

EASY-SET PRECISION DRILLING MACHINE ENHANCER

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ABSTRACT: *The Easy-set Precision Drilling Machine Enhancer integrates the functionalities of a work-holding device and a drilling jig to improve the accuracy and efficiency of drilling operations. The work-holding component secures the workpiece firmly during drilling, while the jig precisely positions the material and guides the drill bit using hardened steel bushings, ensuring uniform hole placement across multiple parts. The total production cost of the device is minimal, and its construction is deemed feasible given the availability of required materials, tools, and equipment. The device's acceptability was evaluated using Garvin's Eight Dimensions of Quality by expert respondents, yielding an overall average rating of 3.87, described as "very acceptable." Based on the findings, a technology package was developed, demonstrating that the innovation significantly enhances drilling precision, reduces material wastage, and improves production speed and cost-efficiency.*

Keywords: easy-set, precision drilling, drilling machine, work-holding device

1. INTRODUCTION

Technologically advanced and developed nations have transcended poverty and achieved higher levels of economic productivity through their relentless pursuit of innovation. Increasingly, technology is being recognized as a powerful developmental tool—playing a pivotal role in addressing global challenges in education, livelihood, and health. While technology was not originally created with development in mind, it has evolved into one of the most influential drivers of societal transformation. Young people, in particular, are natural adopters of new technologies, and the potential of these tools to spark innovation, improve learning, and effect meaningful change is only beginning to be fully realized.

One of the hallmarks of progress in developed countries is the widespread use of state-of-the-art machinery in industrial production. In an effort to keep pace with these technologically advanced nations, the Philippines has sent several technology instructors abroad to acquire new knowledge and skills. It is hoped that the expertise they gain will benefit not only their respective institutions but also contribute to the nation's broader goal of industrialization.

Technical-vocational schools serve as key implementing agencies in the government's strategy to produce highly skilled graduates who can drive the country's industrial engine toward economic progress. However, this mission cannot be accomplished without additional support to enhance instruction and practical training.

In this context, the present study aims to design and fabricate an Easy-Set Precision Drilling Machine Enhancer—a modification of existing equipment used in the Machine Shop Department of the Negros Oriental State University (NORSU) system in Negros Oriental. This innovation seeks to improve accuracy, reduce material wastage, and enhance overall productivity in machine shop operations.

The concept of fabricating the Easy-Set Precision Drilling Machine Enhancer originated from common issues encountered during drilling operations, such as drill bit breakage and misaligned or imprecisely drilled holes. To address these problems, certain attachments and accessories originally designed for use with drilling machines were modified and upgraded to reduce errors and enhance operational efficiency.

According to the *Metal Cutting Tool Handbook* (Seventh Edition), the high level of efficiency in modern drilling operations is the result of innovative designs rigorously tested in

engineering departments, laboratories, and production facilities of drill manufacturers, machine tool builders, and end users. These innovations and accumulated testing have contributed to the collective knowledge often referred to as the "art" of drilling. Continued improvements in this field are anticipated in the coming years.

The Easy-Set Precision Drilling Machine Enhancer combines the principles of a work-holding device and a drilling jig. The work-holding component securely holds the workpiece during drilling and related operations, while the drilling jig ensures precise positioning and guidance of the drill bit for consistent hole placement.

The research methodology encompasses several key elements: the research design and method, the study environment, the procedural flow, data gathering techniques, and the selection of respondents. These components were systematically implemented to support the successful design and fabrication of the device.

This section outlines the processes and considerations involved in the construction of the Easy-Set Precision Drilling Machine Enhancer. The project began with thorough planning and design, during which concepts and ideas were studied, analyzed, and translated into preliminary sketches, block diagrams, and finalized design plans. This phase was crucial in ensuring the feasibility and functionality of the proposed device.

The study adopted a systems approach model, incorporating insights from related literature and previous studies to inform the design and development process. Following this, the required materials, tools, and equipment were identified and checked for availability and suitability. A cost analysis was conducted based on the canvassed prices of supplies and estimated labor expenses, leading to the determination of the total production cost.

The actual construction process began with the finalization of the design, including detailed technical drawings with precise measurements. These served as the foundation for the fabrication stage. Each phase of the construction—ranging from material preparation to assembly and finishing—was documented carefully to ensure reproducibility and to support the study's validity.

This structured methodology ensured that the development of the device was guided by a clear process, from conceptualization to completion, aligning with the objectives of the study.

After the construction of the Easy-Set Precision Drilling Machine Enhancer, the device underwent functionality and performance testing. A series of test runs were conducted to evaluate its operational effectiveness. Minor adjustments were made based on observed issues during the testing phase. The final output of the study was the successfully fabricated Easy-Set Precision Drilling Machine Enhancer.

The fabrication and testing of the device were carried out at the Machine Shop Department of the Negros Oriental State University (NORSU) System. NORSU comprises eight campuses across the province of Negros Oriental: Bayawan-Sta. Catalina Campus, Siaton Campus, Bajumpandan Campus II, Dumaguete Campus I, Pamplona Campus, Bais Campus, Mabinay Campus, and Guihulngan Campus—serving as the research and testing sites for this study.

Among these, NORSU Dumaguete serves as the flagship campus, offering the largest number of academic programs and hosting the most student organizations. The university system accommodates approximately 15,000 students per semester, with enrollees coming from various regions across the Philippines, including Luzon and Mindanao. In the first semester of Academic Year 2016–2017, NORSU reported a total student population of 21,849, with over 10,000 students enrolled in its Dumaguete City campuses alone ([NORSU Official Website](#)).

The respondents of this study were selected from among the students and faculty members of the NORSU System who are directly involved in drilling operations within their respective shop-related programs. Their practical experience and technical knowledge provided valuable insights into the functionality and acceptability of the newly developed device.

The primary data-gathering instrument used in this study was a researcher-made survey questionnaire, structured around Dr. David A. Garvin's Eight Dimensions of Product Quality. A formal written request to conduct the study was initially submitted to the research adviser, who subsequently endorsed it to the Dean of the Graduate School. Upon receiving approval, the researcher then prepared and forwarded a letter to the President of the Negros Oriental State University (NORSU) System, seeking official permission to carry out the study involving the Easy-Set Precision Drilling Machine Enhancer.

The questionnaire was designed to collect data on the number of respondents, frequency distributions, percentages, and weighted means. The scoring system was based on levels of implementation and agreement, and the results were used to evaluate the device in accordance with Garvin's Eight Dimensions of Quality: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality.

2. RESULTS AND DISCUSSION

This study evaluates the acceptability of the innovated Easy-Set Precision Drilling Machine Enhancer for mechanical students at Negros Oriental State University (NORSU) during the academic year 2017–2018, with the aim of developing a corresponding technology package. Specifically, it seeks to determine the requirements necessary for innovating the Easy-Set Precision Drilling Machine Enhancer in terms of design, supplies and materials, and tools and equipment. The study also investigates how the enhancer can be developed,

identifies the total production cost, and assesses the critical quality attributes of its product design—particularly for work-holding accessories used in drilling—based on Garvin's Eight Dimensions of Quality: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. Furthermore, it explores the formulation of a technology package based on the study's findings.

The innovation of the Easy-Set Precision Drilling Machine Enhancer was driven by recurring problems in drilling operations, such as misaligned holes and frequent drill bit breakage. The design process began with the conceptualization of ideas, which were then translated into detailed schematic diagrams to guide the construction. Materials and supplies used in the fabrication were sourced locally, including square bars, channel bars, round bars, and brass—the latter selected for the lead screw due to its resistance to wear caused by sliding contact. The tools and equipment used in the construction were also locally available and accessible to the researcher, who is a mechanical technology instructor. This accessibility facilitated the efficient fabrication of the device and contributed to the overall feasibility of the project.

The development of the Easy-Set Precision Drilling Machine Enhancer involved a systematic process that included research and design, dimensional planning and drafting, procurement of materials, fabrication of component parts, and final assembly of the device. These procedures were carefully followed to ensure the functionality and efficiency of the finished product. The total production cost for fabricating the Easy-Set Precision Drilling Machine Enhancer amounted to PHP 4,644.35, which demonstrates its affordability and feasibility using locally sourced materials and tools.

A critical aspect of the product's design lies in the integration of work-holding accessories and guide components to ensure precision. The guide bushing, a key part of the guide assembly, positions the workpiece accurately and directs the drill bit or cutting tool through a hardened steel bushing, ensuring that all holes are drilled in precisely the same location. The work-holding component of the device features a special universal jaw that securely holds the workpiece during drilling and other machining operations.

The study also assessed the device's quality based on Garvin's Eight Dimensions of Product Quality. The results indicated a high level of acceptability among evaluators. In terms of **performance**, the device received an average weighted mean of 3.81, classified as *Very Acceptable*, indicating that it effectively performs its intended function and that its components operate as designed. For **features**, the rating was 3.84, also *Very Acceptable*, suggesting that the design incorporates functional and beneficial attributes. The **reliability** dimension scored the highest with a weighted mean of 3.97, affirming that the parts are securely mounted and capable of long-term use without failure.

Regarding **conformance**, the enhancer achieved a 3.90 average rating, also *Very Acceptable*, confirming that the parts and components were fabricated in accordance with established standards. In terms of **durability**, the device received a 3.89 rating, indicating that the casing and framing were properly assembled, with components logically arranged and securely fastened, resulting in a robust and long-lasting construction. The **serviceability** dimension garnered a 3.94 aver-

age rating, signifying that the mechanical parts are not only durable but also easily accessible and replaceable with locally available components.

Overall, the Easy-Set Precision Drilling Machine Enhancer demonstrated high levels of functionality, quality, and feasibility, making it a promising innovation for enhancing precision and efficiency in drilling operations.

The **aesthetic** dimension received an average weighted mean of 3.79, which falls under the qualitative scale of *Very Acceptable*. The design and overall appearance of the device were found to enhance its visual appeal, with particular attention given to the form and function of its major components.

Perceived quality was rated with an average weighted mean of 3.80, also classified as *Very Acceptable*. Respondents recognized that the project effectively fulfills its intended purpose, contributing to a high overall impression of quality.

In summary, the overall level of acceptability of the Easy-Set Precision Drilling Machine Enhancer, based on the evaluations across all eight dimensions of product quality, achieved an average weighted mean of 3.87. This rating corresponds to a *Very Acceptable* qualitative scale, indicating strong approval from the respondents regarding the device's quality and performance.

Based on the findings of this study, a technology package can be developed highlighting the key benefits of the innovation. The Easy-Set Precision Drilling Machine Enhancer significantly improves the accuracy of precision drilling, thereby minimizing material wastage. Furthermore, it enhances production efficiency by reducing the time and cost associated with drilling operations. This makes the device a valuable tool for educational and industrial applications alike.

3. CONCLUSION

Based on the findings of the study, the following conclusions were drawn: The design, materials, and tools required for the construction of the Easy-Set Precision Drilling Machine Enhancer are within the capabilities and resources commonly available to individuals engaged in mechanical technology. With the aid of detailed plans and specifications, the device can be successfully fabricated using locally sourced materials.

The total production cost of the Easy-Set Precision Drilling Machine Enhancer is affordable, making it a practical tool for instructional use in schools and training institutions. The device demonstrates high quality in terms of safety, precision, and performance. Evaluated through Garvin's Eight Dimensions of Product Quality, it received an overall weighted mean of 3.87, corresponding to a qualitative rating of *Very Acceptable* as perceived by the respondents.

The Easy-Set Precision Drilling Machine Enhancer effectively improves the accuracy of drilling operations and supports a more efficient production process. As such, it represents a valuable innovation for individuals and institutions seeking a reliable, precise, and cost-effective solution for precision drilling.

4. RECOMMENDATION

Based on the findings of the study, the following recommendations are proposed:

1. The Easy-Set Precision Drilling Machine Enhancer should be integrated into hands-on training programs for technology students to enhance their practical skills and understanding of precision drilling operations.
2. Technologists and instructors are encouraged to design and develop innovative devices that address common challenges encountered in shop work, promoting problem-solving and creativity in technical education.
3. Schools and training institutions should support and encourage their experts to fabricate instructional devices using locally available and cost-effective materials. These innovations can serve as effective teaching aids and enhance the quality of training.
4. It is recommended that this device be adopted by training institutions and industries for use in production activities, as it can contribute both to increased income and improved time efficiency.
5. The continued production and utilization of the Easy-Set Precision Drilling Machine Enhancer are recommended to improve the quality and accuracy of drilling operations in educational workshops and industrial settings.
6. Finally, the device should be considered for use in mass production and high-precision drilling tasks, given its demonstrated efficiency, reliability, and potential to optimize manufacturing processes.

5. THE EASY-SET PRECISION DRILLING MACHINE ENHANCER

The Easy-Set Precision Drilling Machine Enhancer is an innovative device that combines the principles of a work-holding mechanism and a drilling jig. The work-holding component secures the workpiece firmly during drilling and other related operations, ensuring stability throughout the process. The drilling jig, on the other hand, positions the workpiece accurately and guides the drill bit or cutting tool using a hardened steel drill bushing, allowing for consistent and precisely located holes across multiple parts. The results of the study demonstrate that the Easy-Set Precision Drilling Machine Enhancer ensures accuracy and uniformity in drilling, regardless of the operator, and is highly suitable for mass production tasks.

This device serves not only as a production tool but also as a valuable instructional aid. It offers both instructors and students practical insight into the fabrication and use of equipment designed for repetitive and high-precision tasks. In particular, the enhancer contributes to more effective instruction in machine shop technology, providing students with opportunities to develop essential manipulative and technical skills through hands-on experience.

Notably, the device is capable of performing precise, repetitive drilling on flat, square, and cylindrical workpieces—even in the absence of a punch mark to guide the drill bit. This is made possible through the use of a specialized component

known as the drill guide bushing, which accurately directs the bit to the intended drilling spot. This feature not only minimizes drill bit breakage but also significantly reduces production time and material waste.

Additionally, the Easy-Set Precision Drilling Machine Enhancer includes two movable jaws—an improvement not found in conventional drilling devices—which allow for flexible positioning and secure clamping of the workpiece. As a result, the drilling process becomes more efficient, less labor-intensive, and less prone to error.

Designed specifically to address common issues faced by students in machine shop practice, this portable and innovative drilling jig represents a significant advancement in instructional technology. It offers a practical and accessible solution for schools and training centers seeking to simulate real-world production environments and improve technical competence among learners.

5.1. DETAILED DESCRIPTION

The present invention is a portable precision drilling machine enhancer shown in Fig. 5 which improves the precision and accuracy of the drilling machine in curved and irregular shaped workpiece using different sizes of drill bits. The portable precision drilling machine enhancer shown in Fig. 5 generally comprises a feed stop (1) shown in Fig. 1, clamping-holding assembly (6) shown in Fig. 2, a guide bushing assembly (12) shown in Fig. 3, and a frame (15) shown in Fig. 4. The entire portable precision drilling machine enhancer shown in Fig. 5 enables the drilling machine to drill uniform hole size and hole spacing with stability, precision and accuracy using different drilling machinery such as hand drill, drill press, lathe drilling machine and the like without traces of punch mark. The said portable precision drilling machine enhancer ensures consistency in mass production during machine shop operations.

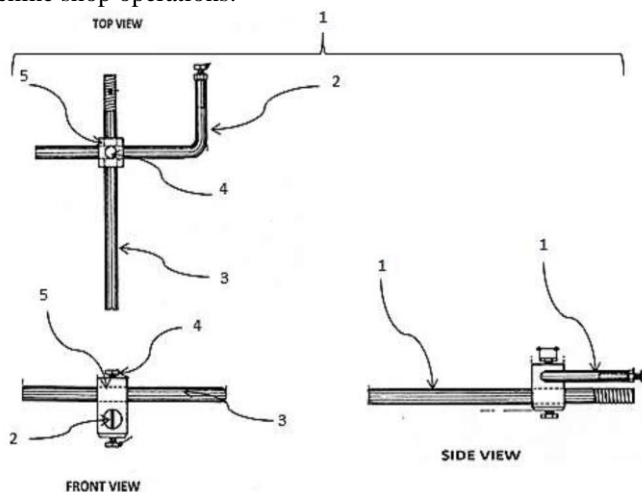


Figure 1. Detailed top view, front view and side view of the feed stop of the present invention.

The feed stop (1) comprising a curved leg (2), a straight leg (3), a bolt (4), and a bearing (5), wherein the curved leg (2) and straight leg (3) are intersecting with each other and is secured together by the bolt (4) and the bearing (5). The straight leg (3) is inserted to the side hole (18) of the frame (15) to connect the feed stop (1) to the frame (15). The straight leg (3) is inserted to the side hole (18) of the frame (15) to connect the feed stop (1) to the frame (15). The curved leg (2) is movable in all directions and is positioned parallel to the clamp (7) to serve as a secondary support to keep the workpiece in place. The curved leg (2) also helps to determine the distance of the holes to be created on the workpiece. The feed stop (1) is adjustable through the bolt (4)

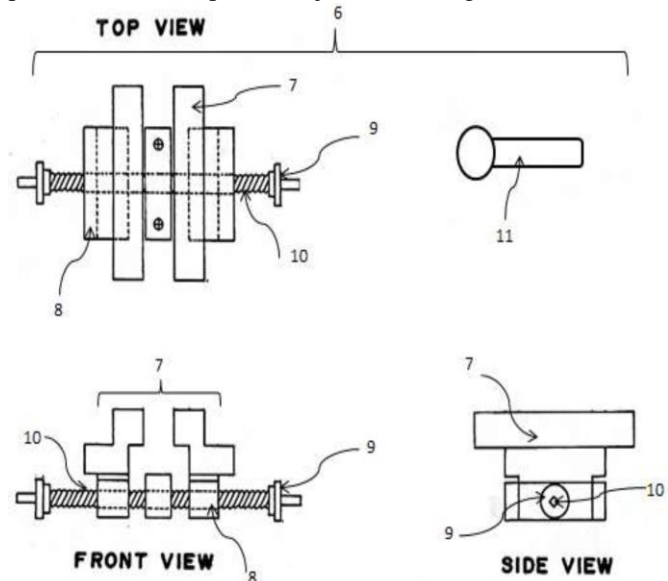


Figure 2. Detailed top view, front view and side view of the clamping-holding assembly of the present invention.

and the bearing (5). The clamping-holding assembly (6) comprising a clamp (7), a holder (8), a nut (9), a shaft (10) and an arm (11). The clamp (7) is mounted on top of the frame (15) by inserting the lower portion of the clamp (7) to the opening (19) of the frame (15) and the holder (8) is placed under clamp (7) inside the opening (19) of frame (15) to hold the clamp (7). The nut (9) and the shaft (10) are attached to the holder (8) while the holder (8) is holding the clamp (7) in place, wherein adjusting the clamp (7) is done by rotating the arm (11) that is connected to the shaft (10) and holder (8). The clamping-holding assembly (6) holds securely the workpiece while drilling and performing other operations. The guide-bushing assembly (12) comprising of the bushing (13) and bracket (14), where in the bushing (13) locates the position of the hole in the workpiece and serves as guide for the drill bit so that the hole drilled in all parts of the workpiece is uniform. The bushing is changeable to accommodate the different sizes of the drill bit.

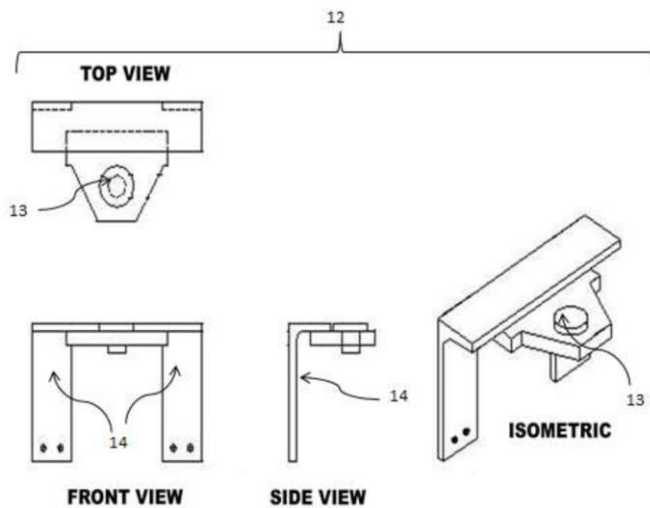


Figure 3. Detailed top view, front view, side view and isometric view of the guide bushing-assembly of the present invention.

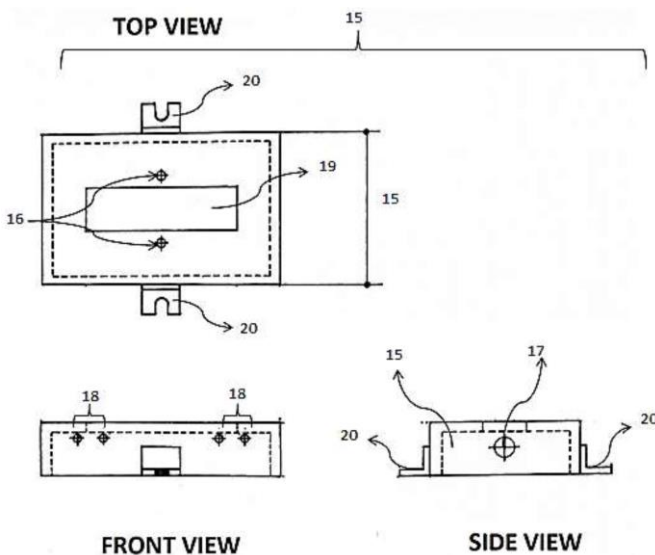


Figure 4. is a detailed top view, front view and side view of the frame of the present invention.

The bracket (14) is used to attach firmly the guide-bushing assembly (12) to frame (15). The frame (15) has two top holes (16) and opening (19) to insert and attached the other components of the machine enhancer shown in Fig. 5 and teeth (20) to mount the frame (15) to the drilling machine. Fig. 1 shows the feed stop (1) comprising the curved leg(2), straight leg (3), bolt (4) and bearing (5), wherein the curved leg(2) and straight leg (3) intersects through the bearing (5) and the bolt (4) and the point of intersection is adjustable. Fig. 2 shows the clamping-holding assembly comprising the clamp (7), holder (8), nut (9), shaft (10) and arm (11), wherein the clamp (7) together with the holder (8) is adjustable by rotating the arm (11) which is connected to the shaft (10). Fig. 3 shows the guide-bushing assembly (12) comprising the bushing (13) and bracket (14), wherein the bushing (13) guides the drill bit into the workpiece and the bracket (14) is used to attached the guide-bushing assembly (12) to the

frame (15). Fig. 4 shows the frame (15) comprising the top holes (16), bottom hole (17) 32, side hole (18), opening (19) and teeth (20), wherein the clamp (7) is attached to the top holes (16) of the frame (15) and the holder (8) is placed at the bottom of frame (15) inside the opening (19). The bottom hole (17) 32 is where the straight leg (3) of the feed stop (1) is inserted.

5.2. TECHNOLOGY PACKAGE

The output product, the Easy-Set Precision Drilling Machine Enhancer, is accompanied by a comprehensive set of instructional guidelines. These include a detailed description of the device's capabilities, designed to inform users of its practical applications and effectiveness in the workplace. Additionally, the limitations of the device are clearly outlined to help users operate it properly and avoid potential issues during practical use.

Furthermore, the construction procedures for the Easy-Set Precision Drilling Machine Enhancer are documented to assist future innovators and fabricators in replicating or improving upon the design. Guidelines on maintenance, safety protocols, and control measures are also provided to ensure the device remains in optimal condition and to prevent operational damage.

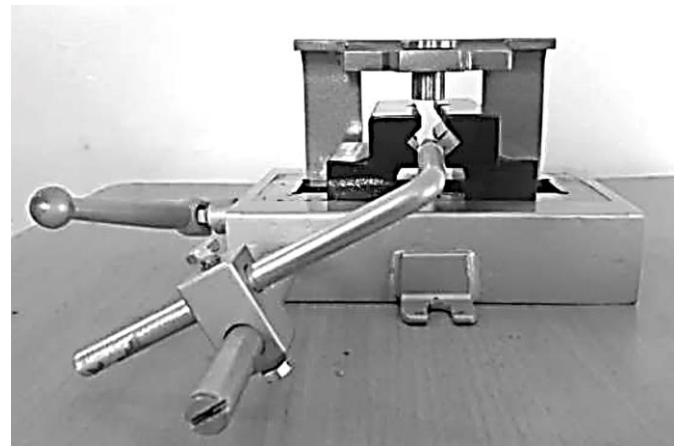


Figure 5. Detailed front view of the entire present invention.

5.2.1. Capabilities

The Easy-Set Precision Drilling Machine Enhancer is designed to improve instructional activities in precision drilling operations and related mass production tasks. This device securely holds the workpiece and guides the drill bit, enabling accurate and consistent hole production. It allows students to perform repetitive drilling on various types of workpieces—such as cylindrical, square, tubular, or solid forms—even without the use of a punch mark to locate the drilling point. The device also helps extend the lifespan of cutting tools or drill bits, thanks to its specialized mounting system equipped with a drilling jig bushing. This component precisely guides the cutting tool while minimizing wear and potential damage. In addition to its educational benefits, the enhancer has practical applications in industrial maintenance tasks, such as fabricating shafts for conveyor systems. It can accommodate

workpieces with diameters of up to 2.5 inches, making it a versatile tool for both training and production environments.

5.2.2. Limitations

The Easy-Set Precision Drilling Machine Enhancer is primarily designed to securely hold workpieces for precision drilling, with its functionality limited to hole production within its specified capacity. Using drill bits that exceed the recommended size may result in damage to the jig bushing, potentially affecting the accuracy and durability of the device. Therefore, it should only be operated by individuals who are knowledgeable about its functions and proper operating procedures.

5.2.3. Operation Procedure

This easy-set precision drilling machine enhancer was designed to guide the drill bit in drilling. The following procedure must be observed in using the device:

1. Mount the drilling machine jig on top of the drill press table.
2. Get the required jig bushing for the size of the drill bit.
3. Mount the jig bushing to the top of the jig plate.
4. Mount the drill bit to the drill chuck of the drilling machine then set the required cutting speed of the drill press.
5. Mount the workpiece on the device and tighten the clamping screw to avoid accident during operation.
6. Check the alignment of the jig bushing to the axis of the workpiece.
7. Lower the drill bit by applying pressure to the feed handle in downward direction, to align the drill bit to the jig bushing.
8. Switch on the drill press.
9. Start drilling.

5.2.4. Maintenance

To maintain the accuracy and effectiveness of the device and to prolong its Easy-set Precision Drilling Machine Enhancer functionality, proper care and maintenance should be observed. The following maintenance procedures are suggested:

1. Clean and remove the chips.
2. Oil the device to prevent rust.
3. Grease the side bushing.
4. Oil the screw thread of the clamping screw once a week.
5. Always check the clearance between the drill bit and the jig bushing.

5.2.5. Safety and Control Measure

To avoid shop accidents and injury as well as to keep the operation safe for the operator, the following precautions are given:

1. Tighten the workpiece securely.
2. Always observe the proper cutting speed of the drill press.
3. Keep the drill press sharp.
4. Do not use the device beyond its capacity. Always protect your eyes by wearing goggles.
5. Change bushing once it is worn out.

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