DEVELOPMENT OF A RICE THRESHER

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ABSTRACT

Rice threshing in Nigeria remains a problem to the average peasant farmer. The techniques for threshing rice are still the traditional method of hand beating. This method is laborious: time wasting and not economical. also the commonly available rice threshers are the imported ones. which are not affordable to majority of Nigerian farmers. A Rice thresher-cleaner with output capacity of 276.9kg/hr. was designed and fabricated to solve threshing problem in Nigeria. The physical properties of Faro 51 Rice crop and grain such as length of ears. length and breadth of grain. grain/straw ratio and moisture content were studied. The thresher was fabricated and evaluated for its performance in terms of threshing efficiency. cleaning efficiency and percentage grain loss. At rice average moisture content of 13.83% (wet basis). and design cylinder speed of 556rpm. test results reveals that the rice thresher has a threshing efficiency of 98.01%. cleaning efficiency of 99.32%. total percent losses of 4.78%.

INTRODUCTION

Threshing is the first and most important post-harvest operation of grain crops. It involves the detachment of grain kernels from the stalk heads (Nkama. 1992). The traditional method of grain threshing in Nigeria is by hand beating with stick or hitting the grain stalk or pods on the floor. This method is not only inefficient but also very laborious and the output is low resulting in delay in handling large volumes of grain harvest and subsequently leading to losses. Mechanical or powered threshers have been introduced to overcome these difficulties. but local acceptability have been very low due to failure of the threshers to reach their rated capacities and efficiencies under continuous usage in the field. The use of engine powered machines and equipment in Nigerian Agriculture dates back to the early 1960s following the establishment of farm settlements in the eastern and western regions of Nigeria (Chukwu. 1994). Also. there is now a general awareness in Nigeria and other developing countries that the rapid development of agriculture depends on a large extent on the successful introduction of modern indigenous agricultural machinery. Most of the farm equipment presently used in Niger State are imported from several countries as shown in Table 1. This has resulted in assortment of different machines with inherent problems ranging from mis-matching within the machine combination and with local farming systems to non-availability of spare parts. inadequate provision of power drive units among others. Based on the above reasons. a rice thresher was designed. developed and it's performance evaluated. It is capable of reducing drudgery. grain damage. grain losses and improving the quality of rice grain. The physical properties of rice crop and grain such as length of ears of rice crop. grain length and breadth. grain/straw ratio were studied. Parameters such as cylinder peripheral speed. type of beaters concave clearance among others were selected (The Food Agency. 1995. Hem. 1981).

TABLE 1: Inventory of rice threshers by establishment and by make in Niger State in 1993.

Establishment	No. of makes	Votex	FAT E	Vico n	Akshat	Embee	Cecoe o	Kubot a	Alvan Blanch	TNA *
NSADP. Minna	One	-	-	1	-	-	-	-	-	1
NSADP. Bida	Six	9	2	1	2	1	1	-	-	16
NRBDA. Minna	One	-	-	-	-	-	-	3	-	3
NSADP. Kuta	One	2	-	-	-	-	-	-	-	2
FMANR. Minna	Two	2	-	1	-	-	-	-	-	3
NSMANR. Minna	Nill	-	-	-	-	-	-	-	-	0
SANBEL FARMS LTD.	One	6	-	-	-	-	-	1	-	6
BAKO FARMS	One	3	-	-	-	-	-	-	-	3
UMMA FARMS	Two	2	-	-	2	-	-	-	-	4
FARM INS'T Tegina	One	1	-	-	-	-	-	-	-	1
NCRI. Badeggi	Two	2	-	-	-	-	-	-	2	4
TOTAL		27	2	5	2	1	1	3	2	43
% OF TOTAL BY MAKE		62.79	4.65	11.63	4.65	2.33	2.33	6.97	4.65	

TNA* = TOTAL NUMBER AVAILABLE
Source: Chukwu. 1994

MATERIAL AND METHOD

Design Considerations And Relevant Engineering Properties Of Grain

Before the design and fabrication. it was necessary to consider some physical and engineering properties of the rice grain in order to select the best machine parameters such as sieve hole diameter. hopper size concave clearance thresher capacity etc. These include. length of ears of Rice crop. length of rice grain. breadth of rice grain. moisture content and grain straw ratio (Chabbra.1975).

Determination Of Physical & Engineering Properties Of Rice

The following properties of rice pertinent to the design of the thresher were determined: length of rice grain. grain breadth. grain/straw ratio and length of ears of rice crop. The length and breadth of grain was used to select sieve hole diameters. length of ears of rice crop was used to select hopper size and the grain/straw ratio was to determine the theoretical capacity of the thresher. The grain size were determined by measuring the length and breadth with a micrometer screw gauge while a tape rule was used to measure the length of ears of rice crop. Grain moisture content was determined by

oven dry method at a temperature of 104°C for 24hours (A.O.A.C 1984) all measurement were taken in the laboratory at a room temperature of 28°C. The following design parameters were established after measurement of the physical properties of the Rice grain and review of available literatures (Hem. 1981. Ahuja and Sharma. 1989. The Food Agency. 1995). 556rpm was selected for cylinder speed. 4.46m/s fan air velocity. 40mm concave clearance. 8mm and 3mm sieve perforation diameters for top and bottom sieves respectively and a power requirement of 7.9kw.

DESCRIPTION AND OPERATION OF THE RICE THRESHER

The main features of the rice thresher are: The hopper. the transmission unit. reciprocating cleaning unit. straw outlet. grain outlet and the supporting frame. The drawings. and dimensions of the thresher are shown in Figs 1& 2. The hopper is trapezoidal in shape. It forms the feeding chute through which rice heads are fed into the threshing unit. The material of construction was gauge 16 mild steel sheet with all sides slanting inwards. The transmission unit consists of five pulleys. bearings. shafts and v-belts. Two pulleys are mounted on the cylinder shaft. one on each side. The threshing unit consists of a cylinder. beaters and a concave made of mild steel iron rods. formed into semi circle with 8mm spaced in between. The cylinder is placed above the concave. it is made of 37.5mm mild steel flat bar rolled into circle of 300mm and connected with eight rows of 37.5mm flat bars. This arrangement and orientation is to aid the conveyance of the straw to the straw outlet. The beaters are made from mild steel iron rods. in each row. the beaters are spaced at 100mm from each other. and the clearance between the free end of beaters and concave is maintained at 40mm. The threshing unit is covered with a trapezoidal shaped steel plate (gauge 16) to prevent loss of rice grains through scattering.

A reciprocating sieve arrangement unit made of mild steel sheet arranged at a determined angle for free flow of paddy resting on four bearings is positioned 100mm below the concave. Below the sieve unit is the clean grain outlet. The fan is stationed below the first sieve to give a cleaning effect. It is an axial flow type with three blades made of gauge 16 mild steel sheet welded to a shaft. The structural frame forms the mounting support of all other units of the thresher and is made of 50mm angle iron. The overall dimension is 1700x1730x850mm. The Rice thresher works on principles of impact. Rice heads are fed uniformly into the hopper. The ear/heads fall by gravity on the rotating cylinder and are threshed by impact of the beaters and are whirled round between the concave and the rotating cylinder. The grains and little chaff fall through the concave openings onto the reciprocating sieve plate. Just before falling into the collection chute/grain outlet. the blower air stream blows off the chaff over the second screen. leaving behind clean grains. The sieve is automatically agitated to further grade the grain before collection at the grain outlet by the cam.

Fig. 1: Picture of the Rice Thresher

Legends for Fig. 2

No. of item	Description and specification	Qty	Material
1	Trapezoidal feeding hopper (540x760x330mm)	1	Gauge 16 ms sheet
2	Threshing cylinder 2300x680mm	1	37.5mm flat bar
3	Threshing concave semi circular 2460x380mm	1	iron rods
4	Sieve 28x1200x570mm. 28x700x570mm and 23x1000x570mm.		gauge 16 ms sheet
5	Pulleys 2120. 2300. 2190. 2120 and 2100mm.	3	Alluminium
6	Fan housing 2450x530mm	5	Gauge 16 ms sheet
7	Fan blade 280x196x500mm	1	Gauge 16 ms sheet
8	Frame 50x50mm angle bar	3	Ms angle bar
9	Grain outlet 2300x150mm	1	Gauge 16 ms sheet
10	v-belts AA 85. AA55 and AA38	3	Leather
11	Prime mover gasoline engine 10.5 hp	1	Ms iron rod
12	Cam	1	Gauge 16 ms sheet
13	Shaft		
14	Straw outlet		
15	Bearings. FSP206. FSP205	6	

16	Threshing teeth (beaters) 26x50mm	48	
17	Cover plate (trapezoidal) 220x300x220x600mm	1	
18	Bolts and nuts. 13mm. 17mm. 19mm		

PERFORMANCE EVALUATION

Short-run tests were carried out to obtain the following information: total losses. threshing efficiency. cleaning efficiency. input capacity and output capacity. At design cylinder speed of 556rpm. the threshed materials were collected at the outlets cleaned and weighed. The portion of the material containing unthreshed grains was separated from straw and weighed after hand threshing and cleaning in order to determine the threshing and cleaning efficiencies in terms of total grain received. The formula used for calculating these parameters are as follows:

DETERMINATION OF TOTAL LOSSES

a. **Percentage unthreshed grain**

$$= \left(\frac{\text{quantity of unthreshed grain obtained from straws in kg}}{\text{total grain received at grain outlet in kg}} \right) \times 100$$

b. **Percentage of cracked and broken grain**

$$= \left(\frac{\text{cracked and broken grain from grain outlet in kg}}{\text{Total grain received at grain outlet in kg}} \right) \times 100$$

c. **Percentage of blown grain**

$$= \left(\frac{\text{quantity of clean grain obtained at straw outlet in kg}}{\text{Total grain input in kg}} \right) \times 100$$

d. **Percentage of sieve loss**

$$= \left(\frac{\text{clean grain at sieve overflow +sieve underflow + stuck grain in kg}}{\text{Total grain input in kg}} \right) \times 100$$

e. **Total losses** = Sum of losses obtained at (a). (b). (c) and (d) above.

DETERMINATION OF EFFICIENCIES

a. **Threshing Efficiency**: This is the ratio of total weight of grains threshed to the total weight of grains fed into the thresher for threshing expressed as a percentage. It is also the difference between 100% and the percentage of unthreshed grain.

Threshing efficiency (TE) = 100 - percent of unthreshed grain

b. **Cleaning Efficiency**: The ratio of the weight of clean grains that pass through the cleaning unit to the total weight of grains at the outlet of the grain retainer expressed as a percentage.

Threshing efficiency (CE) =

$$\left(\frac{\text{clean grain received at grain outlet in kg}}{\text{total grain received at grain outlet in kg}} \right)$$

DETERMINATION OF OUTPUT CAPACITY

weight of threshed grain received at specified grain outlet is taken and recorded

RESULTS AND DISCUSSION

The result of the physical properties of FARO 51 rice crop and grain are presented in table 2. The average length of ears of FARO 51 rice variety was 78.9cm. average length of FARO 51 rice grain is 6.99mm. breadth of grain is 3.36mm and the grain straw ratio is 1.22.

The result presented in Table 3. represents the average performance evaluation of the rice thresher. At Rice moisture content of 13.83%. cylinder speed of 556RPM. the threshing efficiency was determined to be 98.01%. cleaning efficiency of 99.32% total loses of 4.78% output capacity of 267.9 kg/hr. Therefore. the machine is efficient in terms of threshing and cleaning.

To determine the output capacity. the

Table 2: Some Physical Properties of Rice

S/no.	Length of ears of Rice crop(cm)	Length of Rice Grain (mm)	Breadth of Rice grain (mm)	Grain/Straw ratio
1.	90	6.30	3.36	1.22
2.	92	7.56	3.05	1.25
3.	80	6.76.	2.85	1.20
4.	70	7.84	3.14	1.23
5.	89	6.49	3.76	1.30
6.	78	7.14	3.82	1.18
7.	93	6.50	3.46	1.18
8.	56	7.56	3.22	1.22
9.	50	6.82	3.44	1.24
10.	91	7.00	3.55	1.20
Average	78.9	6.99	3.36	1.22

Table 3: Capacity data of Rice Thresher

I.	Variety of rice handled:	FARO 51
II.	Grain/Straw ratio:	1:1.22 (average)
III.	Moisture content of rice handled:	13.83% (average) wet basis
IV.	Power requirement:	7.9KW (10.5hp) gasoline engine
V.	Losses:	
	a) Unthreshed grain:	1.99%
	b) Cracked and broken grain:	0%
	c) Sieve loss:	2.79%
VI.	Threshing efficiency:	98.01%
VII.	Cleaning efficiency:	99.32%
IX.	Input capacity:	480kg/hr.
X.	Output capacity:	276.9kg/hr.
XI.	Observation affecting performance:	
	a) Moisture content of rice crop and straw	
	b) Length of rice crop exceeding 93cm	
	c) Number of workers required is three	
	d) Machine requires continuous feeding	

CONCLUSION

A rice thresher has been designed and developed to simultaneously thresh the commonly available rice varieties. it will be very useful to both small and medium scale farmers.

The following could be concluded from the experimental results. the maximum output of the thresher was 267.9kg/hr at a design cylinder speed of 556rpm. the power required for operating the thresher was 7.9kw. The threshing efficiency was 98.01%. cleaning efficiency. 99.32% and the total percentage losses was 4.78%. The condition of the paddy rice head such as moisture content. grain/straw ratio. length of rice crop. grain length. cylinder speed. concave clearance and size of sieve aperture are machine-crop parameters that affect the performance of the thresher. Thus the use of this rice thresher can reduce or eliminate peak demand of labour during threshing period.

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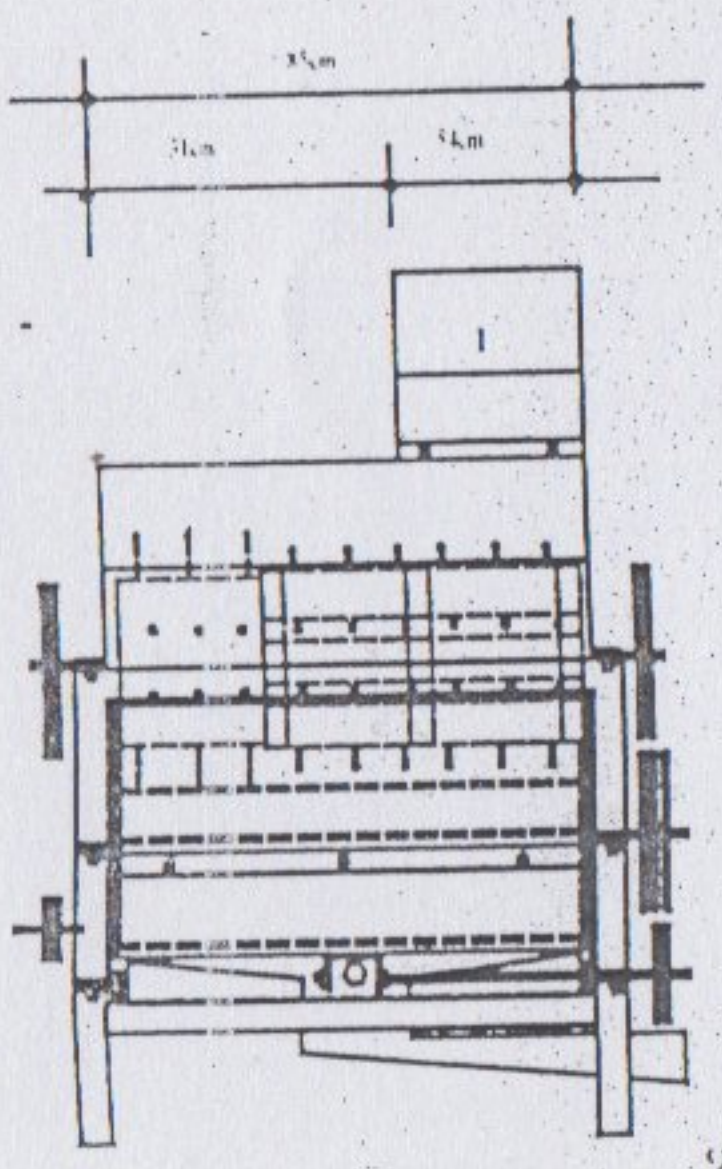
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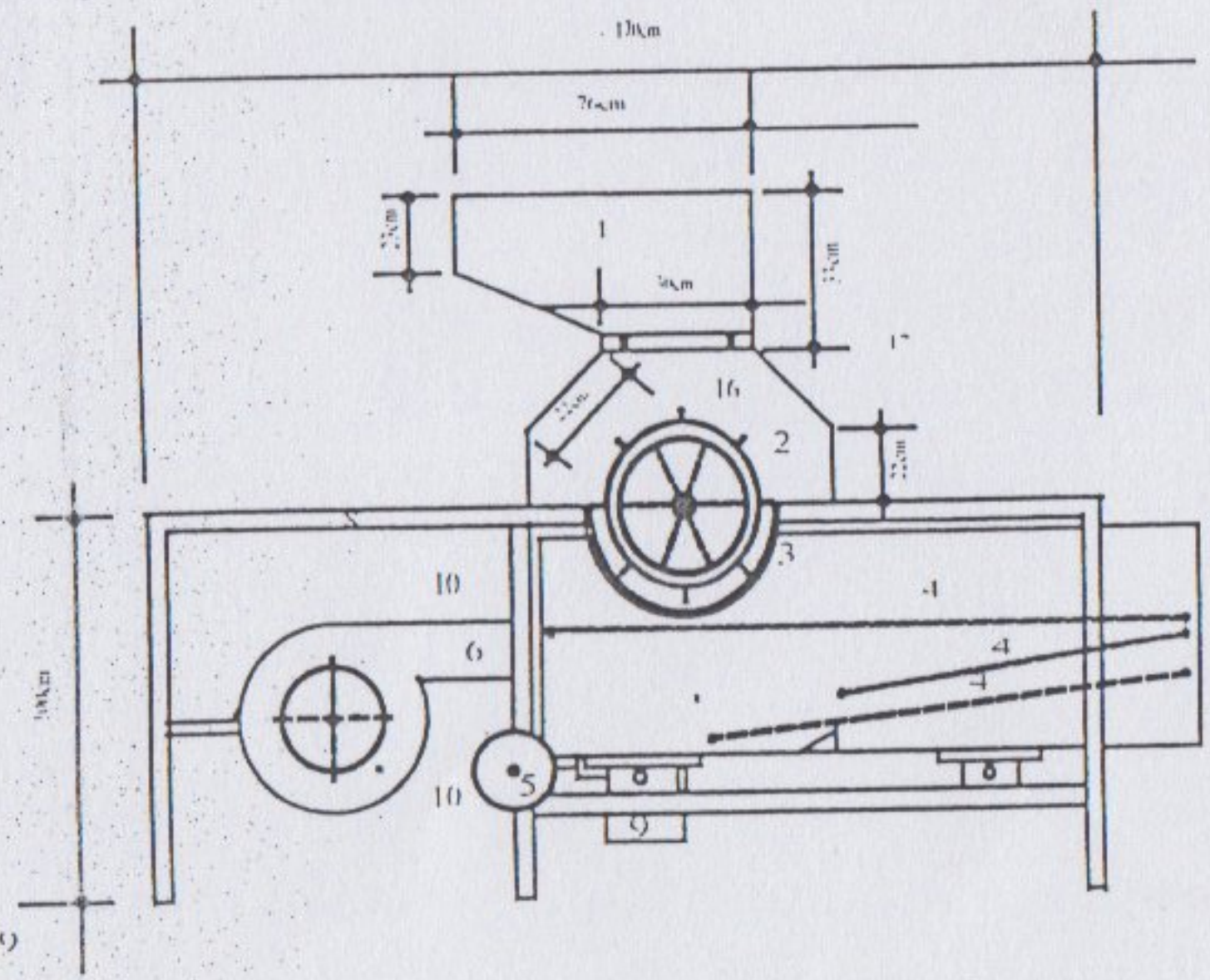
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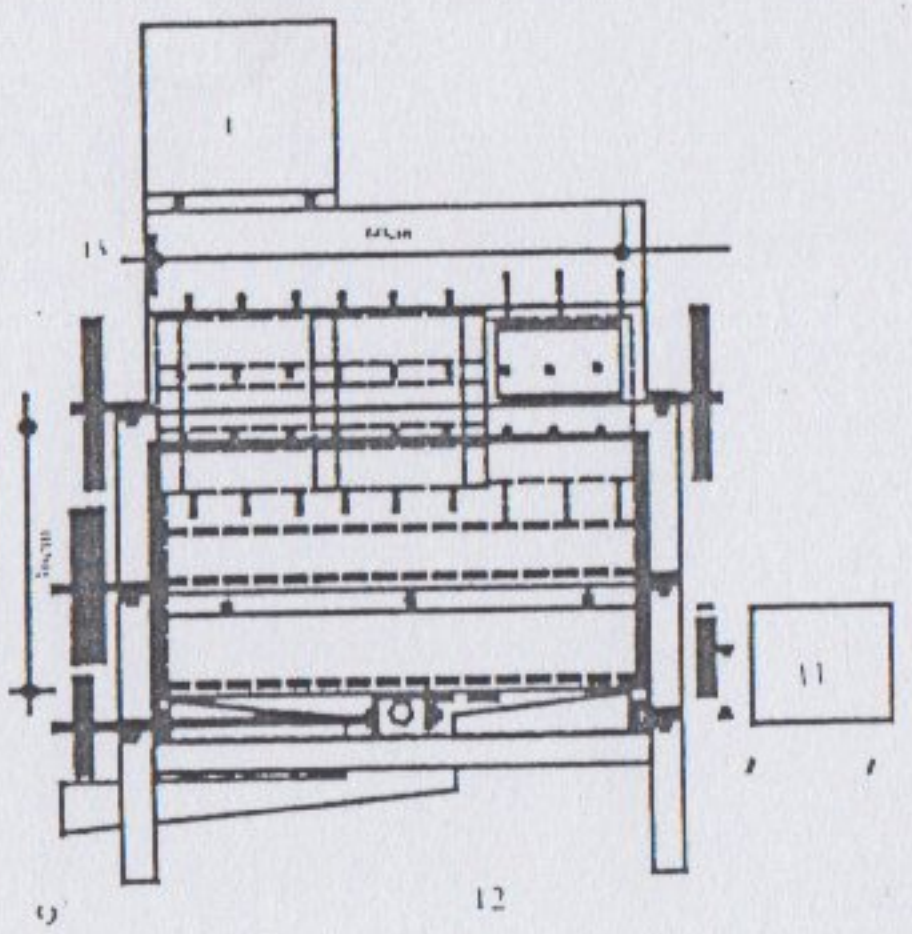
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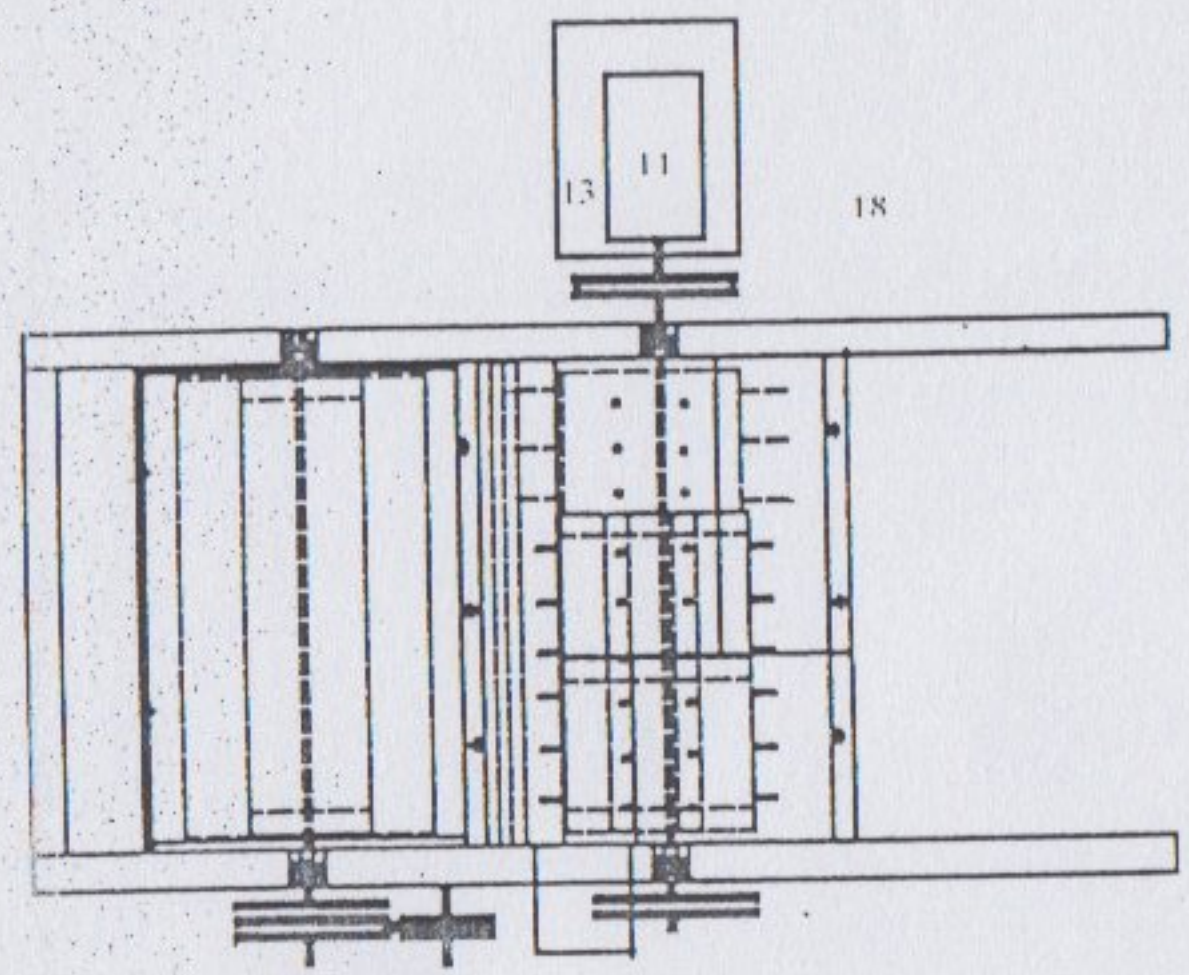
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