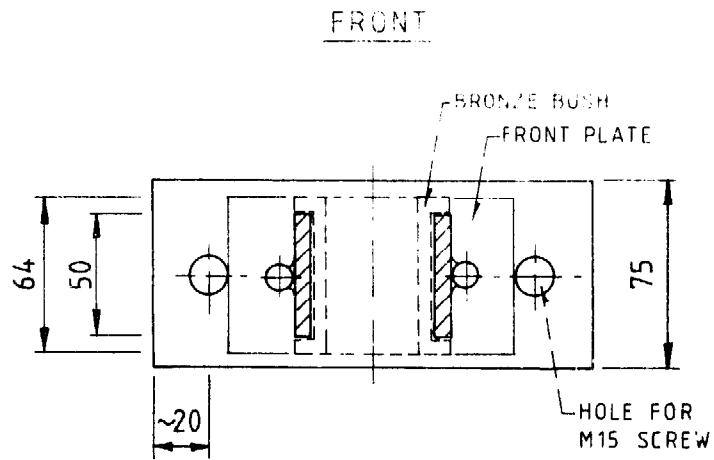
TURBINE WHEEL



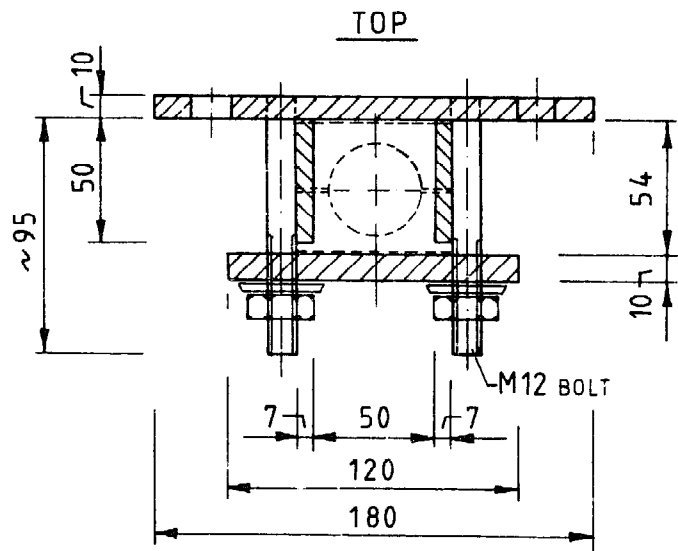
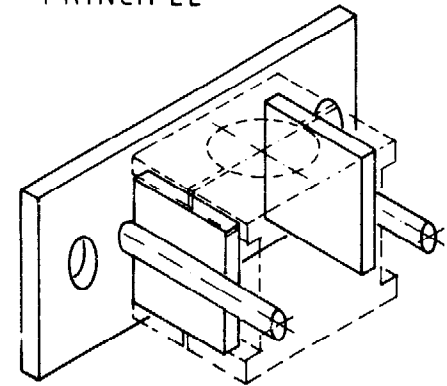
ASSEMBLY / ISOMETRIC

NEW NEPALI WATER MILL
TURBINE + GRINDER
BRONZE BUSH

MEASUREMENTS IN MM
=, □ =



PRINCIPLE



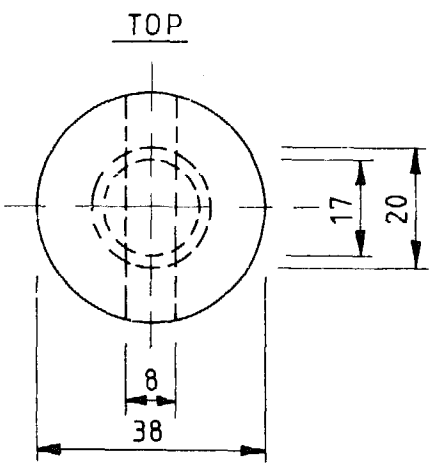
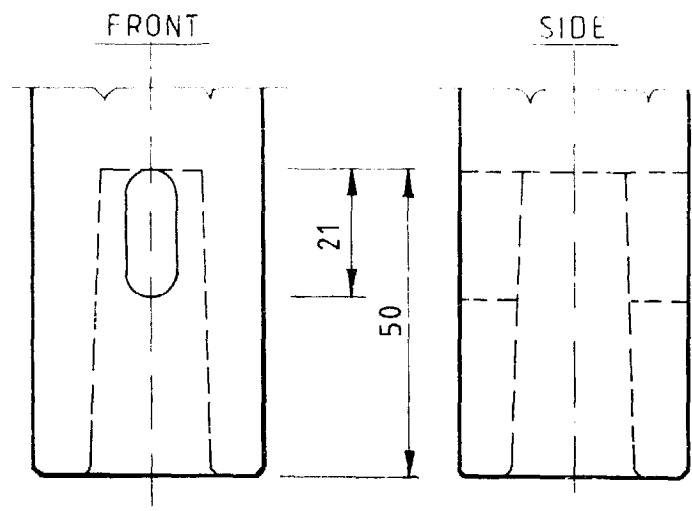
MEASUREMENTS IN MM
0.000

MATERIAL: MILD STEEL
BRONZE BUSH: SEE SEP. DETAIL

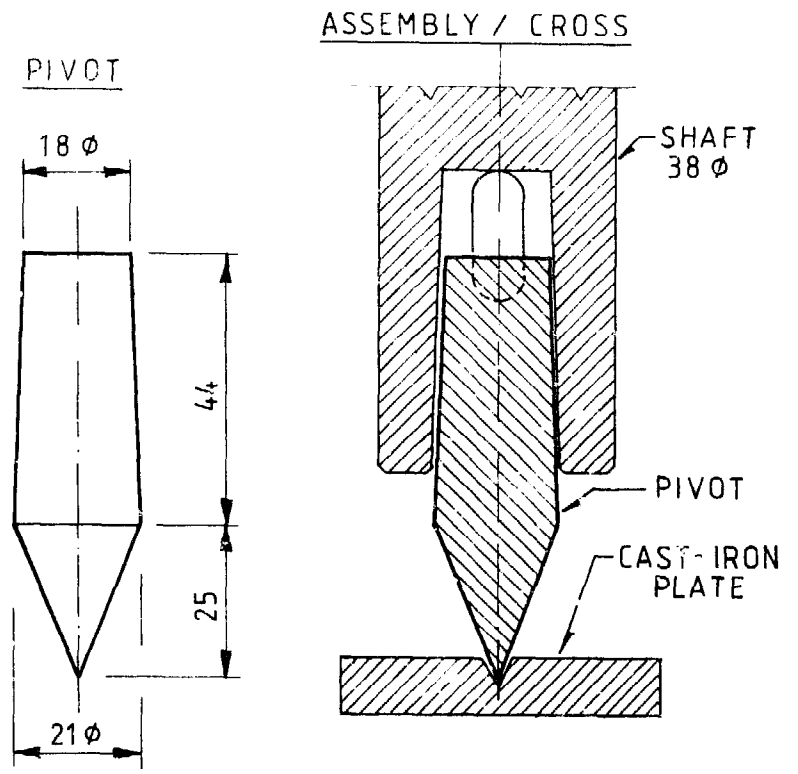
NEW NEPALI WATER MILL

TURBINE AND GRINDER

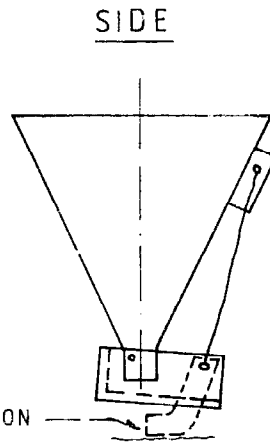
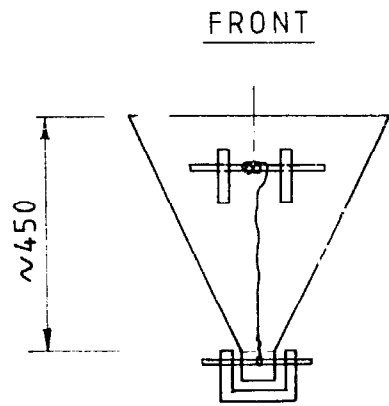
AXLE - FIXATION



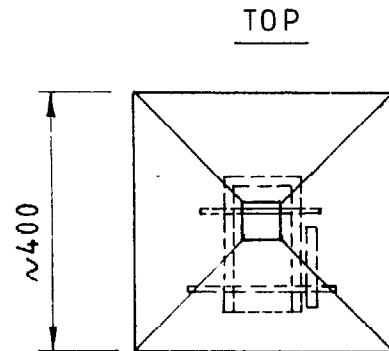
MEASUREMENTS IN MM
a,ba



NEW NEPALI WATER MILL
TURBINE + GRINDER
PIVOT ASSEMBLY

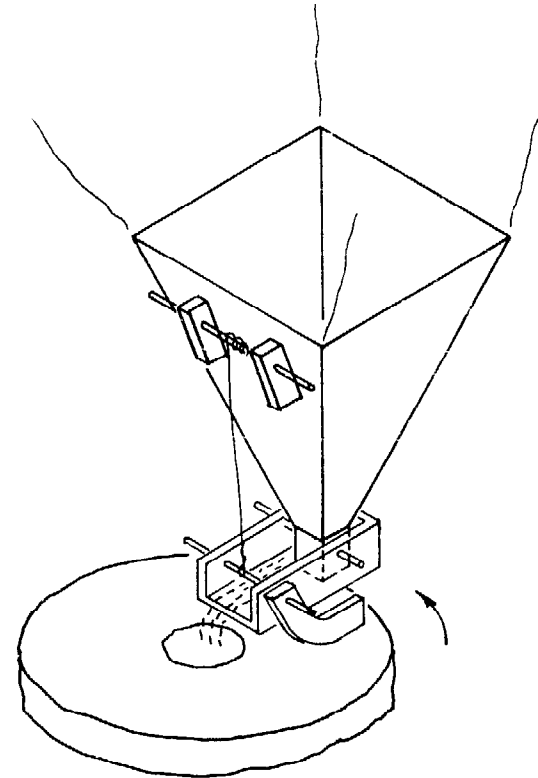


„BIRD“; VIBRATION
KEEPS GRAIN
MOVING



A HOPPER CAN BE MADE OF
BAMBOO OR METAL, OR OF
OTHER MATERIALS.

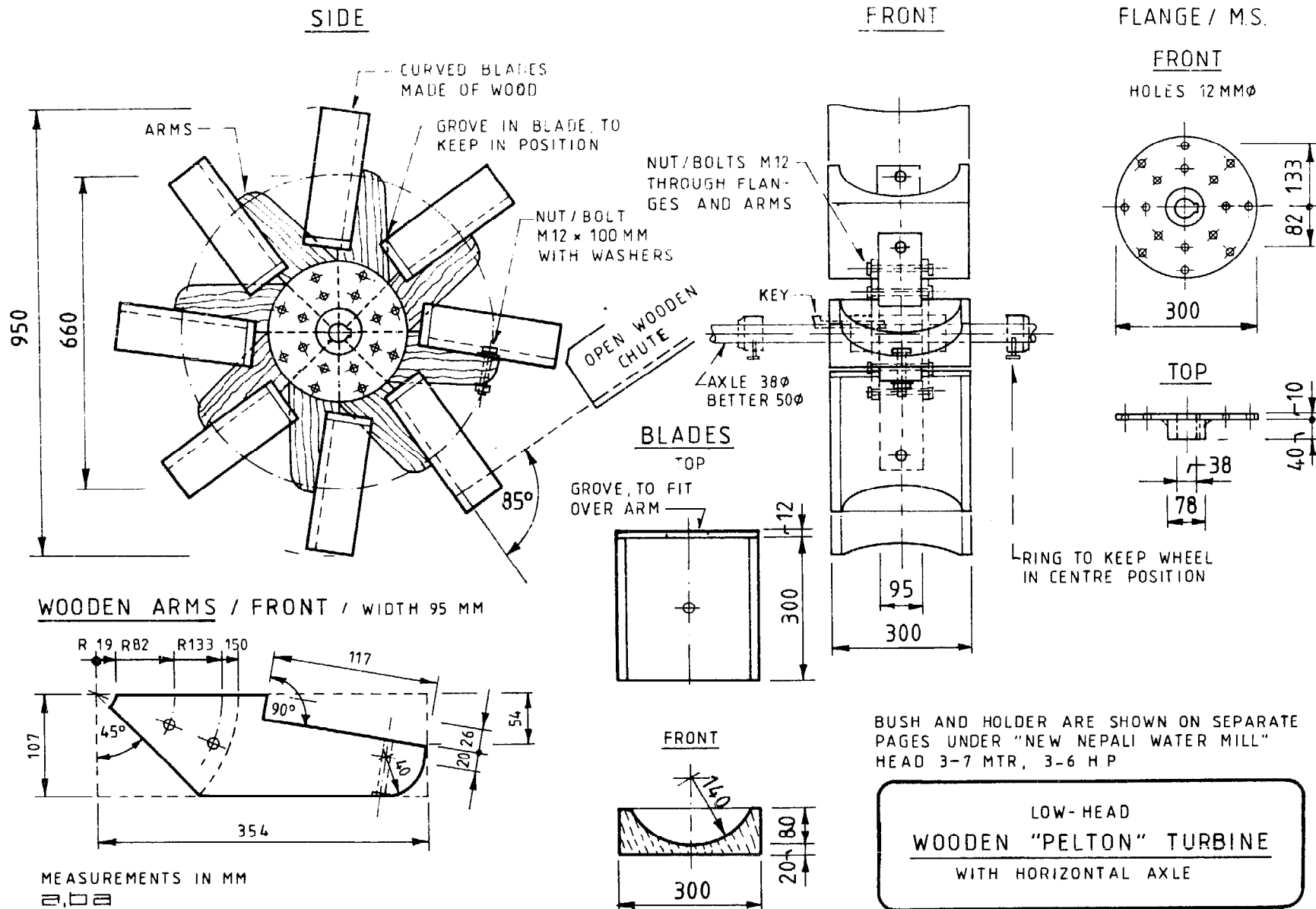
MEASUREMENTS CAN BE
DIFFERENT THAN THESE
ONES.

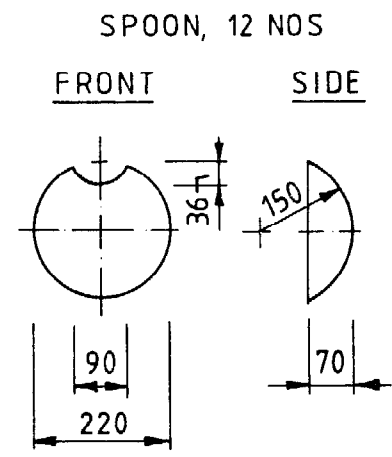
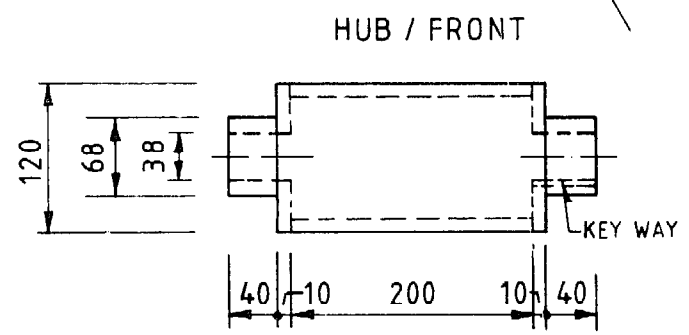
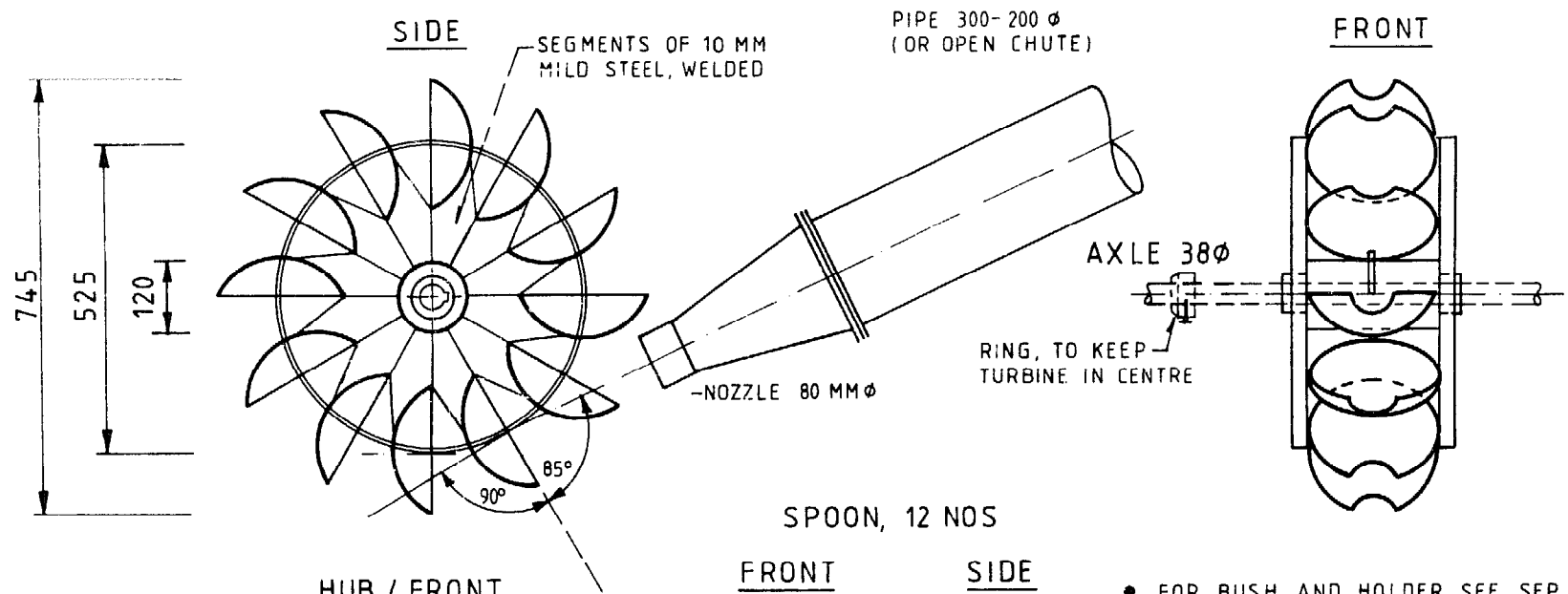


NEW NEPALI WATER MILL

HOPPER

MEASUREMENTS IN MM
8.108 6/83





- FOR BUSH AND HOLDER SEE SEP. DRAWING, UNDER "NEW NEPALI WATER MILL"
- TURBINE RUNS AT APPROX. 200 R.P.M. WITH 50 LTR/SEC AND 7MTR HEAD

MEASUREMENTS IN MM

SPOONS FORGED INTO SHAPE CUTTING: 275 MM ϕ , 3MM THICK

LOW HEAD
PELTON TURBINE
 METAL VERSION

CONSTRUCTION MATERIALS

NATURAL GRINDING STONES These stones are cut from larger stones with hammer and chisel. These stones are often found in river beds, quite near the traditional mill sites. People prefer the flour ground by such stones, because the speed is quite low the flavour remains very good.

Traditionally the upper stone rotates, and the lower stone is laid on the ground above the supporting wood-beam structure (the water wheel is directly below it).

The sizes of the stones vary and may be from 60 to 90 cm diameter. The millers change them depending upon the flow of water available to turn the water wheel.

The upper stones turns anti-clockwise, seen from above (for traditional reasons). As it is loosely laid on an iron key the speed should not exceed 150 rpm.

Interesting enough, people often prefer to have such natural grinding stones (where they can afford to wait for the rather slow grinding) for reasons of better taste.

CAST GRINDING STONES

They are to be bought in shops; and they are imported from India. The material consists of, for example, 75 percent Emery.

These stones are harder, and need less frequent re-dressing compared with natural stones. As they can run at higher speeds they have also a higher productivity. However, the higher speeds heats the material being ground, detracting from its flavour, and also decreases its storage life. In mills using these stones, it is the lower one that rotates (clockwise, seen from above).

The diameter ranges from 60 to 90 cm, but the 60 cm diameter stone is mostly used. Caution that these stones remain dry, especially during transportation, otherwise they will be spoiled!

WOOD

Water wheels and mills made of wood may be justified where wood is quite easily available. Wood has advantages; it can be cheap, local carpenters can handle it, the maintenance and replacement can be managed locally - the device can be copied quite easily by others, and thus technology transfer is facilitated.

On the other side, wood has some acute limitations. In a country like Nepal good quality wood is not that easily available. Even small water wheels are quite heavy, making transportation to remote areas difficult. Wood absorbs water and when it freezes, the wood is spoilt. Durability is reduced by exposure to water and regular drying. Another limitation on quick development of wooden water wheels may be the lack of information on good construction methods.

These days, metal parts, such as axles and bushes, can be incorporated into wooden water wheels. This facilitates construction and results in a better product.

METAL

Turbines made of metal need to be made in specialized workshops. The sizes range from a few horse power to very large ones. With smaller sizes the weight remains quite reasonable, precision and strength guarantees a long lifespan, large production can be done by several manufacturers. Modern information is available: it concentrates mainly on metal turbines.

BEARINGS

Many different bearings are available. It is, however, not easy to say which are good ones on the local market: sometimes they are "re-conditioned" bearings, meaning a combination of old and new bearings. Bearings in the rural context may cause maintenance problems. Proper alignment and replacement also are difficult.

BUSHES Bushes can be made locally and are readily understood, as this material is also used in other machines. If the original pieces wear-out they can be replaced by oil-soaked wooden blocks. */**

PENSTOCK Pipes are essential for any turbine which works with pressure (Pelton; Francis, etc.) and where increased power production is required. Penstocks are normally made of mild steel sheet in Nepal. Of late HDPE has also been used.

OPEN CHUTES Are used for traditional water mills to run the low head horizontal axle water turbines. Open chutes are also successfully used in Bhutan for traditional, horizontal axle water wheels. Latest trials show that open chutes can successfully run low-head "Pelton", MPPU-type turbines - New Nepali Water Mills.

* "Bearing Design and Fitting", by Ian Bradley, :1965
Model and Allied Publications, Argus Books Ltd.
available: META Publications, Marblemount/WA 98267 - USA

** "Oil Soaked Bearings: How to make them", by John Collet,
Appropriate Technology Journal Vol 2, No. 4
available: IT-Publications, 9 King Street, London WC2E, 8HN
U.K.

LIST OF APPLIANCES / R.P.M + H.P. REQUIREMENTS			
S.No.	MACHINE	R.P.M.	H.P./MACHINE
1	<u>GRINDING DEVICE</u> , 600-700 mm ϕ Local stones (capacity approx. 12-16 kg/hr)	100 - 150	1 - 2
	<u>GRINDING DEVICE</u> , 610 mm ϕ Emery stones (casted) (capacity 75 kg/hr) (capacity 1 Muri/hr)	200 - 500	2.5 - 5
2	<u>RICE HULLER</u> , No. 5 (cap. 90 kg/hr; 1/4 Muri/hr)	600 - 750	2.5 - 5
	<u>RICE HULLER</u> , No. 4 (cap. 250 kg/hr; 3 Muri/hr)	1000	5 - 10
3	<u>OIL EXPELLER</u> , No. 3 3 Bolts, approx. 150 kg (cap. 15 kg/hr; 1/4 Muri/hr)	400	3 - 5
	<u>OIL EXPELLER</u> , No. 5 4 Bolts, approx. 350 kg (cap. 45 kg/hr)	175	5
	<u>OIL EXPELLER</u> , No. 6 6 Bolts, approx. 450 kg (cap. 60 kg/hr)	175	7.5
4	<u>CHURA MILL (RICE FLATTENER)</u> - 75 cm ϕ (size 3 HP) (cap. 75 kg/hr; preboiled)	200	3 - 5
5	<u>THRESHER MACHINE</u> (capacity 800 kg/8 hrs a day)	400	1 - 2.5
6	<u>CIRCULAR SAW</u> , 350 mm ϕ (max. cutting 125 mm)	1500 - 2000	2
7	<u>PLANING MACHINE</u> (max. width 150 mm)	2000 - 3000	1
8	<u>WOOD TURNING LATHE</u> (max. 300 mm ϕ) (max. 600 mm length)	100 - 300	1
9	<u>DYNAMO</u> , DC. 12 V, 400 W approx.	1000 - 1200	1/2
10	<u>EL. GENERATOR</u> , AC 220 V, approx. 1 kW	2800	1.3
11			

WATER POWERED GRINDING MILLS IN NEPAL

TABLE OF COMPARISON

	TRADITIONAL (<i>GHATTA</i>)	NEW NEPALI WATER MILL	M P P U (METAL)
PURPOSE	Grinding	Grinding, Multipurpose for small scale: - agric. processing - cottage industry - mini electricity for lighting (e.g. 12V DC or 220 V-AC, 1 kW)	Grinding, Multipurpose with Power take-off device for small scale: - agric. processing - cottage industry - mini electricity generation, (e.g. 12VDC or 220 V-AC, 1-3 kW)
CONSTRUCTION MATERIALS	Wood and stones from the near surroundings	Wood and stones from the near surroundings, in combination with some metal parts	Construction made of metal Cast-grinding stones, to be bought in shops.
HEAD	3-5 mtr, max. (open chute)	3-5 mtr, when open chute, 3- mtr, when penstock	3-30 mtr (and more) Pipe (Penstock)
R.P.M.	approx. 120 - 160	approx. 200 - 240 (variable also with chute or pipe)	approx. 250 - 300
GRINDING CAPACITY (e.g. Maize)	approx. 12 - 15 kg/hr	approx. 20 - 50 kg/hr	approx. 65-95 kg/hr and more
DURABILITY OF MILL	Reasonable, especially in non-freezing areas	Longer lasting, also in colder climate (metal runner)	Longer lasting, also in colder climate (metal runner)

	TRADITIONAL (GHATTA)	NEW NEPALI WATER MILLS	M P P U (METAL)
TASTE OF FLOUR	usual, good	usual, good	good and acceptable, quality is depending on speed of grinding and acceptance of flour taste depending on different localities.
STAGE OF INTRODUCTION	since centuries	pilot designs	Improved grinding device for over 20 years, in hundreds of places (driven by diesel or electro motors): with water turbine since 1980
NUMBER OF WORKING UNITS	approx. 25,000 - 40,000	approx. 5 units	About 65 installed, over 75 MPPU'S ordered and produced (October 1983) With exports to Bhutan and India.
DELIVERY TIME	locally made, seasonal works, depending mainly on available manpower.	locally made, assembly of some additional metal parts - depending on the available skill and instruction to be given to rural people.	approx. 6 - 8 weeks
MAINTENANCE	In any case possible by local craftsmen, using local materials only.	Possible by trained local craftsmen, using locally available materials	Possible by trained local manpower - difficult repairs to be brought to the mechanical workshops.
REDRESSING OF STONES	quite often (soft stones)	more often (soft stones; higher production)	less often (harder stones)

LIST OF TECHNICAL DATA *
OF
NEW HIMALAYAN WATER WHEELS

Type	Axle	Purpose	Head	R.P.M.	H.P.	Chute	ltr/sec	Materials from Workshops
Wooden Water Wheel	Horizontal	Direct off-shaft drive of rice huller, grinder small dynamo	min. 4 mtr.	90 - 100	1 to 2	open wood	90 -	kit of metal parts: axle, bushes, flanges, screws, and belts
"Metal Pelton"	Horizontal	Direct off-shaft drive of rice huller, grinder small dynamo,	min. 4 mtr.	90 - 100	1 to 2	open wood	80 -	complete set, turbine runner, axle, bushes, etc.
		oil expeller (pipe chute)	5-10	250 - 300	2 to 4	pipe metal	50 - 90	
New Nepali Water Mills	Vertical	Grinding and direct off-shaft drive of various machines	min. 4 mtr.	190 - 210	1.5- 2	open wood	65 - 90	kit of metal parts: axles, bushes, flanges, screws, and belts
			3 - 10	250 - 300		pipe metal		
M P P U	Vertical	Grinding and power take-off for various machines	3 to 30	250 - 300	2 - 10	pipe metal	50 - 95	complete unit, incl. grinding stones.

* First Results, need further monitoring

SEQUENCE OF DEVELOPMENT WORKS ON TRADITIONAL WATER MILLS

GODAVARI, Sept. 1980	Metal construction, cast stone, dynamo 12V-DC, <u>gear for vertical/horizontal axles</u> , metal penstock, oil expeller, rice huller, bearings (MPPU)
THAIBO, May 1981	Metal construction, cast stones, dynamo 12V-DC and 220V-AC / 1 kw, rice huller, oil expeller, thresher, <u>power take-off with belt</u> Improvements: solid frame; U-bars straight, pulley fixed at lower level, cover over turbine wheel, dynamo on bottom frame - driven with V-belt
LUKLA, June 1981	<u>MPPU-Turbine part only</u> , for DC generator, <u>with wooden chute</u> (pipe)
NAUBISE, Aug. 1982	Trial with foldable door-frame and <u>natural stones</u> , <u>bushes</u> - instead of bearings, (open chute was not properly adjusted and was replaced by a metal pipe). To run additional machines to the grinding is not convenient, as the upper stone would need to be lifted. The heavy weight of the stones on the frame demands much strength: there is some vibration.
MALEKHU Aug. 1982	<u>MPPU-Turbine part only</u> , <u>with extended shaft</u> , for 220V-AC / 1 kW
NEW NEPALI WATER MILL Sept. 1982	Conclusion of Naubise: separate unit mill from turbine part, natural stone and successful trial with open chute, bushes, turning one huller and one 12V-DC dynamo, followed: <u>Metal only</u> where it is necessary: bushes, axle, flanges, (turbine wheel) <u>Wooden frames</u> for separate grinding part and frame for turbine wheel <u>Open chute</u> ; natural stones

DEVELOPMENT OF MODERN MINI HYDRO POWER IN NEPAL	
Year; approx.	Type
1960 and before	Different Overshot and Undershot Water Wheel Constructions, with horizontal axis, made of wood
1960 and before	Overshot Water Wheel constructions, made of metal Improved grinding devices by Kathmandu Metal Industry (KMI)
1964	Propeller Turbine, horizontal axis, made of metal by Balaju Yantra Shala (BYS)
1965 / 1967	Hydraulic Ram development at BYS
1970	Improvement of a traditional water mill by a German (specific datas not known)
1973 / 1974	Development of the Cross Flow Turbine at BYS (in collaboration with C. Adam)
1974 / 1975	Development of a Cross Flow Turbine at Butwal Technical Institute (BTI)
1976	Development of a Pelton Turbine at BTI
1976 / 1977	Development of a Cross Flow Turbine at Nepal Yantra Shala (NYS), Patan
1978	Improvement of a traditional water mill with a runner made of metal and a closed chute made of cement, by a miller at Kunigaon, Bansbari
1978	Development of a Mini Pelton Turbine at KMI
1978 / 1979	Works on a river-flow turbine (Plata Pump) at BYS (in collaboration with Th. Bürki)
1978 / 1979	Trials with a power take-off from a traditional water mill, by KMI
1979 / 1980	Construction of Overshot Water Wheels, made of metal, at NYS
1979 / 1980	Improvement of traditional water mills (ghatta) wood construction: by the Research Centre for Applied Science and Technology (RECAST) Tribhuvan University, Kirtipur, Kathmandu
1980	metal construction: Multi-Purpose Power-Unit (MPPU) by KMI
1980	Development of Open Cross Flow Turbines, by KMI National Structure and Engineering Company (NSECO) and NYS.

DEVELOPMENT OF MODERN MINI HYDRO POWER IN NEPAL	
Year; approx.	Type
1981	Construction of a vertical axis Propeller Turbine at NYS
1981	Construction of a petrol-drum Propeller Turbine at KMI
1982	Construction of a Wooden Cross Flow Turbine at KMI and NSECO.
1982	Construction of a water-powered Pestle-Hammer by A.M. Nakarmi at NSECO.
1982	Development and construction of a Turgo Impulse Water Turbine, at KMI and NSECO.
1982	Development and construction of a Wooden Water Wheel with curved blades ("Wooden Pelton")
1982	Construction of a Barker's (or Reaction) Mill (also called Segner's Wheel) by BYS
1982 / 1983	Development and construction of larger Hydraulic Rams at Butwal Engineering Works (BEW)
1983	Development and construction of a Propeller Turbine in a scroll case (small size) at KMI
1983	Development and construction of a mini Poncelet Water Wheel to run in small irrigation canals, by Agro Engineering Works (AEW), Butwal.

MANUFACTURERS OF MINI HYDRO DEVICES		
S.No.	Name / Address	Devices
1	AGRO ENGINEERING WORKS (P) Ltd. Butwal Industrial District Butwal	<ul style="list-style-type: none"> - Cross Flow Turbines - Irrigation Canal Water Wheel (Prototype, Poncelet type) - Heat Generator
2	BUTWAL ENGINEERING WORKS Butwal	<ul style="list-style-type: none"> - Cross Flow Turbines - Pelton (Prototype) - Improved grinding devices - Heat Generator - Mechanical and Electronic Load Controllers for rural electrification - Hydraulic Rams
3	BALAJU YANTRA S'ALA Mechanical Engineering Balaju Industrial District P.O. Box 209 Kathmandu	<ul style="list-style-type: none"> - Cross Flow Turbines - Hydraulic Rams - Barker's Turbine (Segner Wheel) - Load Controllers for rural electrification
4	INTERTECH Mechanical Workshop Butwal Industrial District Butwal	<ul style="list-style-type: none"> - Cross Flow Turbines
5	KATHMANDU METAL INDUSTRY 12 / 514 Quadon / Nagal Kathmandu (Tel: 14 069)	<ul style="list-style-type: none"> - Improved Water Mills MPPU and others - Improved grinding devices - Cross Flow Turbines (Conventional and open types) - Pelton (Mini and Low-Head) - Wooden Pelton (Prototype) - Turgo - Propeller (Prototypes) - Pestle-Mortar (Water powered) - Plata Pump Type
6	NATIONAL STRUCTURE AND ENGINEERING COMPANY Patan Industrial Estate Lalitpur Kathmandu	<ul style="list-style-type: none"> - MPPU (as developed by KMI) - Cross Flow Turbines (Conventional and open types) - Turgo (Prototype) -

MANUFACTURERS OF MINI HYDRO DEVICES		
S.No.	Name / Address	Devices
7	NEPAL YANTRA SHALA	<ul style="list-style-type: none"> - Cross Flow Turbines (Conventional and open types) - Improved grinding device - Improved water wheel - Overshot Water Wheel - Propeller Turbine
8	THAPA ENGINEERING COMPANY Butwal	- Cross Flow Turbines
INSTITUTIONS FOR MINI HYDRO ACTIVITIES		
9	AGRICULTURAL DEVELOPMENT BANK / NEPAL Kathmandu / Branch Offices	- Loans for Mini Hydro Installation
10	DEPT. OF COTTAGE AND VILLAGE INDUSTRIES Tripureshwar Kathmandu	<ul style="list-style-type: none"> - Information on Mini Hydro - Licenses to run small machines
11	RECAST Tribhuvan University Kirtipur Kathmandu	<ul style="list-style-type: none"> - Investigations on Traditional Water Mills - Prototype Constructions of Improved Water Mills - Testsite Development

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INFORMATION AVAILABLE ON APPROPRIATE TECHNOLOGY

MINI TECHNOLOGY - VOLUME I / Second Edition

by B.R. Saubolle and A. Bachmann

Contains 36 low-key projects to make life more livable: solar water heaters, biogas, sawdust stoves, room heating and cooling, corn sheller, crow trap, fly trap, and much more. Abundantly illustrated. A real jewel!

MINI TECHNOLOGY - VOLUME II

by A. Bachmann and B.R. Saubolle

This second volume continues the information on technology for rural areas and developing countries, where electricity is not yet available from the power grid. It gives suggestions based on experience on fuel efficient stoves, smokeless kitchens, energy from water. Explains also methods of rat disposal, etc. A welcome addition to the literature in this field!

BEEKEEPING, by B.R. Saubolle and A. Bachmann

An introduction to modern beekeeping in Nepal. Written expressly for the *Apis indica*, this booklet will render great service all over South-East Asia. Clear, to the point, practical. Treats also of wall and log hives and of the African Top-Bar Hive. A treasure!

MULTI-PURPOSE POWER-UNIT - With horizontal water wheel
by A.M. Nakarmi and A. Bachmann

This booklet explains in a few words, but with many diagrams and photographs, one of the latest developments in the field of micro hydro-power in Nepal. In essence it is based on traditional technology and can provide from two to five or ten horse power.

The modular design comes in standard sizes that are manufactured in portable loads, so that it can be easily transported even to remote areas. This device has aroused considerable interest in many places. The booklet provides useful information of alternative and renewable energy resources in rural areas.

Published by:

Sahayogi Press, Tripureshwar, Kathmandu

NEW HIMALAYAN WATER WHEELS

by

A. Bachmann & A.M. Nakarmi

Horizontal water wheels have been traditionally used in the Himalayas for many centuries. With the latest developments in upgrading these useful, decentralized power devices, it is possible to improve efficiency in grinding. In addition farmers can run small machines and a small dynamo for light.

This booklet describes these technologies, provides information with photographs and technical drawings. It is useful for people interested in rural energy development.

Printed in Nepal
at *Sahayog Press*, Tripureshwar, Kathmandu