Development of an Oil Expeller

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ABSTRACT

An oil expeller was developed and tested at the department of Agricultural Engineering, Federal University of Technology, Minna, Niger State. The machine is to provide a means to enhance processing and also to reduce losses associated with local processing operations. The machine was tested with groundnut. The result showed that the machine attained output capacity and efficiency of 6.0kg/hr and 67% respectively.

INTRODUCTION

The Chinese were the first people to express oil seeds (UNIDO, 1987). As far back as the year 3000B.C, the Egyptians knew how to obtain oil using a press composed of a sausage- shaped rush bag slung between vertical post of a strong wooden frame. In the 19th century the ruins of Pompeii, an ancient city of Italy, dated back to 79A.D were excavated. A large pestle and mortar was found; a long pole acted as a grinding pestle and hollowed trunk of a tree held the seeds.

The first mechanical screw press was successfully used back in 1906. The manufacturers have come a long way since then, with improved material of construction, manufacturing methods, research and development and have increased the efficiency of the screw press. As a result, various types of improved expellers were developed to meet the requirement of the processors (UNIDO, 1987).

The most popular method of extraction is by Ghani, which is basically a large pestle and mortar. The mortar is an inverted cone and the pestle is a heavy timber seated at the bottom of the cone and inclined at an angle, so that the meal is crushed against the mortar during rotations either by man or animal (Weiss, 1983).

Hydraulic presses dominated the seed-crushing industry until the 1920s. Daniel, (1982), however, reported the invention of continuous high pressure screw press called expeller in U.S.A. This expeller is noted to be more widely used as compared to other hydraulic presses.

Before the widespread adoption of the screw press, pressing was done either under ambient temperatures and the procedure called cold pressing or at elevated temperatures, which was called hot pressing. Cold pressing is revealed to extract less oil than hot pressing but the oil obtained was purer than that extracted with heat because high temperature as observed, favours the extraction of other components along with the oil (Beryl and Milley, 1986). It is noted that the process of extracting with a screw press itself generates heat that can reach temperatures between 65^0C and 72^0C.

Cooking or scorching of oil seed is needed for three reasons: to facilitate oil extraction, to lower or increase the moisture of seed and to reduce wearing in the screw press. The best temperature and moisture content depends on the extraction system, however, the temperatures attained during scorching should not exceed the point that will lead the material to lose its protein quality, e.g. 120^0C must not be exceeded for groundnut (Weiss, 1983).

Small-scale oil extraction is more common in Nigeria. Most of the large-scale oil processing machinery are imported into the country. Unfortunately these are beyond the purchasing power of many Nigerian peasant farmers.

The aim of this work is to develop an efficient, inexpensive and machinery.

MATERIALS AND METHOD

Design Capacity of the Expeller

The expeller was designed to have a processing capacity that is 20 times the local processing method. The record of the average processing capacity from various local processors was 0.4478l/hr (Mesole, 1998).

Machine capacity = 0.4478x20

$= 8.956 \times 10^{-3} m^3/hr$

Extraction pressure = 13.6×10^6 N/m^2 (Perry, 1984)

Groundnut oil density $\rho = 913.5 kg/m^3$

Thus from the relationship:

Density $\rho = m/v$

Where m = mass of oil seed

V = machine capacity (volume of hopper)

$\therefore m = 913.5 \times 0.008956$

$= 8.1799626 kg/hr.$

Design Procedure

This expeller was designed to have a processing capacity of 8.956l/hr. of oil seeds. The design consists of a frame, feeding hopper, grinding unit, hot water chamber and the expelling unit.

In designing this expeller, the basic factors considered include the choice of materials, their availability, durability, amount of labour and the properties of material.

Prime mover

This generates power to be transmitted through belts to the burr mill and the expelling unit and producing sufficient torque at each unit. A 5hp, 1440rpm electric motor was selected.

Pulleys and Belt drives

These components transmit power from the prime mover to the grinding and expeller shafts. V-groove pulleys and belts were selected due to its advantage over flat belts.

Hopper

The hopper serves as the feeding point of oilseed materials to the grinding unit. It has a dimension of 300x250mm and an opening of 90mm.

Expeller shaft casing and screen

The casing has two openings of which one is for the inlet channel and the other for discharge. The casing has a dimension of 650mm length, 70 and 55mm diameters at inlet and discharge ends respectively. The design volume was $7.5 \times 10^{-3} m^3$. the perforated bottom of the casing collects and drains the oil through a pipe. Wire gauze was used at the bottom to purify the oil.

Expeller shaft

The expeller shaft is made of mild steel and is in form of an auger. It conveys the paste fed through the inlet channel to the tapered end where it is pressed.

Discharge outlet

The discharge outlet is forced open when the paste would have been pressed against the tapered casing by the tangential force of the auger strips. The cake is discharged at this pressure when oil would have been extracted from the paste. The discharger is operated by a spring to effect opening of the outlet.

Hot water chamber

The hot water chamber is a means by which hot water is passed to the auger casing so as to increase the paste temperature for efficient oil expulsion particularly in the case of groundnut paste. The hot water is generated inside a cylindrical container made of stainless steel and the heating element rating is 1000w.

Description and Principle of Operation

The expeller is powered by a 5hp electric motor through pulleys, belts and shafts. The oil seeds such as groundnuts, soybeans, etc are ground into paste at the grinding unit of the expeller called the burr mill, which is linked up to with the expelling unit with suitable transmission elements. This is an advantage over the conventional ones as the oilseed material is processed and oil expelled in one pass. In this unit is a hopper that feeds the oilseeds for grinding. The seeds are conveyed into the grinding discs, made of rough surfaces. One disc is stationary while the other is rotated of which these seeds are constrained to pass in between the disc plates and come out as a grounded paste. The paste is then conveyed to the expelling unit,

where the screw shaft is constrained to rotate in the opposite direction to the burr mill shaft. And this is achieved with the aid of crossed-belt connected from the v-pulleys of the burr mill shaft to the expeller shaft respectively. The screw shaft inside the cylindrical casing transports the paste from a larger area to a smaller area of the casing bringing about increase in pressure which ruptures the oil seed cells to release oil. The oil is collected beneath the cylinder through a pipe, and the cake through the discharge outlet at the tapered end (plate 1, fig.1).

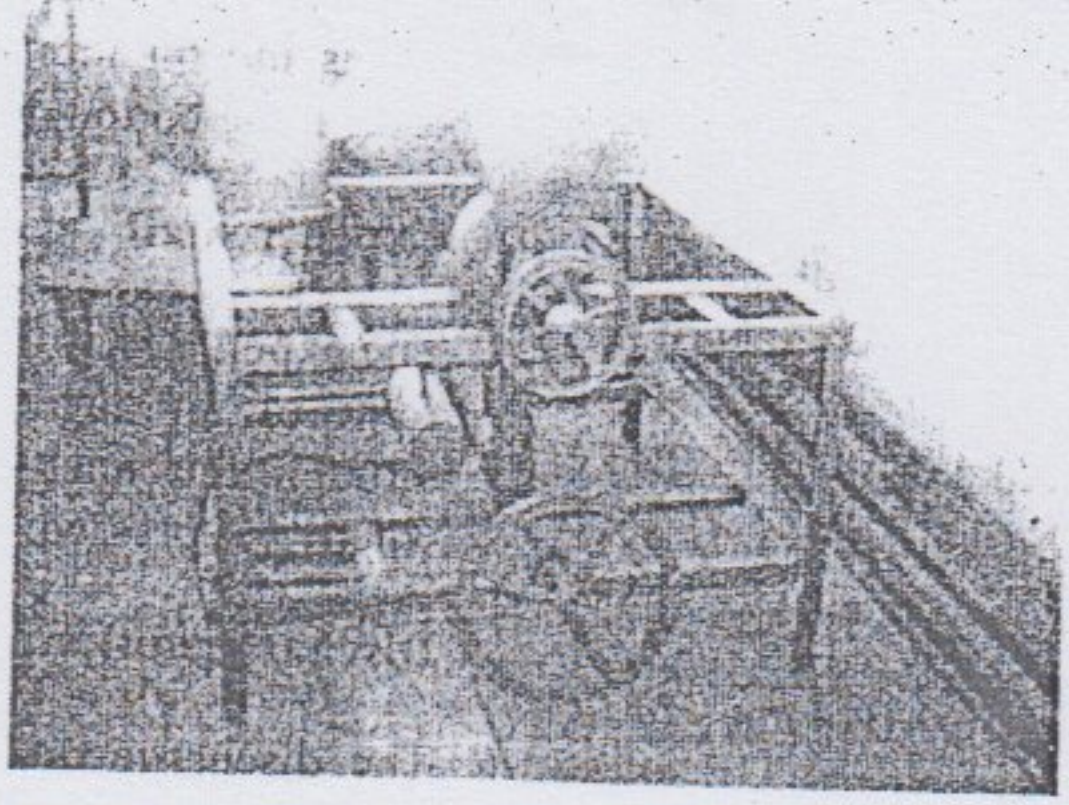

Plate 1: Picture of the multipurpose oil expeller

Test Procedure

In order to test the multipurpose oil expeller, the machine was subjected to performance tests using groundnut. The groundnut was poured into the hopper to the grinding unit, after grinding, the paste was gradually conveyed to the tapered end by the rotating screw shaft. The discharge outlet opened due to cake build-up and the cake was discharged and the oil drained through the oil-collecting pipe into a container. Three readings were taken and the average was calculated.

RESULTS AND DISCUSSION

The following measurements were taken before and after the extraction:

Weight of groundnut sample:	2kg
Weight of cake after extraction:	0.996kg
Weight of extracted oil:	1kg
Losses:	0.0037kg
Extraction time:	10minutes
Water temperature:	60°C

Determination of effective capacity

1.0kg of oil extracted in 10 minutes

10 minutes = 1.0kg

1minute = 1.0/10 = 0.1kg

60 minutes = 0.1 x 60 = 6kg/hr

Effective capacity = 6.0kg/hr.

Determination of extraction efficiency

The efficiency of the expeller was determined using:

1ltr = 1kg

$$\text{Efficiency} = \frac{\text{Extracted oil}}{\text{Extractible oil}} \times 100\%$$

$$\text{Efficiency} = \frac{6.0}{8.956} \times 100 = 67\%$$

The performance of the oil expeller with groundnut indicates that the oil output of the machine was 6ltr/h. and the efficiency was obtained to be 67%. This could be attributed to the measure of oil content of groundnut and degree of its resistance to shear. Thus from the test trials, it is probable that a greater and more steady supply of heat would be required as well as a longer expelling shaft for more effective output.

CONCLUSION

A multipurpose oil expeller was designed, constructed and tested. The main essence of the machine was to provide a means in the machine that would enhance the processing of groundnut oil e.g. grinding and heat treatments of the oil

seeds and to reduce losses associated with processing operations. The machine was tested with groundnut. The result showed that the machine attained oil expelling output capacity of 6.0kg/hr. Heat also facilitates the extraction of the oil. From the fabrication carried out, it can be concluded that the machine is affordable as compared to the worth of equivalent machines, and the materials are locally available.

However this expeller is an improvement over the conventional ones because the grinding unit is incorporated with the expelling unit thereby processing oil in one pass.

Recommendation

For further modification of this machine, the following recommendations are suggested below:

i The water heating chambers should be insulated to reduce heat losses

ii Using of stainless steel should be encouraged to avoid coating with paint

iii The weight of the frame should be able to counterbalance the vibration from the machine operation.

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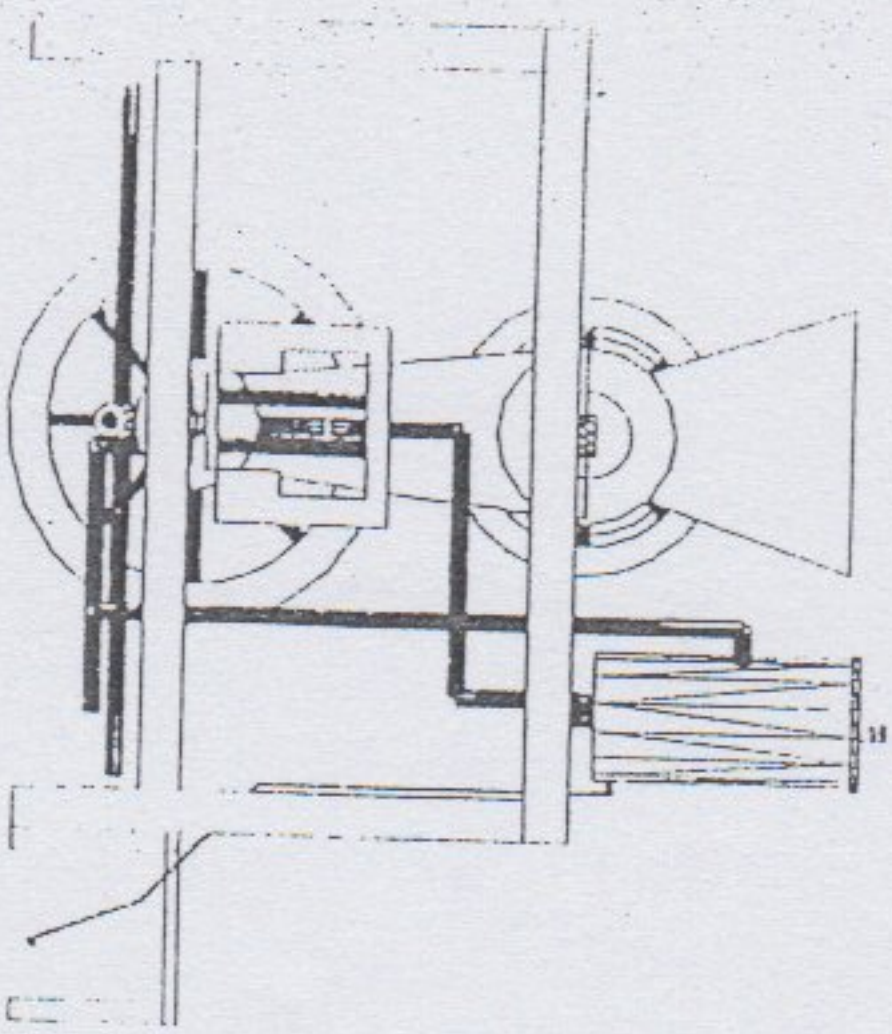

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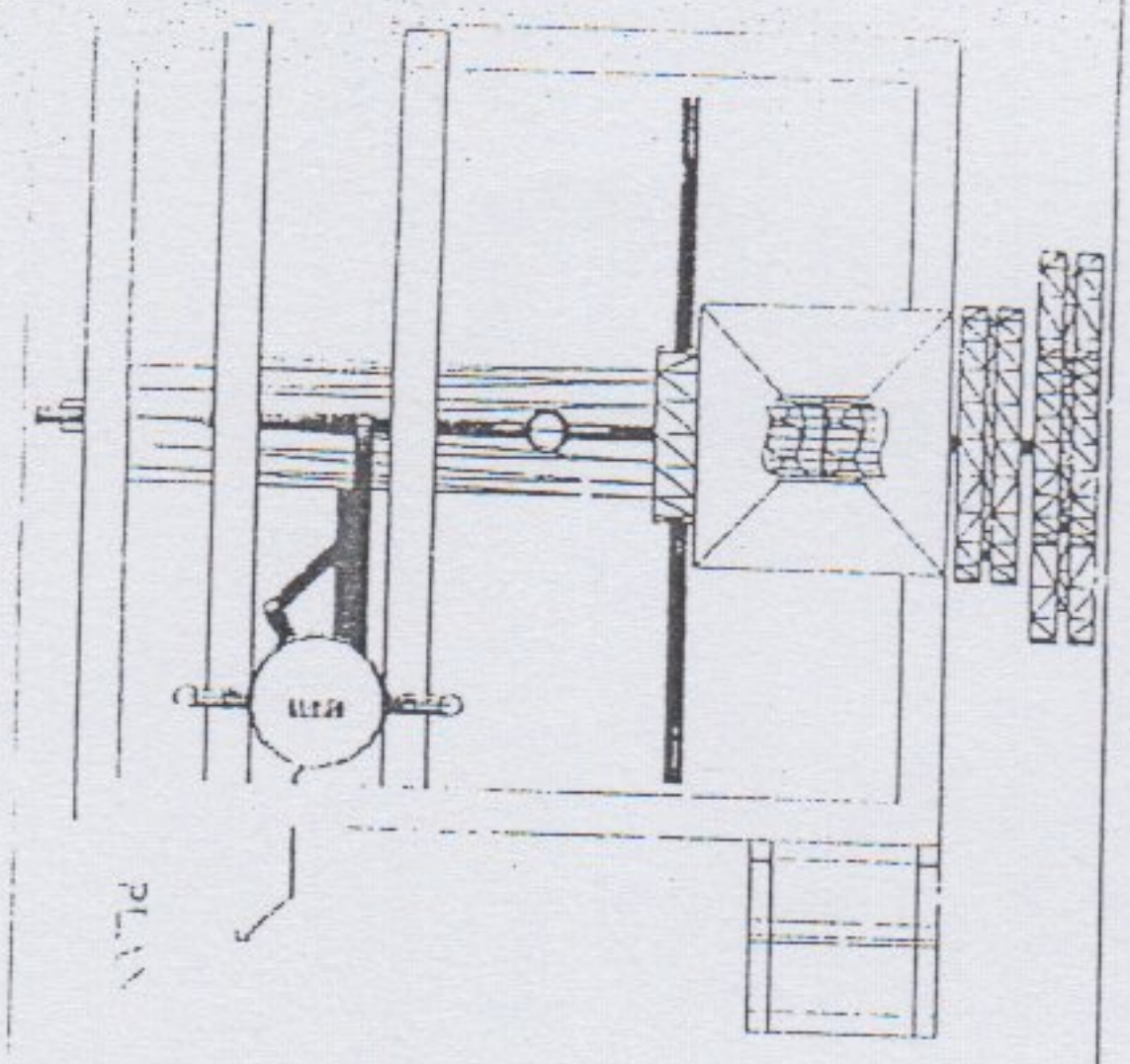

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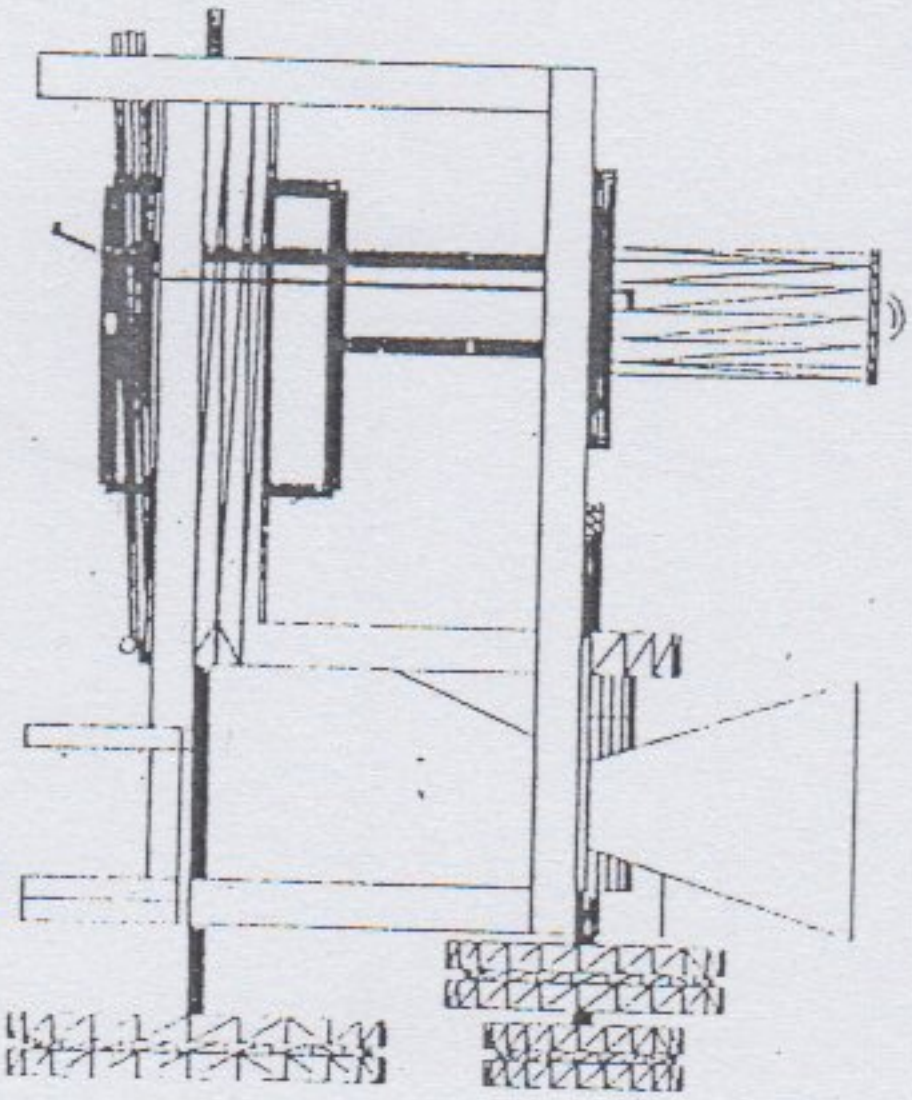

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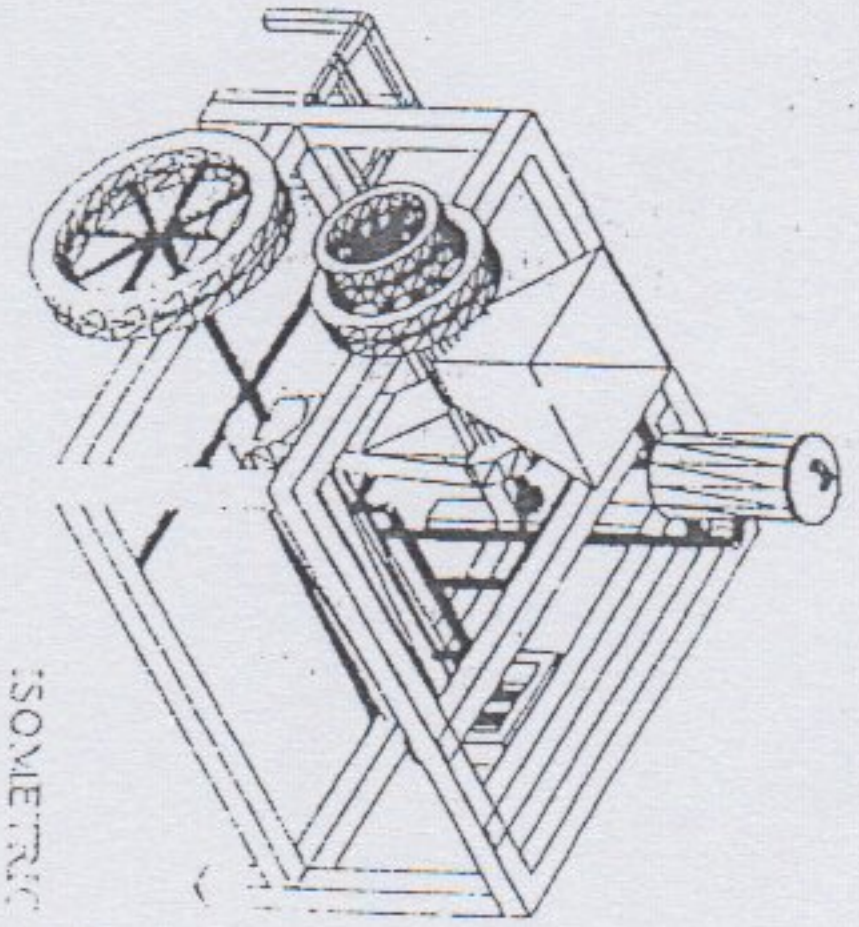

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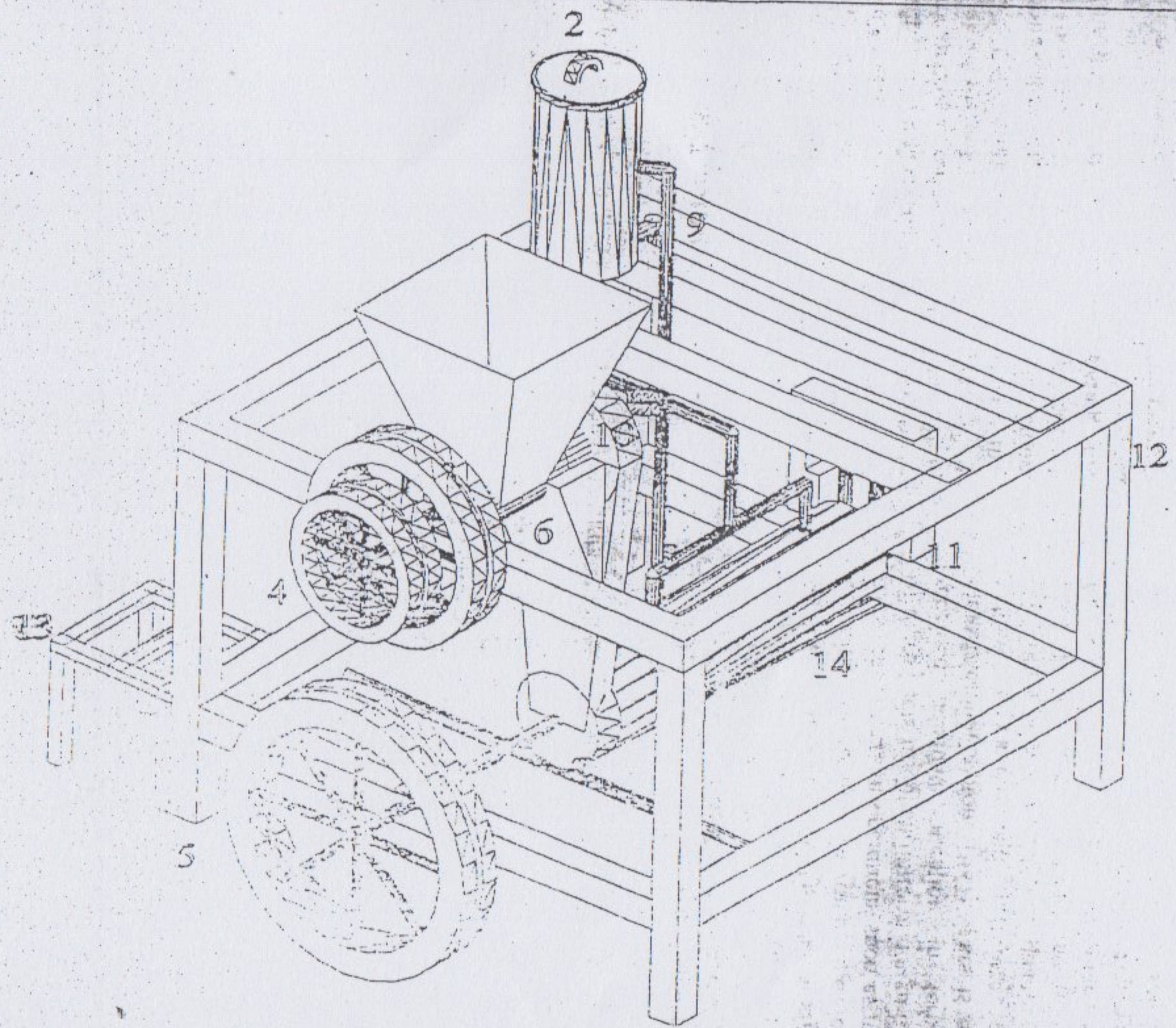

DESCRIPTION	QTY.	MAT. USED
1. Burr Mill Hopper	1	Mild Steel
2. Water Heating Tank	1	Mild Steel
3. Burr Mill Pulley	1	Mild Steel
4. Smaller Expeller Pulley	1	Mild Steel
5. Bigger Expeller Pulley	1	Mild Steel
6. Expeller Hopper	1	Mild Steel
7. Expelling Unit	1	Cast Iron
8. Water Pipe	2	Aluminium
9. Return Pipe	1	Aluminium
10. Grinding Unit	1	Cast Iron
11. Cake Discharger	1	High Yield Ste
12. Machine Frame	1	Cast Iron
13. Prime Mover Frame	1	Cast Iron
14. Oil Collection Unit	1	Mild Steel