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DESIGN AND DEVELOPMENT OF MANUAL MULTIPURPOSE FOOD PREPARATION MACHINE

Priyank M. Ghaskata[1], Jayesh D. Ramani[2], Vishal J. Rana[3], Het G. Sakhiya[4], Meet K. Radadiya[5], Uttam Singh F. Gohil[6]

[1,4,5,6] Student (6th Semester- Mechanical Engg. Dept.) Tapi Diploma Engg. College, Surat, Gujarat, India-395006
[2]H.O.D (Mechanical Engg. Dept.) Tapi Diploma Engg. College, Surat, Gujarat, India-395006
[3]Lecturer (Mechanical Engg. Dept.) Tapi Diploma Engg. College, Surat, Gujarat, India-395006

Abstract - *Most modern food preparation appliances rely heavily on electricity, which poses a significant challenge for vendors and households in rural areas prone to regular power cuts. This paper details the design and development of a manual multipurpose machine capable of performing dough kneading, chopping, and mixing/grinding without electrical power. The system utilizes a hand-operated handle connected to a gear mechanism that drives multiple functional shafts simultaneously or individually. By providing a portable, sturdy, and economic solution, this machine eliminates electricity costs and improves food preparation efficiency for small-scale vendors and rural users.*

Key Words: **Manual Multipurpose Machine, Food Preparation, Bevel Gear, Powerless Solution, Rural Development, Mechanical Design**

1. INTRODUCTION

In daily life, the majority of appliances used for food preparation are electricity-dependent. While this is convenient in urban settings, vendors and small food stalls in rural areas face frequent power interruptions that stall their daily work. Furthermore, using separate machines for different tasks like kneading and grinding is space-consuming and expensive. This project introduces a manual multipurpose machine designed to address these issues by providing a single, powerless solution for multiple kitchen chores.

2. LITERATURE REVIEW

2.1 "Quick-Return Mechanism Design and Analysis Projects": [1]

This research paper includes basics of quick return mechanism in detail. It includes detailed design and study on quick return mechanism, different types, design, their application in industry, etc. We also learned how it is beneficial for students to learn about the design, and different parameters of quick return mechanism.

2.2 "A study on Quick Return Mechanisms in Shaper, Planner and Slotter machines": [2]

This research paper includes detailed information about different types of quick return mechanism used in industries and different machineries like shaper, planner, slotter. Detailed information about this machines, their application and usage. Also how quick return mechanism works and is used in different places.

2.3 "Analysing Bevel Gears for Efficient Power Transmission": [3]

The study compares four different materials—gray cast iron, stainless steel, structural steel, and titanium alloy—to determine their suitability for efficient power transmission. Results show that structural steel exhibits the lowest deformation and strain, making it the most suitable among the tested materials. The maximum stress observed occurred near the tooth base, a critical area in gear design. Overall, the research highlights the importance of material selection and computational simulation in optimizing gear design for strength and reliability. Through this research paper we learned about material selection for gear, and learned about different loads and stresses that effect gear life.

2.4 "Bevel Gear Design and Material Selection": [4]

This paper focuses on the geometric design, modeling, and material selection of bevel gears using CAD and analysis methods. The authors present the theory and classification of bevel gears (straight, spiral, hypoid), define the pitch surfaces and angles, and explain how gear geometry is derived for intersecting shafts. They then select appropriate materials—considering strength, wear resistance, manufacturability—and compute safety factors and stresses for the gear designs.

2.5 "Design of Gear Drives with High Gear Ratio": [5]

This research paper includes different factors to consider while designing the gear ratio. The work emphasizes strategies to minimize transmission error, improve stiffness, and reduce vibration and noise under high-ratio conditions. Through simulation and rigorous design methods, the

authors identify conditions and geometrical constraits under which these systems can operate reliably and efficiently. This contribution advances the understanding of how to design high-gear-ratio drives with improved dynamic behavior, offering useful guidance for applications requiring compact, precise, and robust power transmission.

2.6 "The Optimal Design of Standard Gearsets": [6]

This research paper shows details about how gearsets actually work, with considering different important factor. From this research we got information about how to design a gearset efficiently. It shows study about designs of different gearset like spur gear, planetary gear, etc. And how to fit whole gearset in compact or small areas. Overall, the paper offers a systematic path toward compact, reliable gear design by combining geometric, kinematic, and strength criteria.

2.7 "Design and Development of Manual Mixer": [7]

The paper describes the design, development, and validation of a manual (hand-operated) mixer grinder intended for households in both rural and urban settings, especially where electricity is intermittent or unavailable. The authors conducted market surveys and ethnographic research to understand user needs, then used Quality Function Deployment (QFD) to translate those needs into technical design specifications. Through conceptual design tools and evaluation methods (e.g. weighted ranking), they selected an optimal concept, and performed detailed design using CATIA CAD software, considering material choice and manufacturability. A full-scale working prototype was then built. Tests involved grinding soaked dal (150 grams), using the prototype's gearing mechanism: 1000 revolutions of the mixing unit for every 120 handle turns. The output was a fine-grained paste, demonstrating that the manual mixer is capable of producing adequate grinding performance without electric power. The paper concludes that such manually operated mixers, properly designed via user-centric design tools and manufactured with suitable materials, can provide effective alternatives to electric mixers, especially in areas with unreliable power or for energy savings.

2.8 "An Overview of Engineering Bearings, Types, and Applications": [8]

This paper highlight applications of bearing across sectors such as automotive, aerospace, industrial machinery, construction, robotics, and infrastructure. Finally, emerging trends—such as smart bearings with embedded sensors for predictive maintenance—are identified, along with challenges like miniaturization, high speed, high load, environmental conditions, fatigue, and reliability. It has detailed information about history of bearings, that how they were manufactured before and now also, paper has information about different types of bearing with its usage in today life of modern industrialization.

2.9 "Development of dough kneading machine for small and medium-sized enterprises": [9]

This study reports the design, fabrication, and testing of a motorized dough-kneading machine aimed at supporting small and medium-scale food businesses. The machine uses dual electric motors mounted on the same axis—one above and one below—to rotate in opposite directions, improving kneading efficiency by generating better mixing action. The designers modeled the machine according to locally relevant specifications (materials, bowl size, motor ratings), then constructed it using mild steel for the frame, aluminum for the bowl, and stainless steel for dough-contact components. Overall, the machine proved suitable for SMEs—being fairly simple, efficient, and durable—and offers a good basis for further refinement (e.g. optimizing energy use, mixing time, adjusting for different dough types).

2.10 "A study of bearing and its types": [10]

This paper provides a comprehensive overview of bearings as essential mechanical components that facilitate relative motion between machine parts while supporting loads. The authors classify bearings into two primary categories: sliding bearings and rolling bearings, each with distinct operational principles and applications. They delve into various subtypes, including hydrodynamic, boundary lubrication, hydrostatic, and thrust bearings, explaining their mechanisms and suitability for different operational conditions. The study emphasizes the importance of lubrication in reducing friction and wear, thereby enhancing the efficiency and lifespan of bearings. Additionally, the authors highlight the significance of material selection and design considerations in optimizing bearing performance. The paper serves as a valuable resource for understanding the fundamental aspects of bearings and their critical role in machinery and equipment.

3. DESIGN

3.1 3D design of machine

Fig -1: 3D Design

3.2 2D Design of machine

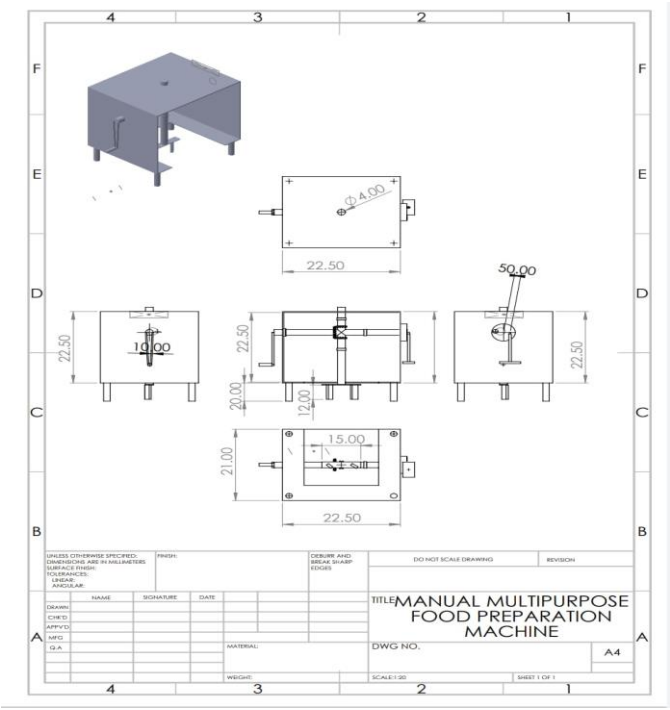

Fig -2: 2D Design

3.3 Design of Main body

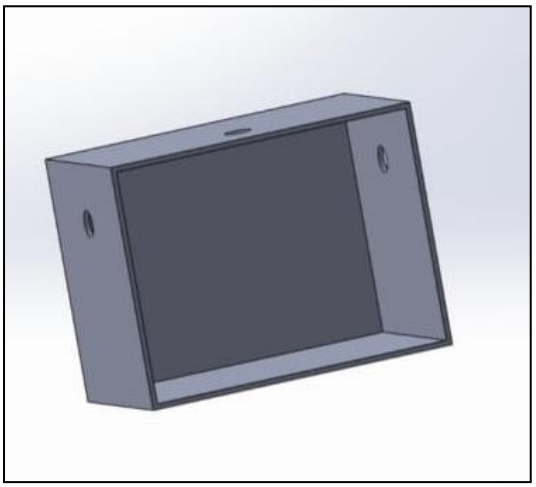

Fig -3: 3D design of main body

It is main outer body which supports and holds whole structure and whole mechanism. On top of the body there is mixer grinder mechanism, on left hand side there is handle to operate whole machine. On right hand side there is chopping/ mashing mechanism. And at bottom there is kneading mechanism.

3.4 Mixer/ Grinder mechanism

On top of the body there is mixer/ grinder mechanism. The capacity of jar is around 750 ml to 1 liter. There are set of gears which increases 1 rotation of handle to rotation of mixer blade.

3.5 Kneading mechanism

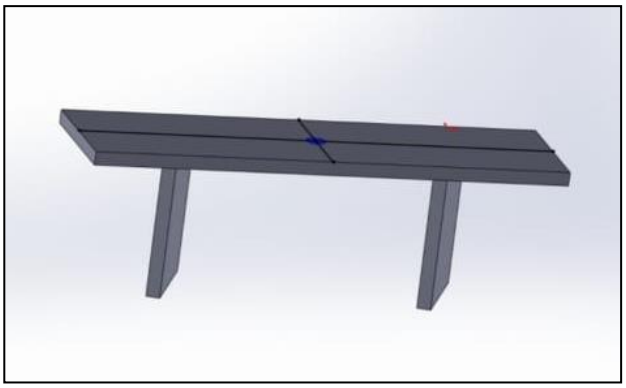

Fig -4: 3D design of kneading blade

On bottom of the machine there is kneading mechanism. Horizontal rotation of handle is converted into vertical rotation of kneading blades through gear mechanism. The capacity of kneading is around 2 to 4 kgs.

3.6 Handle

Fig -5 : 3D design of handle

Handle is made from M.S. rod. It is placed on left hand side of the machine. It is then connected to the gear mechanism at the center of machine.

3.7 Gear mechanism

Gear mechanism in this machine comprises of 4 bevel gears. The main gear from handle to connect to vertical shaft of kneading mechanism, horizontal shaft of mashing/ chopping mechanism and the main gear of handle shaft is mounted with other gear to increase the gear ratio for mixer grinder.

4. ADVANTAGES

1. No electricity required
2. Cost-effective
3. Multi-functional
4. Portable and durable
5. Suitable for rural applications

5. CONCLUSIONS

This project is designed and developed for the manually operated multi-purpose machine that demonstrate an effective approach toward simplifying basic food processing tasks such as mixing and kneading without relying on electrical energy.

The model has a single manual input (handle) to drive three shafts, showcasing efficient power transmission. By utilizing a simple hand-operated mechanism, the system is capable of performing multiple operations simultaneously or individually, depending on the requirement. The inclusion of a dedicated shaft for mixing and another for kneading reflects thoughtful functional design, while the third open shaft provides flexibility for future modifications or additional attachments.

Moreover, since the machine is manually powered, it eliminates electricity costs and minimizes environmental impact, making it eco-friendly.

From a practical perspective, this machine can be highly beneficial for small-scale households, street vendors, and rural users who require affordable and portable solutions.

The design is simple, easy to maintain, and does not require specialized skills to operate, which increases its usability across a wide range of users.
During the development process, various engineering concepts such as power transmission, shaft design, gear ratio, and material selection were applied, enhancing our understanding of real-world mechanical systems. The project also helped in improving problem-solving skills, teamwork, and hands-on fabrication experience.

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