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A LOW NOISE NAIL MACHINE

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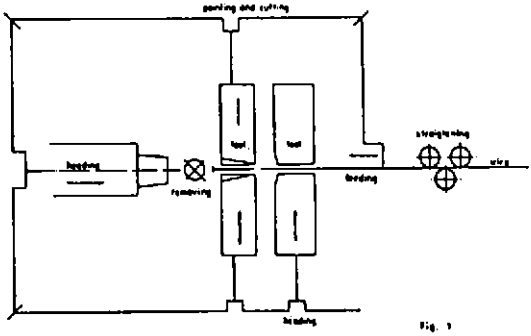
During a Ph.D. study, the prime author carried through the innovation of a new type of nail machine. The machine was awarded the Danish Working Environment Price 1981. A company named Enkotec producing this machine was established, and it is now exported worldwide.

The conventional principle. The traditional method of nail manufacturing is very noisy as it is simply a result of automatizing the blacksmith's old forging process.



As indicated in figure 1 the main steps of the process (feeding, cutting, pointing, heading and removing) are all based on linear movements. These are established by cranks, connection rods ets. To obtain a sufficient speed of productivity the masses are accelerated very fast in order to built up the necessary energy for forging. The result is a considerably impact noise.

The new principle. The main principle is smooth continous movements obtained by means of rotating tools. The heading, being a very noisy part of the process, is changed from forging to rolling.

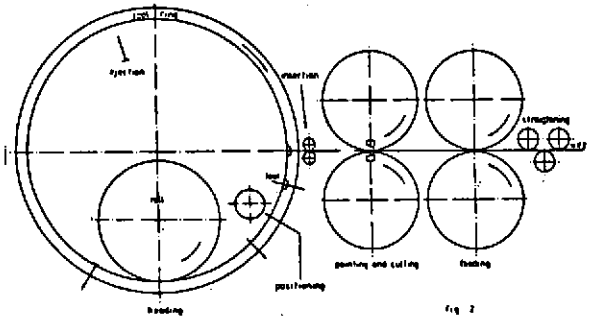


Figure 2 illustrates the principle and figure 3 is an X-ray sketch of the machine. Six pairs of knives mounted on two rings are continously forming the nail points and cutting off the nail wire. Thereupon the blank is placed between two rotating die-rings. As the die-rings are not exactly parallel, the blanks are firmly fixed in bottom position. There a roller forms the nail head. The ready-made nail is subsequently ejected in top position, because the distance between the die-rings is maximum.

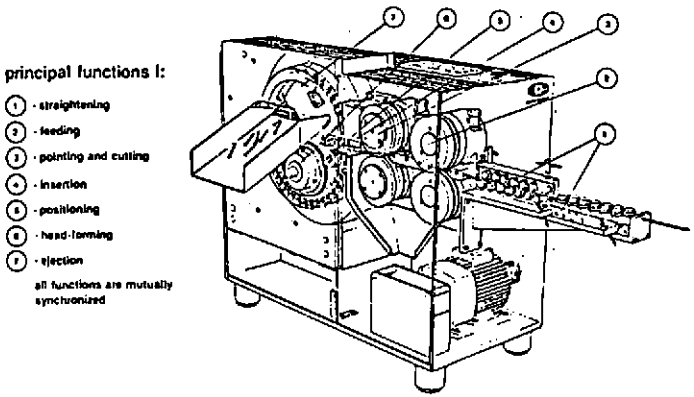


Figure 3.

Noise control. From a noise control point of view the following characteristics of the design are most important:

- Apart from the main motor all movable parts are mounted on a central main plate, thickness 40 mm. Consequently every force circuit is as direct and short as possible, and all forces and their reactions are related to the main plate. This prevents vibrational energy to be transmitted to the casing and radiated as noise.
- Another potential noise source is eliminated by supporting the nail point rings by springs. It reduces the radial change of force during the pointing process.
- The noise from heading is reduced because several nails are being rolled at the same time. This means that the exchange of force is very smooth.
- The transmission is based on helical gears in an enclosed oil filled box. It is driven from the main motor by a V-belt drive.
- The ejection chute is designed as a sandwich plate in order to minimize the noise from the falling nails.
- As the vibrations are negligible no floor fixing is needed. The machine is just placed on its rubber pads.

Sound power level. Using B & K sound intensity measuring equipment the sound power level of a single new machine is PWL = 87.7 dB(A). The conventionel one has 105.1 dB(A).

Sound pressure level. In a traditional industrial hall the noise level of a single operated machine at the operator's position showed SPL = 78 dB(A) compared with 95 dB(A) for a conventional.

Noise exposure. Nail machines are normally operated a great number together in large halls. Under those conditions the noise exposure level from the new machines will be about 80 dB(A) compared to at least 100 dB(A) in a conventional manufacturing hall.

The dominating noise source of the new machine is impacts from the ready-made nails ejected. This noise is rather easy to screen.

Considerations on demands to machinery. During the process of systematic innovation of a new machine a lot of choises must be made. As regards the nail machine any possibility was evaluated on basis of an ideal method of nail manufacturing, as shown in figure 4 (next side). Based on those considerations the continuous rotary rolling process was selected (References (1) and (2)).

The heavy noise was the reason why the project started. However, the customers do not attach as much importance to the reduced noise level as anticipated. The machine was also designed to meet the non-acoustic requirements: Productivity and efficiency are increased, less floor space is required, less or no scrap, more precise products, the durability of the tools is drastically increased etc.

Figure 4:

Demands to an ideal nail machine The importance of the parameters varies. This is expressed by a weighting scale from 1 to 6. 6 indicates the greatest imprtance.	Weighting during the process of innovating the nail machine.	The customers weighting experienced when marketing the machine.
High production rate	4	6
Low noise level	6	3
Low consumption of energy	5	4
Small dimensions	5	4
Min. maintenance	4	6
Low production costs	4	6
Low price	1	3
Easy to operate	6	5
Simple installation	2	4
High stability	6	6
High nail quality	6	6

Concluding remarks. The project leads to two important conclusions, which we consider as generally valid as regards design of low noise machinery:

1. It is not necessary to be an advanced acoustician to design a low noise machine. The most important condition is that the process of machine design is performed professionally. As to acoustics it is sufficient to understand some basic principles about noise generation, see Richards (3).

2. We do believe that for acousticians it is important to realize that most often rest of the world will not appreciate a low noise level, unless it is connected with other progresses.
From a commercial point of view the latter is far the most important. The low noise level has proved to be just a secondary sales argument.

REFERENCES

(1) Nielsen, "Production of gun nails" Technical University of Denmark 1977 (Thesis in Danish).

(2) Nielsen and Wanheim, "Development of a new forming process for nail heads by simulation", Proceedings of American Society for Metals, Ohio 1978 - 79.

(3) Richards, "Noise control - The need to understand the basic principles", Proceedings INTER-NOISE 1982, San Fransisco.