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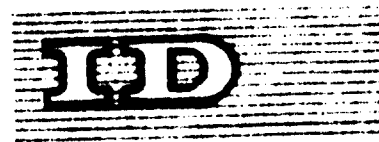
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Regional Seminar on Machine Tools
in Developing Countries of Europe,
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Slatni Pjassazi (Golden Sands) near
Varna, Bulgaria, 18 to 27 October 1971

MAINTENANCE AND REPAIR PROBLEMS
RELATED TO
MACHINE TOOLS IN BULGARIA ✓

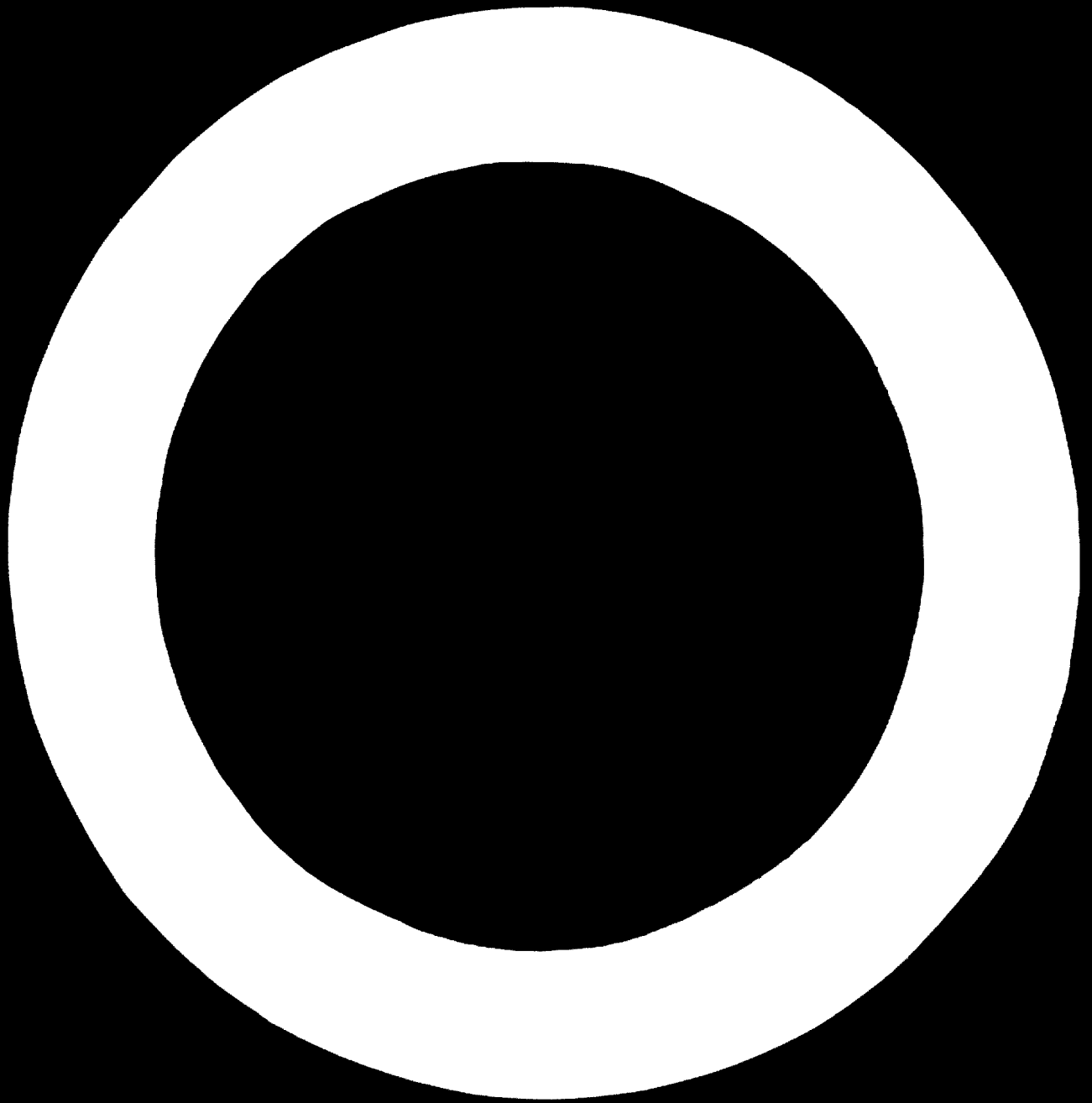
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The last 27 years of socialist construction in this country are also noted for the rapid growth of industry, machine building included. During the same period of time hundreds of new industrial establishments cropped up, most of them being once or twice extended and reconstructed ever since.

Following the April Plenum (1956) of the CC of the BCP the government stepped up its attention towards the Ministry of Machine Building still further and the machine building enterprises are now steadily increasing their productive capacities, acquire the method of deeper specializing, improve the quality of their machines and contribute their share of building up a modern national economy.

The major part of the machine stock now being used in engineering plants and the maintenance shops of the chemical and light industry plants consists of machine tools.

Our country now avails of an enormous amount of machine tools, the number of which is steadily and rapidly growing up. A considerable number of them are home made, while another part of them is already an important item on the national export list.

With such a great number of machine tools being on the shop floor, it would only seem but natural that their maintenance and repair should become essential activities and all necessary measures to this end duly taken.

All questions related to maintenance and repair of machine tools may be divided into two groups: organisational and technical.

As technical questions related to maintenance and repair practically do not differ from country to country and we cannot refer specially to Bulgaria as something isolated and specific. On the other hand such a treatment of the subject would rather involve special audience. Therefore I shall touch upon the essence within

the limits allowed and discuss the problems predominantly from the stand point of the organisation of the maintenance and repair of machine tools in this country.

At the time of going into operation for the first time, every machine exhibits normal efficiency and operational accuracy as specified in the Instruction Book of the manufacturer and the respective accuracy standards for the given machine. This initial standard properties of the machine are due to the careful production of the separate parts and the correct and just assembly of the same.

After a certain definite period of operation (and sometimes earlier, due to mishandling) the quality of the items produced with this same machine begins to deteriorate, while the productivity of the machine gradually decreases.

This is generally due to fresh defects in the parts and a certain derangement of the initial adjustments amongst them.

The defects mentioned above can be: wear and tear, mechanical damage (distortion, destruction, etc), chemical and heat damages (thermal deformation, corrosion).

While damage like deformation, destruction, derangement, etc, can be prevented by careful operation, for instance by avoiding overloading, good lubrication and so on, the wear of rubbing parts is an unavoidable ^{con}sequence even with an absolutely normal operation. Wear can be reduced or ^tsowed off, but not eliminated altogether by means of appropriate design.

The process of wear goes through three successive periods.

The first period - the initial running-in of mating parts. The rate of wear is very closely dependent upon the surface finish of the mating parts.

The second period - with normal work of the mating parts. Wear gradually increase as time goes on.

Third period - Mating parts become intolerably noisy during operation. Wear rate becomes very intensive and the play between the mating parts grows very rapidly.

Depending upon the growth rate of the wear the operational ability of the mechanisms decreases and ultimately they break down altogether.

The reconditioning of the machine tool to its initial accuracy and efficiency can be achieved by means of repair, which includes the detection and the removal of the damage incurred, aimed at restoring the initial ability of the mechanisms to carry out the work they were originally designed for.

When a repair operation has to tackle a normal wear, then everything goes comparatively fast at a low cost, but when a heavy wear is at hand, then the repair takes the form of an overhaul in which considerable amount of material and labour is involved. In such a case a thorough calculation must precede the overhaul in order to find out if the purchase of a new machine would not be a better solution of the problem.

From what we have hitherto said it becomes evident that the good technical condition of the machine tools depends upon their correct operation on the one hand, and on the good quality and timely repair on the other.

The machines are operated by the shop floor workers, hired for this purpose.

A correct operation of a machine tool basically includes the following items:

1. Correct manipulation with the separate units and mechanisms (For instance change of spindle speeds ^{and feeds} must be carried out only with the machine at a standstill to prevent gear backlash or gear

ture wear.

2. Operate the machine with the right cutting rates as for instance, avoiding coarser feed rates than specified in the Instruction Book as this would lead to an inevitable premature wear of the machine.

3. Use and proper lubrication, i.e. observing the time periods and the types of oils envisaged and recommended by the manufacturer. Negligence in this respect would soon bring about accuracy fall and premature wear of the machine.

4. Constantly keep the machine clean and free from chips and dirt. This will prevent the rubbing parts from galls and premature wear. On the other hand polluted elements (as screws) affect accuracy adversely.

5. Protect the machines from hits, shocks, vibrations, scratches and knicks, especially the rubbing parts and surfaces as they will surely worsen the machine's accuracy.

6. See that during reassembly no units are changed with some other machine as many of them (like tailstocks in the lathes) are seat ground on the given machine and would not work accurately on other.

And last but not least, the operators must be thoroughly familiar with the design of the machine, stop it immediately whenever necessary and seek the help of the repair team in case of unheralded noise or deterioration in accuracy.

The operational supervision is carried out by production managers, to whom machine tools are assigned, and by special inspectors from the maintenance service.

The repair of the machines is carried out by specializing workers from the maintenance shop of the respective factory.

The repairs may be casual, in emergency cases, when a machine

obviously breaks down, or scheduled overhauls, following a scheme prepared in advance.

The system of casual repairs has many weak points, as for instance:

In emergency break downs damage is normally heavier than in the scheduled. The machine can even suffer a breakage of the frame.

The emergency repair as a rule involves longer time and more labour because the breakage of one part entails damage in others.

Emergency repairs take the machine out of service unexpectedly and in an unplanned manner, thus hampering gravely the fulfilment of the production plan, especially when bottle-neck machine is involved.

Down time is normally longer with casual repairs than with scheduled because the required spare parts are not always to be obtained on the spur of the moment, or the necessary number of repair workers may not be available.

All this has made casual repairs unpopular in this country and we have adopted the version of scheduled overhauls calling the "planned-preventive overhauls".

By planned preventive overhauls it is meant all the organizational and technical undertakings in the sphere of maintenance and repair work carried in a prophylactic way following a pre-settled plan aimed at preventing the machines from unexpected breakdowns.

The overhaul is a planned one because it follows a planned order and is preventive because it prevents the machine from unexpected accidental damage due to gradual and steady wear or to some other causes.

If the system of the planned, preventive overhauls is correctly organized and the machine properly operated then casual repairs may not occur at all and actually they should not. But if despite all

some do occur, then they must be attributed to bad operation or bad preceding overhaul.

The system of planned, preventive overhauls includes: intermediate servicing, periodic prophylactic measures and scheduled overhauls.

The intermediate servicing includes checks on the condition of the machine, readjustment of mechanisms and removal of minor failures by the service technicians on duty.

The periodic prophylactic measures include: washes, oil changes, accuracy checks and technical inspections.

The washes as separate operations are normally planned with machines that operate in polluted and dusty environment (For instance machines processing cast iron or such that use dry abrasives, etc.)

The washing medium is usually some kind of solvent like naphtha, petrol and the like. Some of the machine units are dismantled in advance (those that are difficult to be cleaned in mounted position).

The oil in the casings is normally changed at the time of the inspections and the scheduled overhauls.

Accuracy checks are usually carried with precision machines designed for finishing operations. Besides the scheduled overhaul accuracy checks such may also be carried out as independent operations

The inspections are intended to detect all the failures in the machine with only those being removed which are apt to hamper the normal work of the machine until the next planned overhaul. The rest of the failures, left for the overhaul, are entered into a special list of defects.

All preventive overhaul operations are carried out by the maintenance mechanics except the accuracy tests which is carried out under the close supervision of the technical supervisor from the supervision department in cooperation with the maintenance mechanics

The scheduled overhauls are divided into running, medium and major overhauls:

During the running overhauls a reasonable number of worn parts are reconditioned or changed and the mechanisms are readjusted in a way to guarantee a normal work of the machine until the next scheduled overhaul.

The machine is only partially dismantled.

At the time of the medium overhaul parts are reconditioned or changed or separate units readjusted in such a way as to ensure normal work until the next medium or major overhaul.

A partial dismantling of the machine is only provisioned.

A major overhaul requires full dismantling of the machine with all worn parts or units being changed or restored so that the machine may regain its initial accuracy, power and productivity as per the data given in the Instruction Book of the plant-producer.

The sequence of operations included in a major overhaul follows in accordance with the diagram on Appendix No1.

The introduction of the scheduled system of overhauls creates all necessary conditions for a regular distribution of the work amongst workers and equipment throughout the year.

The scheduled overhauls do not hamper the fulfilment of the production plan, while planned supply of materials, spare parts, equipment and labour is greatly facilitated.

Within the framework of this scheduled system of overhauls the laps of time between two consecutive major overhauls or that between the commissioning of the machine and its first major overhaul is called a repair cycle.

The working period of a machine limited by two consecutive scheduled overhauls is called inter-repair period, while that between two consecutive inspections, or between an inspection and a

following scheduled overhaul is called inter-inspection period.

An average repair cycle for the machine tools covers a lapse of 7 - 8 years two-shift operation. An average inter-repair period lasts for about 9 - 12 months, while an inter-inspection period covers 3-6 months.

The sequence of operations within a repair cycle is called the structure of the repair cycle.

If we use K to indicate a major overhaul, C - a medium overhaul, T - a running overhaul and P - an inspection, then the structure of a repair cycle would look like this:

K-P-T-P-T-P-C-P-T-P-T-P-C-PTT-P-T-P-K or

K-P-P-T-P-P-T-P-P-C-P-P-T-P-P-T-P-P-C-P-P-T-P-P-T-P-P-K

The structure of the repair cycle largely depends upon the production conditions and the specific features of the machines, but the general tendency is to increase the number of the inspections and the running repairs at the expense of longer repair cycle.

Besides the sequence and timing of the separate overhauls, the system of scheduled repairs allows the planning of labour amount and materials necessary.

In this field we use the terms repair unit and category of repair complexity.

We have adopted 50 hour labour in a major overhaul as a repair unit. Having this in mind we can find out the repair complexity of any machine tool by dividing the total amount of work done by 50 h.

The average repair complexity with machine tools is most often within the limits of 8 - 10.

The maintenance and repair service in each industrial enterprise is headed by a manager, under whose supervision the following units operate:

- A design and Methods team (bureau, group, etc.)

- A prophylactic planning team
- A production planning team
- A supervision team
- A repair machining shop.

Besides these each shop of the plant has its own repair and maintenance units methodically subordinate to the plant's chief maintenance manager.

The deployment of the said units and their personnel strength depends upon the size of the plant and its specific needs, i.e. in some of the shops it may be brought down to ONE man or even none as the work is taken up by some other unit.

With such an organisation the maintenance service of a plant takes care not only of the repair work, but also of the whole complex of problems related to repair. Thus it looks after the adequacy of machine stock, its redistribution, its operation, etc.

The design and methods unit prepares the drawings and the processing route cards of the parts to be produced for repair and stock cards for the spare parts. It also takes part in the determination of the defects of machines subject to major or heavy medium overhauls. It also works out the processing method of the overhaul.

Experience in our plants has shown that best results are achieved when the engineers from this unit are employed both as designers and methods engineers in parallel and not divergingly specializing.

The prophylactic planning team works out all the drafts for machine overhauls. It also keeps record of the machine stock and its changes. Organizes and controls the storage of oils, coolants, spare parts and repair materials.

The production planning unit prepares the drafts for the work of the maintenance shop, prepares the necessary materials and carriage

the economic analysis of the repair work

The supervision team looks after the correct use of the machines in the plant as per respective instructions compiled by its members.

The maintenance shop produces all the parts necessary for the overhauls in addition to the stock of spares.

Various types of repairs are carried out in the maintenance shop of the plant and the separate shop maintenance teams.

The repair work can be organized on three different lines:

- A fully centralized system of repair
- A mixed system of repair.
- A decentralized system of repair.

With a fully centralized system of repair all repair work is carried out in the plant's maintenance shop, while the separate shop maintenance teams take care of the inter-plant servicing alone.

With mixed system the plant's maintenance shop takes up only the major overhauls, while the other two are taken up by the shop maintenance units.

With the decentralized system all types of overhauls are done in the respective shop or inter-plant establishments.

Each plant is free to choose its most suitable system of repair in accordance with the type of equipment it has, the capacity of the factory and the character of its production.

Centralized repair may go beyond the limits of a factory and the necessary steps to this end are already under way in this country with the necessary specialisation being simultaneously introduced. Thus repair enterprises are being organized specializing in different lines based on various types of machine tools. Some of the machine tool plants are developing special repair shops for the machines they produce. It is even envisaged that some of the special precision machine tools be sent back to the producer himself for a

major overhaul.

We may follow the same line for our machines sold abroad.

We have organized already after-sales service work shops in various countries where our machines are on sale and supply them with the necessary spare parts ex stock of the respective producer plants.

A centralized repair system for the whole country has the following advantages.

Conditions are created for batch production of spare parts and higher specialisation of the workers and employees. The latter improves the quality while reducing repair costs.

Centralized system of repair allows the concentration of similar machines at one place, where not only separate spare parts can be kept in store, but also assembled units for them. This, in turn, shortens the repair time of the machines to a considerable extent. We call this method "unit-repair" method.

In order to ensure a normal work for the repair services of the plants adequate stores are set up for lubricants and coolants, for spare parts and for other materials. The stores must meet all requirements concerning capacity, storing conditions, material handling facilities, etc.

It is highly desirable to set up store standards for minimum and maximum variety ranges and quantities.

Until a few years ago the major part of the machines used in this country used to be predominantly multi-purpose machine tools. Now an ever increasing tendency is observed to use programme controlled machines, numerically controlled ones included.

Unitized and special-purpose machines are being introduced at a growing pace. In special cases transfer lines are built. The introduction of computer controlled machine systems is more and more

insistently being discussed.

A considerable progress is already on record in this line of development of our industry.

Our plants are already using unitized machines, special-purpose machines, program controlled machines and transfer lines, all of them home made.

This will be the main line of development up to 1980 as far as machine tools are concerned.

It is quite natural that all this will bring about definite new problems related to servicing and repair due to the specific character and complexity of the said machine tools. In the first place the skill of both operators and repair workers will have to be improved in order that this expensive and highly sophisticated equipment may be properly handled.

On the other hand the question of repair specialisation will inevitably go deeper and deeper. For instance what about the repair of the programme control devices and the computers!

In conclusion we may say that all problems related to the use and repair of the machine tools in Bulgaria, a country simultaneously producing and using machine tools, are properly tackled. This results in maintain the machines in good working condition, full utilisation of their capacity and long service life.

On the other hand in parallel with the repair of the machines modernisation is steadily stepping in, too, but this will be the subject of another report.

D I A G R A M

of operations during a major overhaul of machine tools

Inspection of the machine

Removal of chips, sludge, dust, suds, lubricants from the machine.

Accepting the machine for repair.

Taking the machine to the repair site.

Dismantling the separate machine units.

Dismantling each unit into separate parts.

Washing the parts.

Checking and segregation of parts. Drawing up a defect record sheet.

Separation of parts requiring repair.

Repairing the parts.

Checking the quality of repaired parts

Assembling the units.

Testing the units

Painting the units

Full assembly of the machine

Running-in of the machine and testing.

Painting the machine.

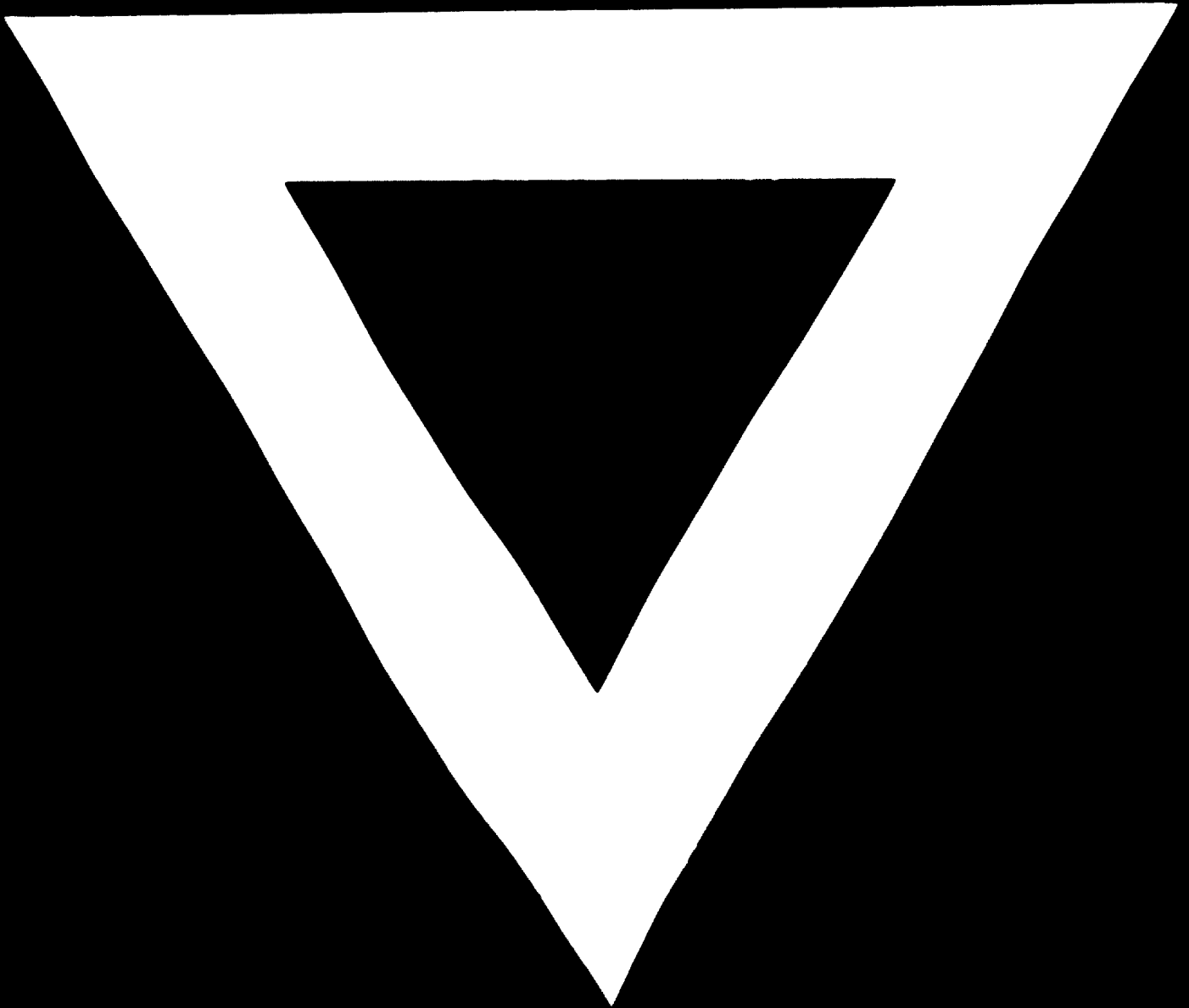
Putting the repaired machine into operation.

parts

Discarded parts.

New parts





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