DESIGN STAMPING MACHINE FOR DOCUMENTS

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Abstract

Automatic stamping machines are currently available on the market, but they only stamp the name, date, and serial number on products, whereas most office workers must stamp documents by hand, which is inconvenient when stamping enormous amounts of documents. As a result, it is important to develop and produce a stamping machine. This article outlines the design, structure, and working principles of the machine, as well as calculating its dynamics. The findings propose an automatic stamping machine that employs an electric motor with a gear gearbox, a revolving disc, and four hinges. Consumers will undoubtedly enjoy a machine that is as little as a printer or a laptop, simple to use, and can be placed on a desk for a modest cost. This study will help to reduce the workload for office personnel who have a large number of documents to stamp.

Keywords: connecting rod, **g**ear transmission, mechanism, slider, stamping machine

1. Introduction

The seal (figure 1), which serves as the front face of businesses, government agencies, and organizations, must be discussed while discussing stamping. Employees continue to stamp documents by hand in limited quantities-a few A4 pages each day-just as they have up until now. However, stamping thousands of A4 pages by hand every day while organizing entrance exams for schools, preparing inspection paperwork, stamping products for businesses, stamping parking fines, and other such tasks will wear out the workforce. Office workers will find some use for the stamping machine owned by the author.

Figure 1. *Several types of stamps and marking inks*
Source: https://luatquangphong.com/khac-dau-tai-quang-ninh.html

At the moment, office staff mostly stamp documents by hand, and there is very little study on document stamping machines. Hand stamping is even used on meat intended for sale, such as pig, chicken, and duck. The author has looked through numerous websites but has not been able to locate a supplier of stamping machines. Because of this, the author of this article offers a stamping machine design in figure 2. This device will undoubtedly assist a lot of individuals.

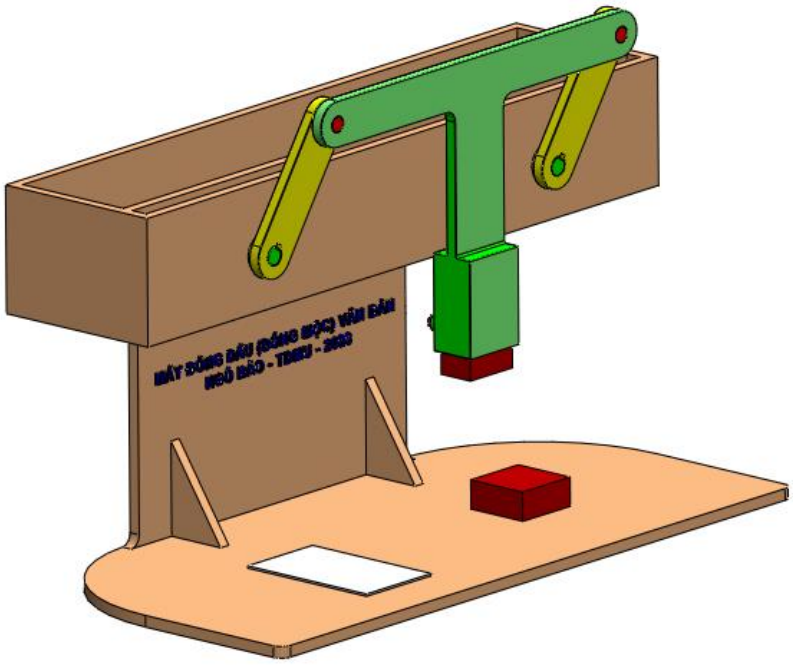


Figure 2. *Machine shape stamping machine for documents*

2. Summary of known related studies

As was already indicated, document stamping machines are extremely rare these days. There are few documents related to this type of machine. Most people directly hold the wooden stamp to stamp it on paper. Some related research such as: the foot pedal stamping machine (figure 3a), the stamping machine for documents of a group of students at Ho Chi Minh City College of Industry and Trade (figure 3b), the logo stamping machine on wood, fabric, car tires, etc. (figure 3c), the badge stamping machine (figure 3d), the embossed stamping machine (figures 3e and 3f), the date stamping machine on packaging (figure 3g), the stamping machine on documents of a group of students at Da Nang University (figure 3h) and depict a stamping machine Model: STM – VN1 (figure 3i).

Figure 3. *Several types of stamping machines are available*
a) Foot pedal stamping machine (Guixiong Ou and sidekick (2020));
b) Stamping machine for documents of a group of students at Ho Chi Minh City College of Industry and Trade; Source: https://khoahoc.tv/nhom-sinh-vien-dung-do-ve-chai-lam-may-dong-dau-tu-dong-70527;
c) The machine stamps car tires by heating; Source:https://www.youtube.com/watch?v=SgRrG-ZOdRY
d) Badge making machine. Source: Shop online Shopee;
e, f) Embossing stamp machine; Source: https://mucinthanhdat.com/may-dap-chu-noi-the-nhua.html;
g) Date stamping machine on packaging; Source: https://thinhvuongjsc.vn/may-dap-date-nhiet-dy-8/;
h) Stamping machine on documents of a group of students at DaNang University;
Source: https://www.youtube.com/watch?v=Tiq_pUySerw;
i) Stamping machine Model: STM – VN1;
Source: https://sttech.soctrang.gov.vn/cungsanpham/611/may-dong-dau-model-stm-vn1.html.

3. Designing a stamp machine for documents

To design this machine, the author used actuators as shown in figure 4, including:

• The Rotating disc - connecting rod and slider mechanism, figure 4a (Faa-Jeng Lin & Rong-Jong Wai, 2001).

• Figure 4b shows the rack-pinion transmission (Dan Gibson & Steven Kramer, 1984).

• Figure 4c and 4d of the four-link hinge structure (Kevin Russell & Raj S. Sodhi, 2005).

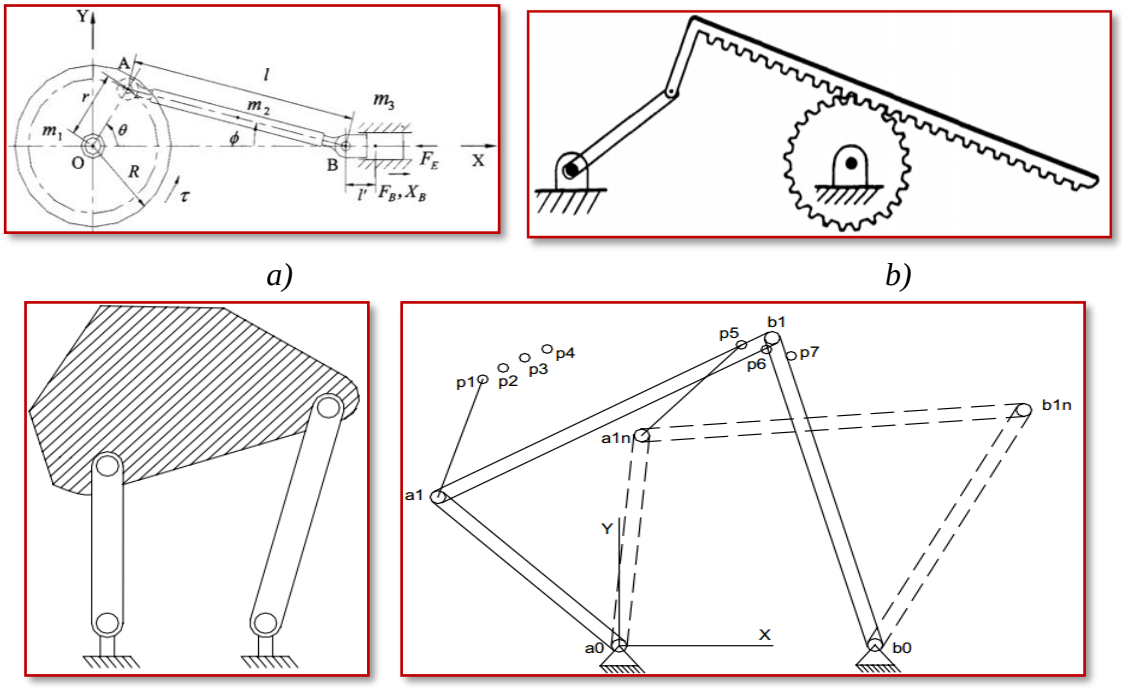


Figure 4. *Actuators to design stamping machines for documents*

3.1. Structure

The author employs three-dimensional perspective to illustrate the general external design and internal detail structure of the machine, as depicted in figure 5.

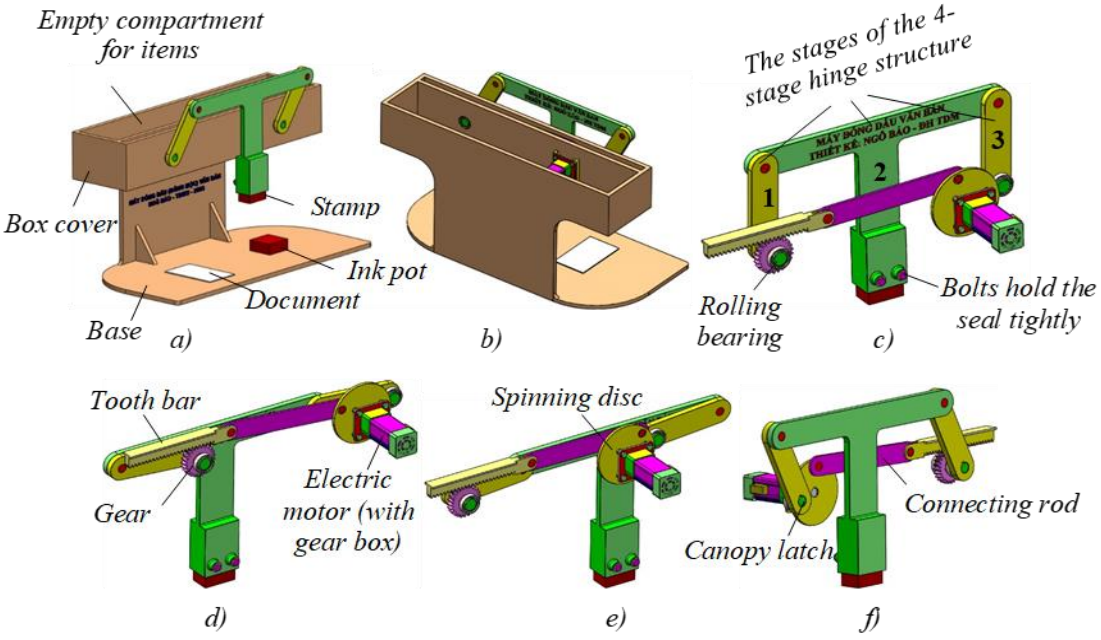


Figure 5. External and internal structure of document stamping machine
a, b) Overall figure from the front and back of the machine;
c) Internal structure figure;
d) Figure machine status is stamping;
e) Figure machine status is dipping ink;
f) Figure view from the front of the machine.

This machine consists of main parts described as follows:

• *Electric motor:* This tiny motor is affixed to the gearbox. Output shaft capacity ranges from 50 to 100 W, and speed from 30 to 100 rpm. Due to the low power of this machine, the electric motor was selected based solely on the structural harmony and practicality of using single-phase electricity in administrative agency offices.

• *Four-step hinge structure*: This is a familiar structure in mechanical engineering. It includes stages (1), (2), (3) linked together by rivets as shown in figure 5c and stage (4) is the fixed support. Stage (1) is driven by a rack-pinion transmission. Link (1) transmits motion to links (2) and (3). Steps (1) and (3) exhibit a 180° angle of swing, while phase (2) has a special translational motion (i.e. a motion similar to the cabin of a ferris wheel). Stage (2) is the inking and stamping mechanism. The lower end of the stitch (2) has an empty space to clamp the stamp (depending on the size of the stamp, this space can be adjusted to the appropriate size). In addition, two more M6 bolts are included to secure the seal firmly or to move it to a more convenient location.

• *Rack-pinion transmission:* This is the transmission that converts translational motion into rotational motion or vice versa. In this machine, we use the rack to drive the gears. The toothed rack has edges to slide forward and backward in a fixed direction in the slot of the machine case. The gear only rotates about half a turn, then reverses. This rotation causes link (1) in figure 5c to swing back and forth at an angle of about 180^o.

• *Rotating disc:* It is a circular steel disc 5 mm thick, 50 mm radius, with a central hole for mounting with the output shaft of the gearbox (the gearbox is attached to the electric motor). At a distance of 40 mm from the center hole, drill a hole to install with a rivet to the connecting rod. When the output shaft of the gear reducer rotates, this disc also rotates, causing the connecting rod to move in parallel (a combination of translational and rotary motion). The connecting rod pulls and pushes the rack, thereby causing movement for the entire machine.

• *Box cover:* This is the part that covers the machine. It is constructed of wood or plastic. In certain circumstances, it may be cast in cast iron or welded with steel plates. There are two empty chambers in its upper part. The large compartment is for storing office tools such as staplers, paper clips, pens, scissors, rulers, etc. The small compartment is for installing transmission mechanisms such as rotating discs, gears, racks, connecting rods, etc.

3.2. Principle of operation

The transmission part includes an electric motor, four-link hinge mechanism, rotating disc - connecting rod - slider mechanism and a rack - pinion transmission. Motion is transmitted through the following steps: motor shaft rotation → disc rotation → connecting rod moves in parallel → rack and pinion reciprocation → gear rotation up to half a turn and back → stitch (1) swings over, shake back at an angle of about 180^0 → stitch (2) special translational motion → the process of inking and stamping the text occurs.

After stamping a document, the employee takes that document out and replaces it with another document to continue being stamped. How to position the ink cartridge and document in the correct position to ensure smooth inking and stamping is up to the machine operator. If we want this machine to only apply ink once and make many marks, the staff will pull the ink cartridge away from the stitch position (2) that needs to be inked. At that time, the inking process still occurs, but the ink does not stick to the stamp. The employee can also position the seal securely in the compartment (attached at the end of stitch (2)) by adjusting the 2 bolts pre-attached there (figure 5c).

3.3. Kinematic calculations

To facilitate calculation, the author names the stitch from number 1 to number 7, draws a horizontal center line, places points, and draws the corresponding velocity vectors as shown in figure 6.

• When disc (4) rotates with angular speed ω, the velocity of point B is $v = r. \omega$.

• Stitch (5) moves parallel to the plane, so according to the velocity projection theorem (Do Sanh et al., 2007), the author calculate the velocity of point C by projecting the velocity vectors at B and C onto the EA direction (horizontal), to get: $v_1 = v.\cos(90^0 - \alpha) = r.\omega.\sin\alpha$.

• Stitch (7) moves forward, so the velocity of point D is equal to the velocity of point B. Therefore: $v_D = v_1 = r.\omega.\sin\alpha$.

• Stitch (6) is a gear with a radius of division r'. It rotates around a fixed axis, so its angular velocity is: $\omega' = v_D/ r' = (r.\omega/r').\sin\alpha$.

• Stitch (1) is a rocking bar with the distance between the two hole centers R. It rotates around a fixed axis, so the velocity at point F is: $v_F = R.\omega' = (R.\ r.\omega/r').\sin\alpha$.

• Stitch (2) moves forward, so the velocity at G is equal to the velocity at F, that is: $v_G = v_F = (R.\ r.\omega/r').\sin\alpha$.

We know the parameters R, r, r', ω. And α is the angle that changes over time. Ideally, when stitch (2) performs the stamping or inking operation, the angle $\alpha = 90^0$. At that time: $v_G = v_F = R.\ r.\omega/r'$ (*).

The formula (*) tells us the instantaneous velocity when this machine is stamping or inking.

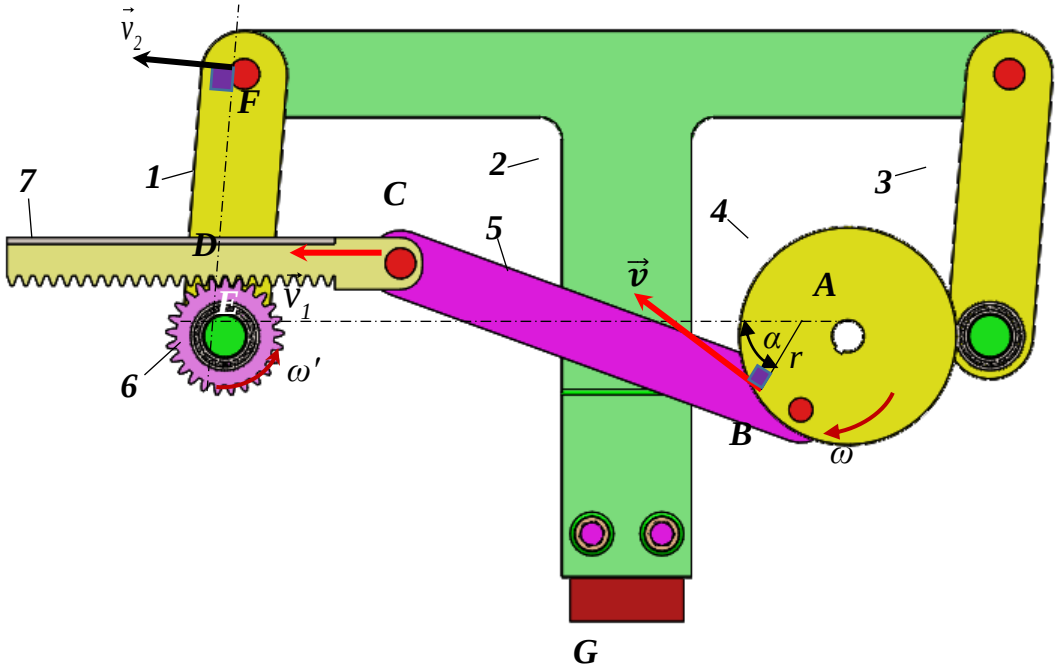
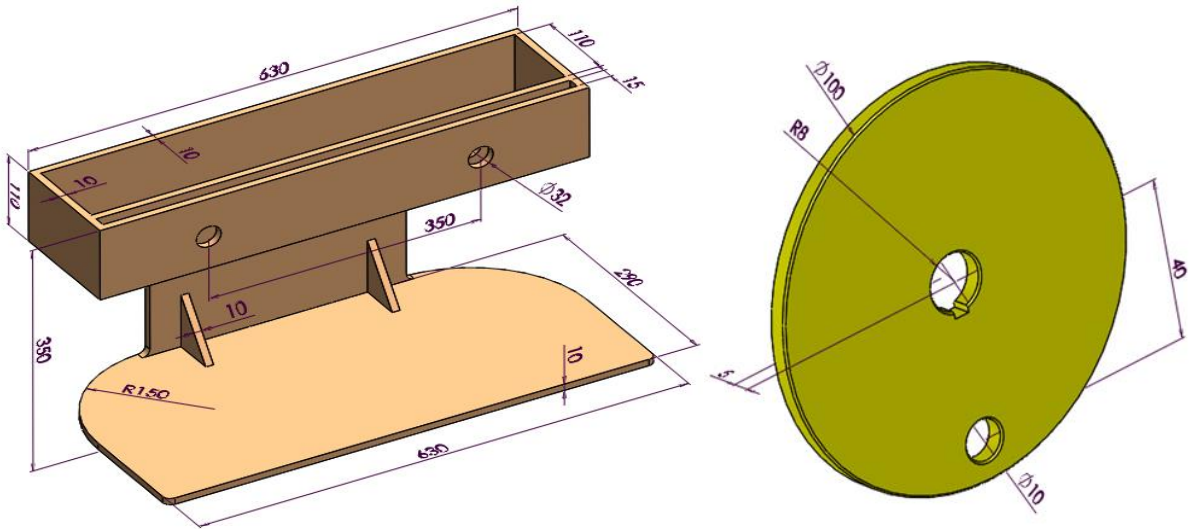


Figure 6. *Calculating stamping machine kinematics for text*

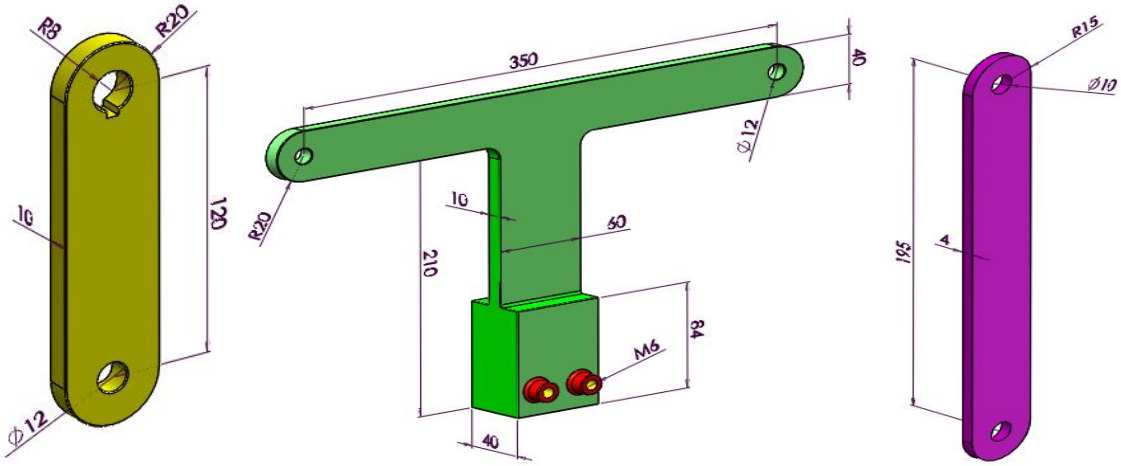
4. Result

By giving the idea of the structure and operating principle of the stamping machine as mentioned above, the author has designed its details appropriately (figure 7). This is a simple and cheap machine. When it works, the force exerted on it is negligible and does not pose a danger to humans. Therefore, the author pays much attention to working principles, structural rationality, materials, manufacturing technology of details,... but does not pay much attention to calculating the strength of details. Because the author thinks it is not necessary to calculate endurance for each limb.

The dimensions shown in the image are for reference only, depending on the material chosen, the dimensions of the details may vary. We can use 3D plastic printing to make these parts or can also make them out of wood. In special cases, if we need to stamp meat, poultry or want to make an industrial stamping machine, we should make steel parts.



a) Box cover (plastic or wood) b) Rotary disc (steel)



c) Stitch 1 d) Stitch 2 e) Connecting rod

Figure 7. *Preliminary design of some details of a stamping machine for documents (Depending on different materials, choose different sizes of details)*

5. The development direction

The stamp machine as the author just presented above is simple, cheap and easy to use. However, it does not automatically feed paper in and out, but requires human intervention. Therefore, the productivity of this machine is still low and manual. To overcome these shortcomings, the author offers directions for its development. Specifically, add to it the function of supplying paper in and taking out paper. That is, the author designed additional paper trays, paper supply rollers and paper conveyor belts (figure 8). In particular, the author used a gear transmission with ¼ of the teeth missing to drive the conveyor belt (figure 8c). Ensure that in one cycle, the conveyor belt runs ¾ of the time and stops ¼ of the time. During the time the conveyor belt stops, the seal mechanism will close immediately. The author's notes on the parts are also clearly stated in figure 8. Readers can watch the simulation video of this machine on the author's You Tube channel.

The development direction as mentioned by the author above has increased the applications of stamping machines. At that time, this machine can be used as a stamping machine, a machine to stamp poultry and livestock meat when trading, a machine to stamp the product's expiration date on packaging, etc.

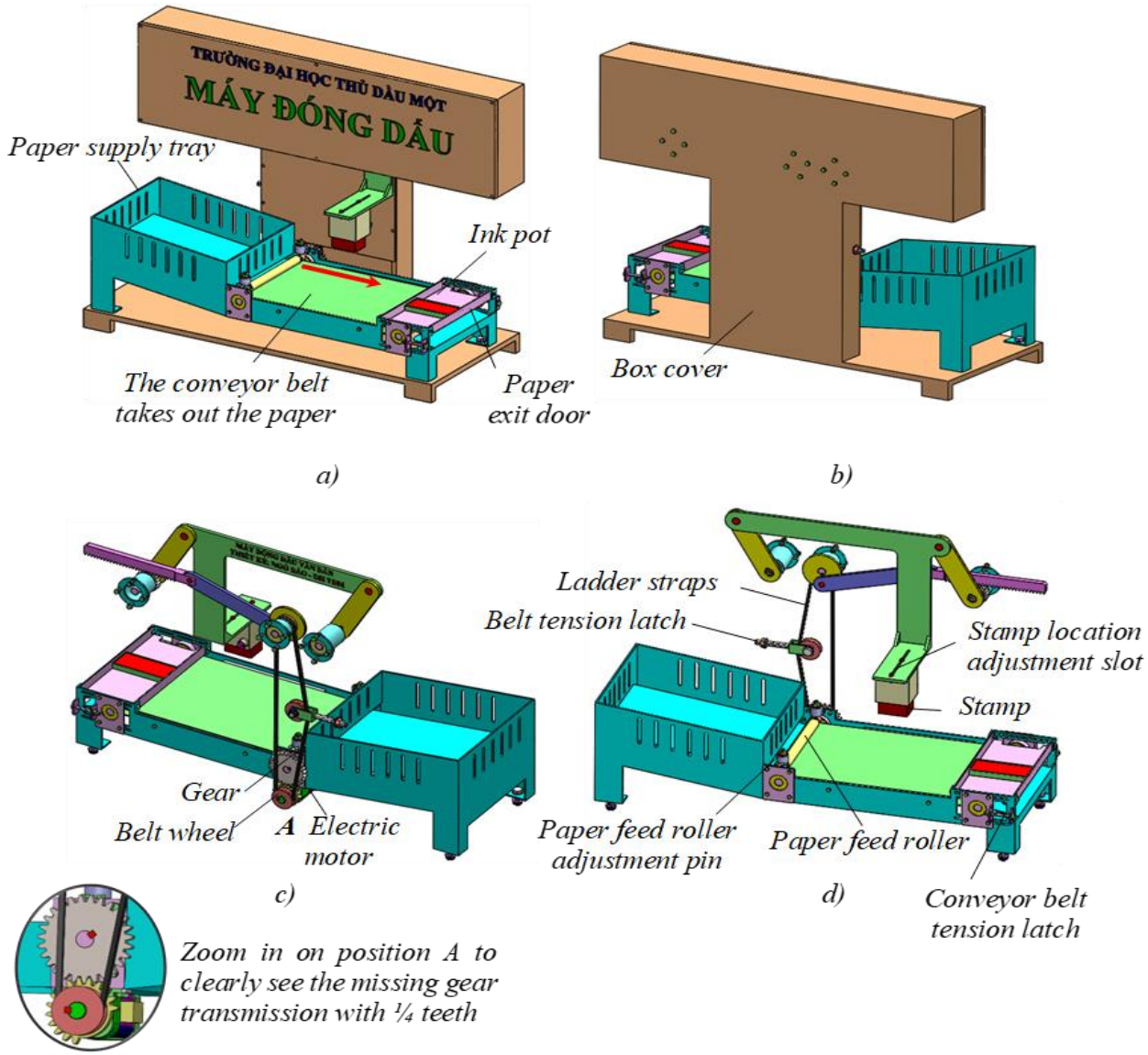


Figure 8. Complex stamp machine design

a) Figure viewed from the front;
b) Figure viewed from behind;
c) Figure viewed from behind after removing the box cover;
d) Figure viewed from the front after removing the box cover.

6. Conclusion

The author has briefly presented related research on stamp machines. Next, the author provided design drawings, structural descriptions, operating principles and kinematic calculations for a type of stamping machine. The author ensures that everyone can comprehend and apply by using 3D images to visually illustrate.

The document stamping machine offered by the author is very simple, cheap but has many benefits for office workers. Maybe because of it, office workers who have to manually stamp a lot of documents are not as exhausted.

The author has not updated the paper supply and paper retrieval structure, which is one aspect of the study that is missing. This machine is being built and tested by the author. There are undoubtedly some restrictions, but the author intends to get around them.

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