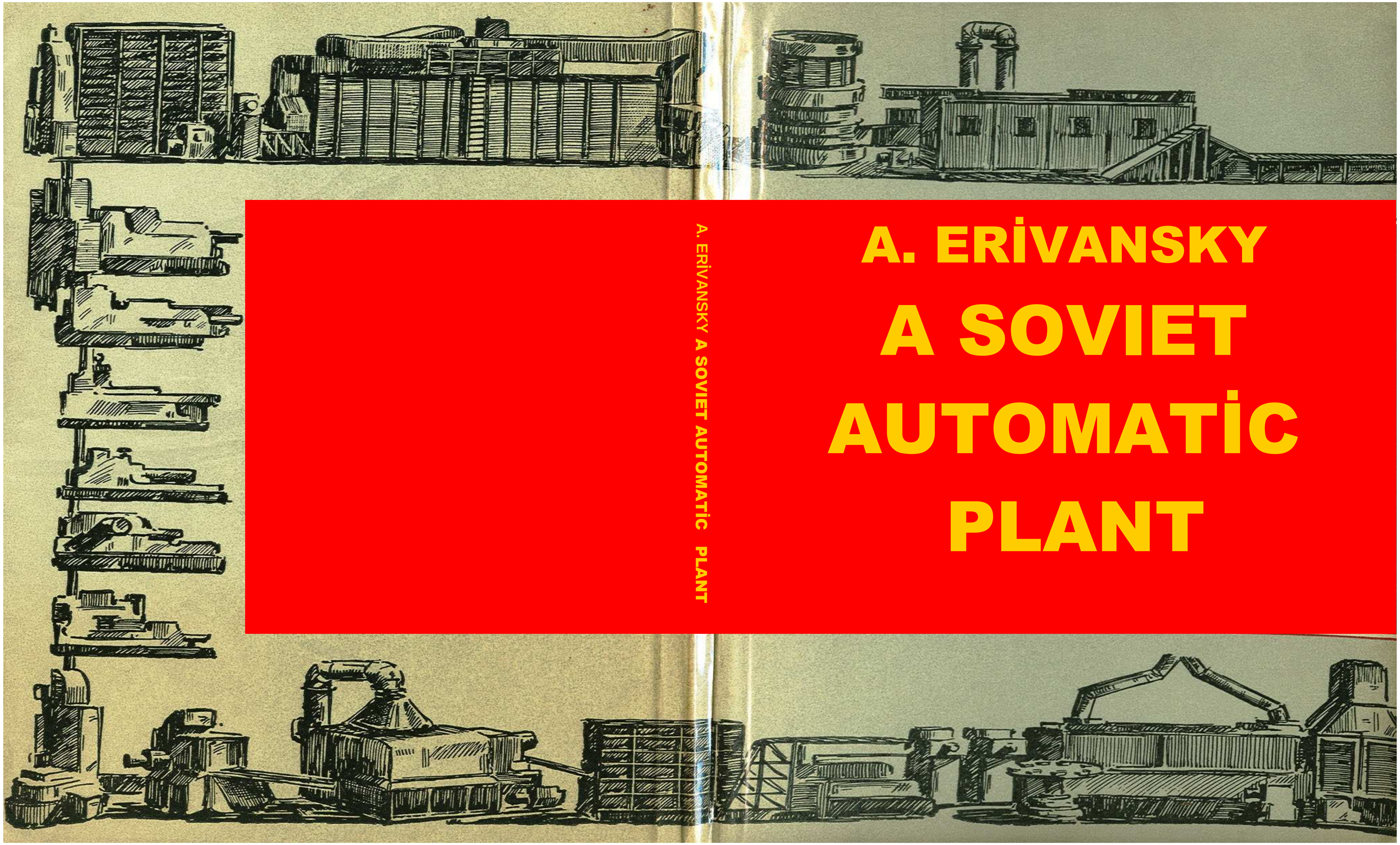

A. ERİVANSKY

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SKETCHES OF SOVIET LIFE

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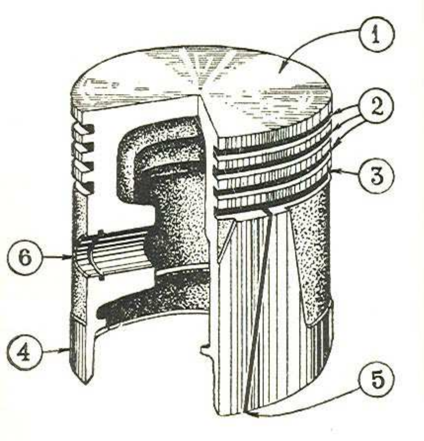

1. Piston Top
2. Piston Ring Grooves
3. Oil Ring Groove
4. Piston Skirt
5. Oil Groove
6. Cross Hole

This book tells about a Soviet automatic plant producing automotive pistons, how it was built and how it works. In this plant, designed and erected by Soviet engineers, all operations, from casting the rough piston to packaging the finished product, are mechanized. The workers at the plant need only watch the machines, and make adjustments when necessary. Automatization not only makes work easier, but increases the output per man-hour by many times and greatly reduces production costs as well.

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A TRIP INTO TOMORROW

In one of the spacious shops of the Experimental Machine-Tool Research Institute (ENIMS)[*] near the old and hoary towers of the Donskoi Monastery in Moscow I saw what was formerly to be found only in scientific romances. Taking fantastic trips into the more or less remote future on their non-existent time machines, the writers of those romances rarely failed to describe automatic factories, in which all the work was done by machines and manual labour was completely eliminated.

Today this bold dream is a reality. As if transplanted from the future into our days, the automatic factory has been erected and is actually producing. You can walk down its continuous line of machines and units, following the shapeless lump of metal from operation to operation as it gradually becomes a finished article of great perfection.

Escorting us through a small door into a huge bright structure, Engineer Yakov Kolodny asked us to close our eyes for a moment and try to imagine where we were.

Closing our eyes and listening attentively to the harsh dissonance of noises, we vividly saw in our mind's eye an immense machine shop with hundreds of machines. and hundreds of men bending over them.

Not far from us we could hear tools, directed by the lathe operators, cutting into metal. Over there we could discern the splash and gurgle of coolant as the boring machine attendants did their job. Now one operator, now another, would start his machine and each motor, after a drawn-out whistle, would settle down to a monotonous

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[*] ENIMS—initial letters of Russian name of the institute.—*Tr.*

hum. There was a clank of workpieces being carefully moved from machine to machine.

"And now take a look around," said our guide. We opened our eyes and saw only five men walking up and down the machine line….

This factory, which does everything "by itself," has already produced millions of automotive pistons. Called locally "AZ"* for short, it has already been removed from the premises of the institute and now occupies a large building with pale yellow walls.

All its machines and units, some of them the size of railway wagons, others looking very much like bookcases, and still others resembling standard machine-tools, such as may be seen in any machine shop, are arranged n-wise. Rearranged into a straight line, they would exactly take up a one-hundred-metre race track.

The machine-tool builders have created a wonderful plant-a metal-working factory in which silvery ingots of an aluminium alloy are fed to the head conveyer, and finished, packaged and labelled automotive pistons come off the tail conveyer, without human hand having so much as touched the workpieces or the push-buttons of the machines in between. The makers of the factory—scientists, engineers and workers-were awarded the Stalin Prize, First Degree. By solving this extremely complicated problem, Soviet men have scored an achievement unprecedented in the history of engineering. There are many plants in the Soviet Union which produce automotive pistons. The piston plant of the Stalin Automobile Works is considered one of the best. The organization of labour at this plant is the most effective. It

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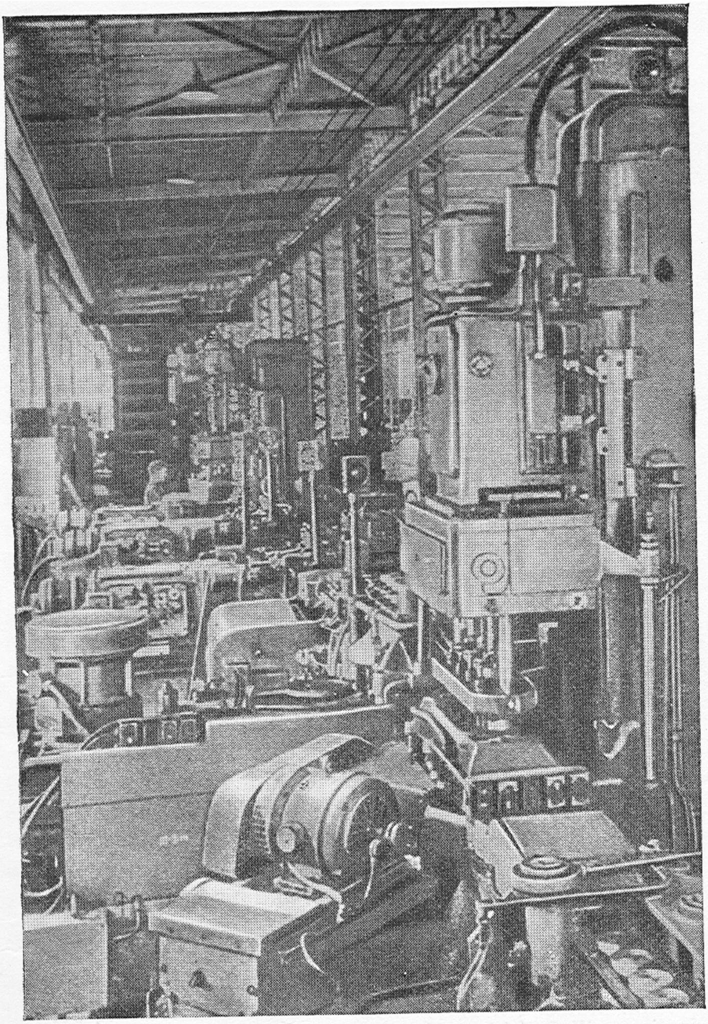
* AZ—initial letters of "avtomatichesky zavod"—the Russian for "automatic factory."—*Tr.*



The Machine Shop of the Automatic Plant

The Machine Shop of the Automatic Plant

is equipped with machines of the latest models, many of which are automatic.

But this plant is not fully automatic. It employs several times the number of workers engaged at the automatic factory, and yet the output rate of the latter is twice as high.

At the AZ machines do all the casting, mechanical and chemical treating, they automatically control and regulate all the processes, handle the pistons, remove the chips, and themselves check the accuracy of their results. This is called all-round automation. It not only increases the productive capacity of the machines, not only reduces personnel, saves raw materials, fuel and power, but, above all, tangibly improves labour conditions. The AZ is a glimpse into the future. This is approximately what all Soviet factories and plants will be like.

This factory, in which hard, unskilled physical labour has been completely eliminated, in which man does not have even to give orders to the machine, vividly illustrates how the aspect of the Soviet worker is changing: he uses his brains more and more, and his hands less and less. Labourers in the usual sense of the word are not to be found here. The factory employs highly skilled fitters, who might more appropriately be called adjusters.

A worker who cannot handle all kinds of tools to perfection will find himself just as helpless at the AZ as one who lacks a rather extensive knowledge of engineering. He would not be able immediately to detect the cause of any trouble that might arise in the extremely intricate mechanisms of the machines, nor would he be quick enough in repairing the automatic, in which the principles of electrical engineering, mechanics and pneumatics are so closely intermingled.

The fitters of the AZ are just as unerring in determining the cause of trouble in their machines as they are quick in removing it. These workers are not the kind that have to wait for the engineer's orders; they know their machinery no worse than any engineer. On the other hand, they need no "junior" labourers to do the manual work, since they are quite at home with their tools themselves.

Thus, the socialist method of production plus automation breaks down the age-old barrier between the work of the labourer and that of the intellectual, between physical labour and “white-collar” work.

… Not far from us two young workers were conversing so loudly and unconstrainedly that one might have thought it was lunch hour or that they were waiting for their shift to come on.

Our guide, Yakov Kolodny, pointed at one of them, a lean, fair-haired chap:

“That fellow over there, the taller one, is Yury Spirov. One of our best workers. His working hours are almost entirely at his own disposal. He can, as you observe, chat to his heart's content, and even has time to read; see, even right now he has a book under his arm, probably something on engineering. He's in love with engineering.”

I thought at the time that the engineer was being sarcastic. Indeed, would a good worker stand around chatting with a friend instead of working? Is it possible that a supervisor should seriously praise a worker who reads during work hours? It was only afterwards, when I had fully grasped the essence of the life of this, for the time being, unusual factory, that I realized that the engineer had been quite in earnest.

The automatic factory brings the future within arm's reach. Here you can see a close likeness of what work will become in the plants and factories of the communist tomorrow. Complete automation of all industrial processes at the AZ has changed the very nature of work.

No wonder, therefore, that at the automatic factory the best worker is not the one who never lets go of his tools the least often. It is not the worker, but the machines entrusted to his care that do the work. And the better they are adjusted, the better they do it.

The task of the worker at the AZ is to secure uninterrupted operation of all the machines in his care at full capacity over the entire 480 minutes of his shift. Hence it is quite clear that the greater the skill of the fitter and the broader his general knowledge, the more unfailingly will the automatics under his care work, and the higher will be his efficiency.

But the most curious point about it is that the less physical effort the worker puts into his work, the higher his efficiency. In other words, the less the worker at the AZ has to use muscular energy in repairing his automatic, the less is the machine idle, and the greater is its output. All the worker has to do is to look out for distress signals from the machine.

We came up to Yury Spirov, who was in charge of one of the unique automatics. Twenty years of age, Yury Spirov, just like his mates and elder comrades at the factory, is a worker of a new type. He is a ten-year school graduate and his professional skill is rated as seventh class (eighth-class rating, which is the highest, is usually given to foremen). This means that he is quite able to work on such complicated machinery.

Spirov himself explained to me the structure of the automatic centreless machine under his care, speaking freely and easily, like a specialist talking on his favourite subject.

“Let me show you how it works,” said he.

He took a small note-book from the upper pocket of his overalls and began to draw. “The carriage pivots round its axis 90 degrees, moving spirally upwards at the same time. Like this,” he illustrated with his pencil. Afterwards I found that all the employees of the AZ, engineers and workers alike, speak this way to visitors, using technical terms and sketching drawings.

THE BIRTH OF A PISTON

“The complicated process of fabricating a piston,” Engineer Yakov Kolodny explained, “begins with feeding the raw materials-ingots of an aluminium alloy. This is done by the conveyer in front of the electric melting furnace. Its duty is to feed the ingots to the furnace.” But the conveyer, I observed, did not seem to be in a hurry to do its duty. I asked:

“What's the matter? Is it out of order?”

“Wait a minute. It knows what it’s doing.”

Suddenly the conveyer gave a jerk and began to move. An ingot fell from the head of the conveyer on to the platform in front of the furnace.

A current of hot air rushed out at us as the furnace door opened. At the same moment a push rod shoved the ingot into the fiery feed chamber, and the door snapped closed. The ingot began its complicated journey through the furnace.

It is generally known that in this furnace the solid metal is reduced to the liquid state. But this process also has its niceties.

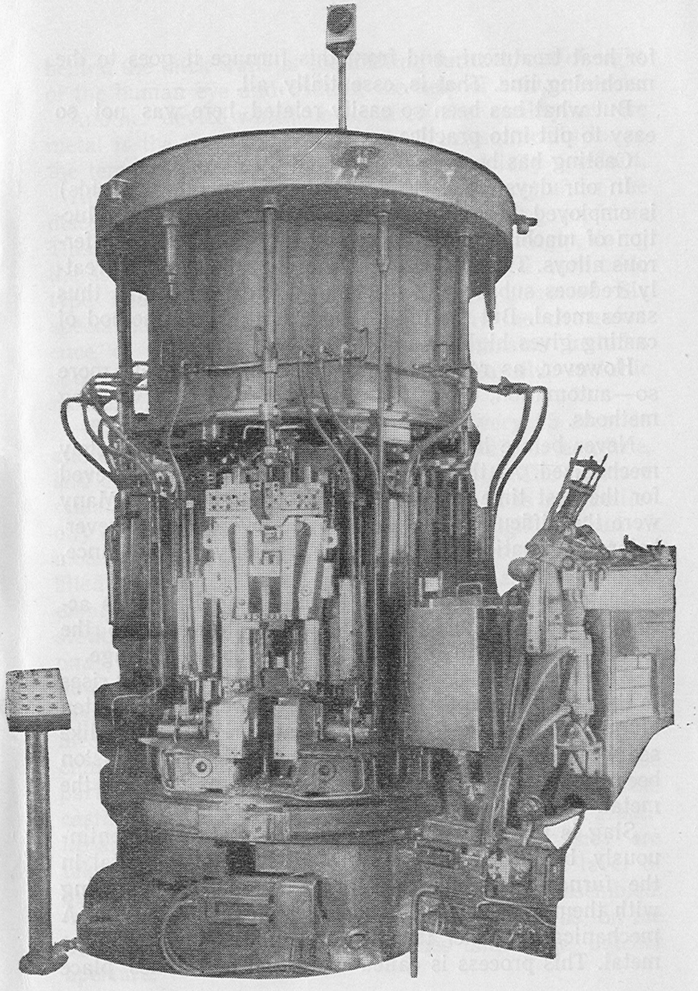
It would hardly occur to anyone not well acquainted with metallurgy that the aluminium ingot contains moisture. Still, this is the fact. Moreover, there is quite enough moisture on the surface of the ingot to cause violent vaporization which may result in a small explosion when the ingot comes into contact with the molten metal. To avoid this, the ingot is “dewatered” by heating in the feed chamber before it is melted. Each time a fresh ingot enters the feed chamber it pushes out a “dried” one.

As the ingot passes from the feed chamber into the melting zone, it is enveloped in the strong radiant heat currents coming from the electric heaters mounted in the furnace roof. The ingots enter the furnace as they are needed. This “need” is determined not by the furnace itself, but by the casting machine following it.

One ingot contains enough metal to cast twelve pistons. Each time this quantity of pistons has been cast the counter on the casting machine signals the conveyer: “Go!” And if all is well, every three minutes the conveyer comes to life, and every three minutes one more metal ingot is pushed into the furnace.

Before being poured into the mould the molten metal flows thrice from chamber to chamber, becoming purer each time.

Every 15 seconds a metallic mould-called a die-swings around and stops under a batcher device fastened to the furnace. A portion of the metal measured out by the batcher pours in a silvery-red stream into the die. Forty seconds later the mould opens to eject the silvery casting of a future piston.



The Batcher Device and Casting Machine

The Batcher Device and Casting Machine

After the projections—the “runners”—have been cut off, the casting slides down a chute into the next furnace for heat treatment, and from this furnace it goes to the machining line. That is, essentially, all.

But what has been so easily related here was not so easy to put into practice.

Casting has been known to man for ages.

In our days die casting (casting in metallic moulds) is employed more and more extensively for mass production of machine parts, especially those made of non-ferrous alloys. This is due to the fact that die casting greatly reduces subsequent mechanical treatment, and thus saves metal. But the main reason is that this method of casting gives higher output rates.

However, as regards mechanization, and even more so-automation, casting is still far behind cold working methods.

Never before had the casting process been completely mechanized. At the automatic factory this was achieved for the first time in the history of engineering. Many were the difficulties that had to be overcome, however, before automatic casting became a reality. For instance, slag….

Casters have good reason to hate slag. It always accompanies the liquid metal and tends to slip into the mould. And slag in the mould always spells spoilage.

With heavy metals such as steel or iron, the slag rises to the surface, and thus is easy to remove. But in molten aluminium the flakes of slag float at various depths, like sea-weeds in water. The slag is in a state of suspension because its specific gravity is the same as that of the metal.

Slag is removed from the aluminium alloy by continuously bubbling chlorine through the molten metal in the furnace. The bubbles float to the surface, carrying with them any slag they encounter on their way up. A mechanical skimmer then takes it off the surface of the metal. This process is called “refining” and takes place behind the thick walls of the melting furnace, out of sight of the human eye and without the help of human hands.

Another device which looks after the quality of the metal is the thermoregulator, which automatically keeps the temperature in the melting furnace strictly constant.

After refining, the metal fills the die swung under the discharge aperture of the batcher by the casting machine.

This tireless machine works swiftly and unerringly, doing the strenuous work of the caster. It is of the turn-table type and somewhat resembles a merry-go-round. Six special mechanisms are arranged around the circumference of its table; each of these mechanisms includes special parts which form the die, a collapsible metallic mould.

The table revolves intermittently. Every 15 seconds one of the dies is brought under the batcher aperture, and a stream of molten metal flows into it. The aperture remains open for 7 seconds, after which it is automatically closed. During this time exactly the right amount of metal runs into the mould. Then the table rotates and the filled mould is replaced by another, assembled but empty. Meanwhile, the filled mould shifts to the second station, and thence to the third, in which, after four seconds, it begins to open. By this time it has been cooled down sufficiently with cold water. The shining silvery casting is then carefully extracted from the open die by a mechanical “hand” which passes it on to the next machine. In one of the subsequent stations the cores (those parts of the mould which form the inner cavity of the casting) are submerged in a mixture of water and graphite and left there for several seconds. When they are taken out their surface is coated with a thin layer of graphite. In the sixth station the mould is reassembled. All these operations take up exactly 90 seconds; on the 91st second the mould again comes under the batcher aperture.

THE MACHINE CALLS TO MAN FOR HELP

But what if the die should not close tightly enough, what if a fragment of metal should stick to the wall of the mould, what will happen then? Spoilage? Will the molten metal flow out of the die and make all kinds of trouble?

No, even if this should happen, the machine will not allow metal to be poured into the defective mould. And immediately a signal light will go on: the machine will stop and call to man for help.

Then Alexei Sorokin, seventh-class fitter, First Degree Stalin Prize winner, who is on duty today, will hurry over to the casting machine.

But the machine does not signal. Its red signal bulb, mounted like others of its kind on a thin pole, burns dimly, which means: “I’m all right.”

And Alexei Sorokin, a clean-shaven, stocky man of about forty-five, comfortably seated, puffs quietly away at his pipe.

Now that the casting machine is working so smoothly, he may well allow himself this luxury. The drudgery of the adjustment period is over. During that period Sorokin and his comrades had no time indeed for quiet smokes. In the beginning the casting machine would just not work as it should.

It took the designer of the machine Zakharov, Stalin Prize winner, and his assistants, fitters Kubyshkin, Nazarov, Sorokin and Kolesnyov a lot of time and energy to get it going right.

During the preliminary tests with dies empty, the machine functioned normally, but as soon as it was put to work under load and the molten metal 'made the machine hot, the trouble began: now the mould to be filled would not close tightly, now one of the cores would refuse to slip into place, and Kubyshkin or Sorokin had to hurry and reach into the hot machine, because it had to be adjusted while hot.

It was only afterwards, when Vyacheslav Zakharov invented an automatic temperature equalizer, that things became much easier. But at that time, during the adjustment period, there was more than enough trouble.

When the workers of the Experimental Machine-Tool Research Institute took up the task of designing the casting machine, they had nothing to go by. There was neither precedent nor predecessors' experience—nothing but the fervent desire of the personnel to fulfil the task at all costs. Meanwhile, the task assigned to the institute was very urgent: it was necessary in the shortest possible time to create a machine capable of accomplishing the whole process of casting automatically.

One day in March E. Alexeyev, Head of the Machine Tool Research Laboratory, called Engineer V. Zakharov to his office and said:

"Vyacheslav Alexeyevich, our institute has been assigned the task of designing an automatic factory for the manufacture of automotive pistons, and our laboratory is responsible for the casting and heat treating end of the factory. Here is the scheme submitted by the technologists. All these squares, circles and ribbons will have to be turned into machines and conveyers. You will take care of the automatic casting machine, including the batcher device."

There was a silence. The task was not an easy one. Both men strained their memories in an effort to recall something similar to the machine they had to create, but in vain.

There had been an attempt in the West to build a casting machine. But nothing came of it. The project was left unfinished and rejected.

Still, this task had to be fulfilled. It was meant to make the work of the foundrymen easier.

On hot summer days everyone does his best to keep out of the burning rays of the sun. But in the foundry the men who work with molten metal are exposed to considerably greater heat than on the hottest day in summer. And casters have to be heavily dressed for protection from sparks and splashes of liquid metal. Besides, the trade of the foundryman is a very toilsome one. It requires enormous physical exertion.

A toilsome trade…. Was it not a noble task to make it easier? But how? How to create a machine' capable of going through all the various movements as accurately and swiftly as they are performed by man and at the high temperatures developed in casting?

To meet precision requirements the supports to which the individual sections of the die are fastened must move in sliders with small clearances. But small clearances could not be employed owing to heat expansion of the parts and thickening of the lubricant. How were these contradictions to be reconciled?

But that was not all. In assembling and dismantling the moulds many movements must be made in a strict sequence. Consequently, high precision apparatus would have to be installed in the immediate vicinity of the working organs of the machine to control these movements. But such apparatus cannot work under high temperatures.

Many problems of this kind confronted the designers of the first automatic casting machine. Their solution required knowledge and once again knowledge, daring and once again daring.

But finally the day came when the last calculation was finished. Pacing the room, as was his habit, in long strides, Zakharov unconsciously came up to the window and, looking out at the bright July sky, ejaculated in surprise: “Why, summer’s at its height already!”

The machine was virtually ready. True, it still lay motionless on sheets of paper. But the engineers already visualized it in the machine line of the future automatic factory. In their imagination the machine was already functioning. Its dies moved intermittently round and round, opening and closing. Each of the seven main parts of each mould slipped accurately and tightly into its appointed place. And this was achieved by such a simple system! It seemed strange that the solution had not occurred to them from the very first. How many times had they had to calculate and recalculate….

The drawings were sent to the pilot plant, and Zakharav drew on his overalls. In the shops, he made friends with the four fitters who had been assigned the task of assembling his machine. And afterwards all five of them were transferred to the AZ.

In assembling, adjusting and regulating the casting machine, they worked on, regardless of the passage of time. And many a hint did the designer receive from the fitters during this period.

The adjustment of the other units of the casting and heat-treating section was no easier than that of the casting machine.

But now, when all is done, Alexei Sorokin meditates:

"Soon machines like this will be set up in all foundries. Just now the foundryman's job is a pretty tough one, in spite of die casting being used more and more extensively. The temperature is too high. But in the future it will be just as comfortable in all foundries as it is here now…. Although, if you examine our machine closely and we do-there is still a thing or two that can be improved…."

Great were the efforts exerted by Soviet men to mechanize the casting process. Nor were they exerted in vain. The casting machine now functions unfailingly and requires no interference on the part of the personnel.

The automatic factory changes our usual conception of the interrelations between man and machinery.

Before this casting machine we fail to see the operator we are accustomed to seeing before even the most perfect of mechanisms. The machine is self-acting and needs no man to command it. This is true, moreover, not only of this particular machine, but of the whole complex of machines, of the factory as a whole.

The AZ is a striking illustration of how in post-war years Soviet people have been equipping all branches of industry with the latest types of machinery, have been introducing improved technology and more effective organization of production.

THE LARGEST UNIT

While we were thus occupied with reminiscences, the, piston castings went through the trimming machine and had passed on into the annealing furnace. Here the temperature must be kept strictly constant. This is accomplished, as was the case in the melting furnace, by means of an automatic mechanism. In the annealing furnace it regulates the intake of air heated to 210℃.

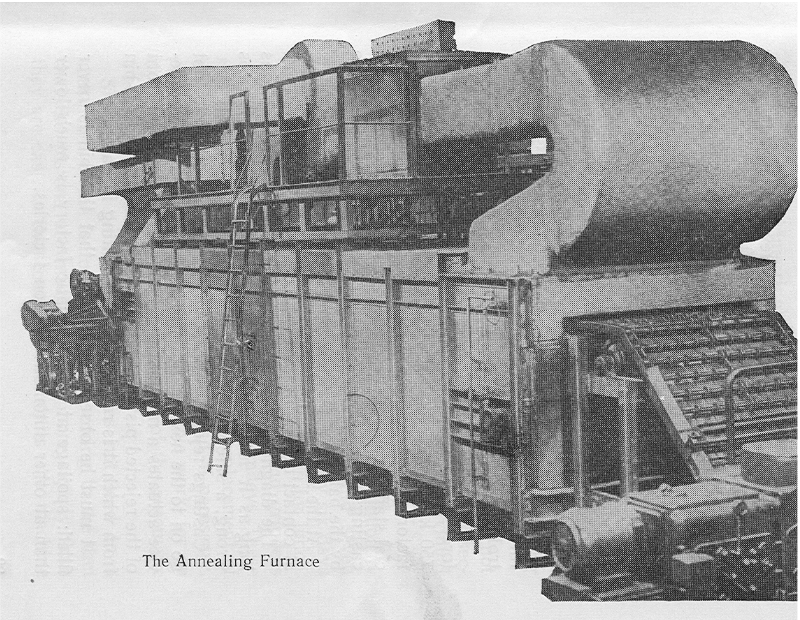
Each piston remains in the annealing furnace for 5½ hours. This is the time needed to remove the internal stresses in the casting and to give it the right toughness and hardness upon cooling. But up to this point production has been going on at a much faster rate: one piston has been cast and trimmed every 15 seconds. And now they are to undergo an operation which will take not seconds, but hours. What is to be done?

In order to keep up a continuous flow, the capacity of the annealing furnace has been made very large. Every two minutes eight pistons roll into the furnace, making a total of 1,320 in 5½ hours. All these pistons keep moving slowly on a long belt conveyer which turns back and forth three times within this annealing furnace—the largest unit in the factory.

The continuity of flow was, however, interrupted once: on the day the factory was put into operation. On that day all the units following the annealing furnace remained shut down for exactly 5½ hours: they had to wait until the first 8 pistons were annealed. After this 8 pistons began to roll out of the furnace regularly every two minutes.

And so it goes on day after day. Every two minutes there come out of the furnace eight pistons ready to be machined. But are they really ready? Does the metal of these rough castings meet the requirements set for the future pistons? This is determined by an automatic controller stationed at the furnace exit.

To test the hardness of the casting an automatic press forces a tiny steel ball into it under a constant load



The Annealing Furnace

of 750 kilograms. Such devices can be found at ordinary factories. Only, ordinary factories have to employ a special staff of controllers to check the hardness of the piston castings by measuring the size of the indentation made by the ball.

At the AZ this is done automatically: a special electrical contact device measures the depth of the indentations. The diagnosis of this controller is irreproachable as long as it is in order. But if the slightest thing goes wrong, a safety device immediately de-energizes it.

Castings rejected by the automatic controller do not go on to the next operation. The electrical measuring device actuates a mechanism which opens a hatch in front of the rejected piston, and the latter falls into a reject-bin from which it is returned to the melting furnace.

It must be observed, however, that this bin is never filled: spoilage at the automatic factory is much lower than at other automotive piston factories.

THE INTERMEDIATE STORAGE HOPPER

The carefully and unerringly selected castings, possessing all the necessary qualities, are not sent immediately to the machine shop, which is next in line.

They first go through a special device called intermediate storage hopper or “magazine.”

This automatic hopper looks more like a large deep book-case than anything else, the difference being that its shelves are not parallel to one another, but are slanted and arranged to form a continuous zigzag runway from top to bottom.

The hopper serves several purposes. One of them is that of a buffer to link up the casting and annealing section with the machine shop.

Although production at the AZ is mechanized, it is not altogether of the continuous flow type: the different sections and shops of the factory have their individual working hours, those which are the most rational in each case.

The casting and annealing section, which continuously produces liquid alloy, works in three shifts and seven days in the week. The machine shop works only six days a week, two shifts a day, and even shuts down for lunch. The automatic turners, drillers, millers and grinders always "test" during night shifts and on Sundays. These rest periods are taken advantage of for replacement of worn-out tools, inspection of machines and, if necessary, preventive repairs. This is very responsible work, for on it depends the uninterrupted operation of the automatic machines during the next two shifts.

Shut-down of the machine shop does not lead to a shut-down of the factory as a whole, owing to the fact that the pistons are machined even more rapidly than they are cast. In the course of two shifts the machine shop and the shops following it handle all the castings made in three shifts.

It is easy to understand how the production flow is kept intact during the day: the castings, as they are made and annealed, are fed continuously to the machine shop.

But how about the night shifts? Where do the castings go at night, when the machine shop is shut down, while the casting machine continues to put out a new piston every 15 seconds, and every two minutes eight pistons roll out of the annealing furnace?

It would seem that at nights and especially on Sundays whole mountains of castings must block up the foundry shop, and that this will interrupt the continuity of the automatic process.

But nothing of the kind ever happens.

All-round automation of the entire technological process has closely linked all units and made them interdependent. It has combined and synchronized operations of widely different nature and cycle length.

The pistons produced in the casting shop go to a very large storage hopper capable of holding all the casting machine can produce in 24 hours and more, and fill up its shelves, waiting for the factory whistle to announce the beginning of the morning shift.

Then the first casting made during the night shift is let out of the hopper and sent by conveyer to the cutting and grinding tools. During the day the castings are delivered from the hopper at a greater rate than they enter it. By the end of the two day-shifts of the machine shop the hopper is empty and again ready to receive the night's production of the casting machine. Thus, one of the “duties” of this hopper is to regulate the “traffic.” It equalizes the production flow between adjacent shops with different working hours.

There are several such hoppers at the automatic factory and each of them serves one more very important purpose. The all but reasoning automatic, notwithstanding all its merits-tirelessness, unerringness, etc.—is nevertheless no more than a machine. And like any other machine it may run out of order, and then it will stop working until man comes to its aid.

This fact led to a singular internal contradiction which grew as automation developed. It was a kind of vicious circle: the greater the number of automatic machines linked up in a line, the more of them would have to stand idle in case of trouble with one. However, this obstacle was soon removed.

The manufacture of pistons is a single, automatically interlinked process. But this does not mean that trouble with one of the machines on the line need necessarily lead to a shut-down of the whole factory.

The hoppers installed between sections make such general shut-downs unnecessary. If any group of machines is idle due to trouble with one of them, the other sections of the factory go on working just the same: for the time being they can receive work from and store it in the hoppers.

The automatic factory has no parallel machines which could substitute one another in case of emergency. Each mechanism is the only one of its kind. Notwithstanding, trouble with one of the machines does not result in shutdown of the others.

All this is made possible by the simple and clever contrivance called the storage hopper. This “magazine” is handy in all cases: if a machine following it breaks down, the storage hopper automatically begins to accumulate parts and stores them until it receives the “deliver” signal; if a machine preceding it breaks down, it automatically feeds those following it from its stores. When everything is normal the pistons pass through the hopper, just as if it did not exist at all.

COMPLEXITY NO BARRIER

The machine shop, where the pistons are turned, drilled, milled and ground, is a long line of machines which outwardly resemble one another. Their housings are all painted a pleasant colour, and from beneath these housings comes a sequence of gritting, rustling and scratching sounds, always accompanied by the incessant splash of coolant flowing rapidly under pressure.

The first impression is that of having seen this line somewhere before. This impression is not misleading. Many factories in the Soviet Union have automatic machining lines. In particular, the scientists of the Experimental Machine-Tool Research Institute and the other Moscow machine builders who took part in making the factory we are describing had built many automatic lines of other types before this one.

Hooking up the automatic metal-working machines into one line was far from easy. But difficulties have never daunted Soviet engineers and scientists. It is in the struggle with difficulties that novelty is born. And, of course, no few difficulties had to be overcome before the first automatic machine line in the world was built at the Stalingrad Tractor Plant by I. Inochkin, a worker of that plant, in 1939.

In this line rough castings were inserted in the first unit and finished caterpillar roller bushings ejected from the last. This was a part of simple configuration, which made automatic handling very easy.

Afterwards, following up the idea of group automation, the designers lined up automatic machines for the treatment of more complicated automotive parts, such as cylinder block, cylinder head, gearbox housing, etc. These parts move automatically from unit to unit along a kind of endless rail, but are always stationary while being machined.

For a long time designers could not make an automatic line in which the workpieces, stationary in one machine, could be rotated in another. This retarded the automation of the machine-building industry and limited the number of parts machinable in automatic lines. These previous lines, for instance, could not include turning and circular grinding together with milling operations.

The machine shop of the automatic factory resembles the existing automatic lines only outwardly, viz., in its being a line of machines linked together by means of a common conveyer. But this is no longer the automatic line of the old type, on which parts could be machined only in a stationary state or only in a state of rotation.

At the automatic factory turning lathes and grinders have been put in the same line with milling and drilling machines.

In some of the machines of the machine shop the piston is held stock-still while being worked upon, just as in the previous lines. Thin, needle-like drills approach it from all directions and bore holes in it.

But the cylindrical surface of the piston can be machined only if it is made to rotate. And the piston, when it comes to the lathes and grinding machines, begins to rotate at high speed.

This was not easily achieved. The main thing was to find a method of automatic handling that would make it possible to index the piston in the exact position necessary for treatment in each of the machines throughout the line. For this purpose the designers employed so-called locating plates, moved from unit to unit along runners by a special type of conveyer. These locating plates-or base plates-fasten themselves to the pistons and stay with them throughout their entire journey along the machine line.

The first unit (called the “base” unit) machines the part of the piston which is to come into contact with the locating plate. Two holes of different diameters are drilled in lugs provided especially for this purpose at the bottom of the casting.

Why of different diameters? We shall see in a moment. At the "threshold" of the machine shop the piston is set upon the two locating pins of the base plate which fit into these holes. But the bottom of the casting and the base plate are both round. How, then, is the machine to tell the left side of the piston from the right? This is what the difference in diameters is for: the left-side pin simply will not enter the right-side hole.

The locating plates have special holes and grooves by means of which they are indexed in various positions in the various machines, depending on technological requirements. Together with the plates the pistons are stationary in one machine, rotate in another, and pivot to a given angle in a third.

But this handling equipment by itself was not enough to make up the automatic line. It was necessary, besides, to select the machines.

There were two ways of selecting machines for the automatic line, an easy way and a difficult one. The first way would be to install standard-type manually-controlled machines and invent special mechanisms which would duplicate the movements usually performed by the operator.

However, in most cases this would lead to exceedingly complicated handling and loading equipment, making: the whole system unreliable. For this reason the designers decided to solve the problem of all-round automation in the second way, which involved designing several new types of machines.

Three main considerations were taken as starting points in designing these machines: the position of the workpiece in each machine must be the best possible for technological operations; this position, besides, must be selected in such a way as to permit the use of the simplest possible methods and equipment for automatic handling and loading; each unit must be of a capacity high enough to ensure fulfilment of the annual output planned for the automatic factory.

All three considerations were accurately observed in designing the machines now lined up in the machine shop. And now it seems that they could not have been made otherwise.

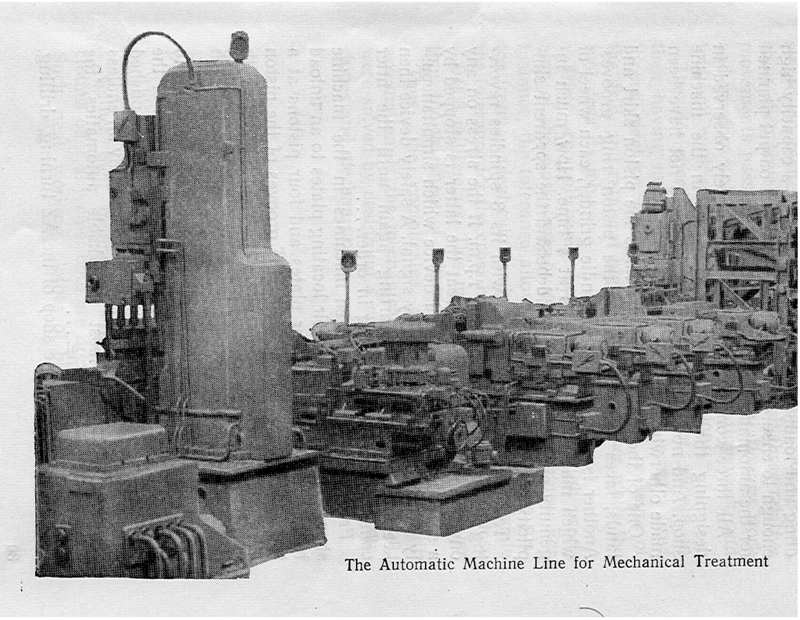
One of the machines rough-turns the piston skirt and lands, faces the top and cuts the piston ring grooves.

Another is a unique multi-spindle grinder, each wheel of which machines two pistons at a time. How much ingenuity and complexity is hid behind the apparent simplicity of these machines!

Take this boring machine with its 8 spindles revolving at a speed of 6 thousand r.p.m. If the stress on any one of the spindles is too great the latter is stopped by a special automatic overload device which simultaneously switches on an emergency signal. A safety device then keeps the spindle from starting again until the fitter comes and puts everything in order....

From the last of the seven machines in the machine shop, the pistons go on their locating plates to an unload table which can hold four plates and four pistons at a time. On the way to this table the grooves of the piston slide on to special pick-up rails. And when the table with the plates on it is lowered, the pistons remain hanging between the rails as if caught up by the arm-pits.

The pistons and locating plates now divide and go in different directions. The plates return to the head of the line to take on new castings, while the pistons are pushed on to a conveyer. Now the pistons are taken by an



The Automatic Machine Line for Mechanical Treatment

The Automatic Machine Line for Mechanical Treatment

endless pelt to one of the most remarkable automatics, the weight milling machine. . . .Thus, in the machine shop of the AZ turning, drilling, grinding and milling operations have been combined for the first time in the history of world engineering in a single automatic machine line. The designers of the machine shop have completely mechanized all three relative movements possible for tool and work: stationary work and moving tool, stationary tool and rotating work, and tool and work rotating in opposite directions.

The designers' accomplishment lies not merely in their having made the work automatically remain fixed in one machine without budging under the pressure of the drill, and rotate at high speeds in another while the tool does its job.

Their accomplishment lies no less in the high precision of the work done by the automatic machines. For instance, the tolerance allowed for deviation of the piston from an ideal cylinder is only 0,04 millimetres, while the tolerance for the cross-hole bore is ten times as close -0.003 millimetres. This magnitude is 30 times smaller than the thickness of a human hair.

Thus, the complicated problems connected with automation of the mechanical treatment of the pistons were solved by designing a number of new types of machines and mechanisms.

TWO FITTERS

All the automatics in the machine shop are tended by only two men per shift. One of the crews consists of: Pavel Nikiforov, who was recently awarded the Stalin Prize, First Degree, and Sergei Chinenov.

Who are these workers of the automatic factory?

What kind of work do they do-physical or mental?

Neither their manner of speech, nor their working clothes offer any clue: both are dressed in clean overalls. Such neat working clothes of blue rep are worn by foremen, and shop book-keepers, and office employees whose duties sometimes to be discharged in the shops.

Since the external appearance of these men has been of no help to us, let us have a look at the register.

In the pay list both their names are followed by the same words: “Fitter. Seventh class.”

So, they are workers?

That is not an easy question to answer.

As to Nikiforov, the engineers at the factory say:

“No matter what task is assigned to Pavel Alexandrovich, he always finds the most rational and simplest way of doing it—will always suggest something new in the technology, immediately fashions some contrivance to help him. If you give him a drawing, don’t think he takes up his tools right away. He accepts the drawing not as a ready-made task, but as material to be checked. Any worker will notice the designer’s mistake only in working the metal, but Pavel Alexandrovich finds it in the drawing. This requires an engineer’s eye. And if he is explaining a suggestion or proving to you that you are wrong in anything he takes a pencil out of his pocket and draughts-not draws, but draughts.”

An experienced worker may often be quicker than the engineer in noticing the necessity of making some correction or improvement in a machine. But it is not every worker who is able to decide what to do and how to do it. That is why collaboration between workers and engineers is so common in rationalisation drives. Nikiforov has also made many changes in the design of the automatic machine. But he always thinks them out himself and always shows you what has to be done and how to do it.

The factory, for instance, was once in great difficulties for lack of a reliable device for holding the piston securely in position during the responsible operation.

At last such a device was invented by Nikiforov. He not only thought up the idea, but draughted it in all its details and proved its advantages in theoretical argument. Then he clad his idea in metal. And after the device had been tested and re-tested, the commission decided: “This is the right solution to our problem.”

And when asked about Chinenov the engineers at the factory say: “Sergei Petrovich is an expert in hydraulics. He knows it as well as any engineer. Moreover, he sort of senses it as we, unfortunately, still cannot. It was he who adjusted all our main hydraulic mechanisms, and introduced many improvements while he was at it. We should have had a much harder time of it without his knowledge and experience.”

Not long ago Chinenov was asked into the manager's office and offered the position of department head, which is an engineer’s position.

So, what are they: manual labourers or intellectual workers?

The great Russian writer Maxim Gorky once wrote that foremost Soviet workers show how “... the hand teaches the brain, then the enwisened brain teaches the hand; then the hand, having become wiser, again, and now to a greater extend, helps in the development of the mental powers.”

In our days, and, especially at such an enterprise as the automatic factory, it is very difficult to tell whether these two men are workers or intellectuals.

THE PISTON CONTINUES ITS JOURNEY

After leaving the machine shop, the pistons go to the weigh milling machine. Then, uniform as balance weights of equal gauge, they roll along to the finishing grinder.

An automatic loader feeds them in batches to the centreless grinding machine. Smoothing away the last microns of metal, the abrasive wheels prepare the piston for chemical processing in the tin-plating unit.

The piston is dipped successively into several tanks. It is freed of grease in one of them, washed in another, tin-plated in a third, washed again with hot and cold water in a fourth and fifth.

Now a thin layer of tin coats the piston like armour. The purpose of this layer is to make it easier for the piston to lap in when inserted in the engine.

After the tanks the piston is dried in a strong current of air, which cools it down to room temperature.

Still, in spite of all these “sanitary operations” the piston is not yet clean enough from the standpoint of modern engineering practice. It has to be washed once more, this time in a hot soda solution, and then dried again in a current of hot air.

This is done in a washing machine, where special instruments keep the temperature always strictly at the same level.

But before reaching this machine the piston has to go through another hopper and one more automatic which brings the bore of its cross-hole to ultimate precision.

This storage hopper, which stands next to the tinning unit, serves the same purposes as the one already described. Depending on the circumstances, it either accumulates pistons, keeping them from going any further down the line, delivers, them, or lets them pass through unhindered.

But the design of this hopper differs from that of the former one, since it has to be much more “careful” with the piston, this being no longer a rough casting, but an almost finished product. Therefore care must be taken not to scratch its surface.

The hopper switches to the regime necessary automatically, just as everything is done at this factory. It “knows” at any moment, whether to deliver pistons, keep them back or let them pass through freely.

Coming out of the hopper, the pistons are sent to the cross-hole finishing unit, which performs the most high-precision machining operation. The bore tolerance of the hole finished by this machine is of the order of thousandths of a millimetre.

After the washing machine the finished piston is given a final check-up by an automatic controller and sorter.

This device is of such high precision that heat expansion of the piston caused by a temperature change of only a few degrees is quite enough to affect its readings. In order to keep the temperature of all the pistons going through the automatic controller and sorter the same, it is kept strictly at one level in the washing machine preceding the device.

An internal combustion engine can work well only if its parts fit each other with great accuracy. The accuracy required is so great, that if it were to be observed in all parts, the manufacture of the engine would be very laborious and costly. For this reason, when manufacturing some of the parts the tolerance is fixed at a somewhat greater magnitude than required. Then, when the parts are finished, they are sorted into groups according to size and when assembling the engine, adjacent parts are selected from the same size groups. Thus, high accuracy is attained without excessive complication of production methods. For instance, pistons within the same size group may differ in one of their dimensions by no more than 2.5 microns. The controller and sorter divides the pistons into 4 such groups.

This device automatically labels the pistons according to tolerance. Then they are sent to the packaging machine which prepares them for shipment: greases them, wraps them in oil-paper and packs them in cardboard boxes, which it makes itself, six pistons in each box. Criss-crossed with paper strips, these boxes are sent by roller conveyer to the shipping room.

UNDER THE SURFACE

When you see how deftly, smoothly and harmoniously the automatic machines do their work, you involuntarily get a childish impression of their being secretly run by someone hidden away out of sight.

The machines and devices live their own hidden but tense life, breathed into them by electrification and electro-automation. The latter have linked them together into a single harmonious mechanical organism.

The AZ has a very complex "nervous system"—50 kilometres electric wiring, laid under the floor. One hundred electric motors are its tireless "muscles." Over fifteen hundred switches, contactors, relays and other electrical devices constitute its "brain." It controls all the operations of the machines, makes them "intelligent," accurate and unerring.

In designing 'the electric automatic control system the engineers' first concern was to make it as reliable as possible. This system was to ensure full control for both automatic and adjustment period working regimes.

The possibility of trouble was also foreseen. Breakdown of one of the machines will not lead to a lengthy shut-down. The trouble can be located easily and rapidly, although it may appear in any of the fifteen hundred electrical apparatuses. Their great number presents no difficulty for special devices called “trouble finders.” Each of these functions only within the circuit of its own unit and locates the trouble instantly.

All these tasks are carried out, with very few exceptions, by standard electrical equipment. The AZ makes wide use of electromagnetic relays, which are, on the whole, quite simple devices. Some of these relays are actuated after the passage of certain strictly definite periods of time, others -after the mechanism preceding them has performed a certain number of movements, and still others- when a piston touches their contacts. Each relay has its individual task to perform.

Time relays, for instance, are employed to control the working organs of the machines and to batch out the metal in pouring the castings. The time fixed for these operations is measured out with an error not exceeding 1/4 second.

Computer relays control the feed to the melting furnace. Brake relays stop the machines when necessary.

Special relays keep track of whether the machines are doing their work in the allotted number of seconds. They check each technological operation. And if the duration of any one of them is greater than scheduled, they immediately notify the filter.

The temperature in the tanks of the tin-plating unit and in the furnaces is kept at the right level by means of thermoregulators. These devices automatically keep the temperature constant wherever necessary.

The relays of checking devices “see” to it that the machines keep working all the time.

Automatic control is effected mainly by the actions of the machines themselves: the starting switch of each machine is governed by the position of the working organs of the machine before. The machines send impulses—electrical messages telling of their actions— to electrical instruments, and the latter send back corresponding impulses, electrical commands to turn this on and turn that off. In some cases it is the piece itself—the piston—that gives the command necessary. This occurs when it touches two electric contacts on its way from machine to machine, closing a circuit, as if to say: “Here, I am.”

Only after receiving this signal, and not before, does the packaging machine, for instance, begin to work. A similar system of contacts controls the run and supply of paper strip for wrapping the piston. If it happens to tear, the packaging machine will immediately stop. The same happens automatically when the roll ends.

This is how the automatic electrical devices work when the factory is functioning normally. But when the factory has to be transferred from the automatic to the adjustment regime these devices are abandoned for the time being and ordinary switches resorted to.

During this period the units are controlled by special push-buttons. They make it possible to put into motion any moving part of any machine or device, as required for inspection or adjustment. As soon as the adjustment period is over, however, the automatic devices are again restored to “power”: immediately 100 motors go into action, all the conveyers begin to run, the loading and unloading equipment, rods and "hands" start functioning, spindles and tools approach the workpieces.

But what if someone now accidentally presses one of the numerous different coloured buttons which may be seen in all parts of the factory? What happens then?

An accident?

There might have been an accident, had not all these buttons been de-energized as soon as the factory passed over to the automatic regime. Thus, in this case also, everything has been taken care of beforehand.

Reliability is probably the main thing the designers strove for, as one after another they faced the difficulties inevitable in such a complex undertaking as the electro-automation of an entire factory. These difficulties were overcome by persistent research and bold experimentation. And now automatic electrical devices have completely eliminated the possibility of breakdown due to any kind of disturbance in the normal work of the factory.

But are the electrical automatic devices themselves quite foolproof? Could not, for instance, something injure the insulation somewhere in their 50 kilometre entanglement of wires, resulting in distortion of the command to be given?

This possibility has also been considered. In such cases special insulation checking instruments immediately register the injury and show its location.

Some of the automatic electrical devices and circuits, which work so unerringly at the AZ, have no precedent in singularity of design and simplicity of idea. Such are the device and circuit for automatically checking the load on the chutes along which the pistons roll from unit to unit, the devices and circuits which "see to it" that the machines are kept fully loaded, those which transfer the pistons from machine to machine, etc.

The merits of these devices and circuits are not so much in their originality, as in the fact that each of them can serve as a prototype in designing other automatic plants of all kinds in the future. This is precisely what the designers intended them to be.

... Each machine has a “brain” of its own enclosed in an iron housing. But each of these individual “brains” is connected with those of the mechanisms preceding and following it, forming a unified system of automatic control. Thus, the factory as a whole has a single “mind” to “think” with.

AUTOMATIC CONTROLLERS

Everybody knows how important the role of the production control department is at any industrial enterprise. The chief duty of the personnel of this department is to prevent spoilage among the parts passing from shop to shop and in the finished products shipped out of the plant.

Although ordinary plants do not often employ inter-operation control, as this would require too large a staff, the controllers of the production control department, however, have many helpers: whenever a worker finds his machine is putting out spoilage, he himself notifies the management.

The automatic factory has no production control department. Still, among the millions of pistons put out by this factory you will not find a single spoiled one. Each and every piston conforms fully with the standard both in shape and dimensions.

This is achieved owing to the unerring and vigilant work of automatic controllers. The forms, methods and means of control usually employed in mass production cannot be applied at the AZ, chiefly because most of them only register the quality of the finished product.

At the AZ, where all processes are mechanized, the occurrence of spoilage in any operation is considered a serious accident. The task of production control in this connection is to anticipate and prevent these accidents.

The means of control employed at the AZ are an inseparable and indispensable part of production. The processes of control have lost their independency and have become organically interlinked with the technological process, with the transport, with the general pulse at the factory.

The piston, which is to go through so many widely different machines and units, has to be able to move smoothly along a belt conveyer at one point, to revolve nimbly and speedily at another and to stand rigidly on its locating plate at a third. Moreover, each time the piston has to index in a strictly definite position. If the piston shifts just the least bit from its appointed position, spoilage is inevitable, and a serious accident may occur.

The designers have taken great pains to get the piston reliably fixed in position in all cases. In practice, however, it may so happen that among a thousand pistons which behave perfectly, just one will go into the wrong position, in just one operation. This is quite enough to cause spoilage.

Investigation and reasoning led the engineers to the conclusion that the pistons should be protected throughout their whole journey and at each stop by means of block devices. The block system they designed was similar to those used on railways.

Just as the automatic block system on the railways regulates the passage of trains, preventing collisions, so do the block devices at the automatic factory keep guard over the pistons as they go down the machine line. Only instead of keeping them from colliding they keep them from getting into wrong positions.

Various devices are used for this purpose. Such, for instance, are the electro-mechanical feelers posted like sentinels at all places of danger. They carefully touch each piston as it comes by. Their "sense of touch" is as strong as a blindman's. Feeling around the part, they determine whether it is in the precise position it should be or not. If it is not, a red light instantly flashes on.

Besides these indefatigable controllers, which keep a vigilant watch over the position of the piston, there are others which keep a no less vigilant "eye" on the behaviour of the tools. They register breakage the very moment the drill snaps, almost before the sound of the tool breaking is heard.

These controllers not only notify the fitter that spoilage has occurred. They help him further by informing him where the spoilage has came from and which tool has "violated" the technological regime. All these automatic sentinels, keeping guard over the piston and looking after the tools, are complicated devices. But they are the simplest of all the controllers on the "staff" of the automatic factory.

The block system and other protective devices are reliable, but passive. They do not remedy the trouble nor remove its cause.

An important part in maintaining the technological regime is played by the automatic devices for active control. The majority of these are original devices, apparatuses and machines.

They not only "watch" for the trouble; they anticipate spoilage. If the piston gets just a little out of alignment in the base machine—the first unit in the machine shop—its entire subsequent treatment is of no avail, and spoilage inevitable. But spoilage for this reason is impossible at the automatic factory: if the piston is out of alignment the machine just won't start.

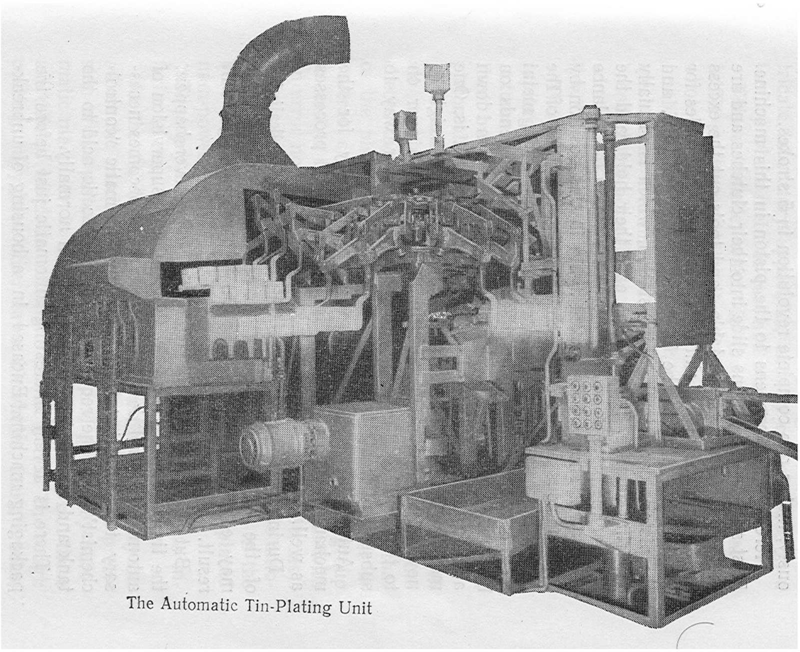
The active controllers cut into the production process swiftly and resolutely and remedy arising inaccuracies literally on the run. If the grooves of a piston coming off a machine are too wide, or if its height is faulty, then... No, there will be no accident at the next machine: the spoiled piston will not be let through, and the machine line will instantly be stopped.

No less diligent controllers are in charge of grinding the piston and finishing the cross-hole. They not only watch over these processes, but direct operations as well, constantly measuring the results obtained. As soon as the required dimensions are attained the controllers instantly stop the machines, thus eliminating the possibility of spoilage.

The automatic controller for correcting the weight of the pistons is still more active. Pistons must not differ in weight by no more than 4 grammes. This controller corrects the weight of the piston by cutting a certain amount off special weight lugs cast on the inside of its skirt. These lugs are of no use to the piston when it is working. But they are necessary to make weight corrections possible.

The round table of the machine, in the recesses of which 5 pairs of pistons undergo treatment simultaneously, makes one complete revolution in 5 strokes.

Here is what happens to the piston in this machine. First stroke—the pistons slide into their clutches and are made fast. A turn of the table—and tools cut the excess metal from the piston skirts, together with the holes for



The Automatic Tin-Plating Unit

the locating pins of the base plate. Another turn, and the pistons come to the third station, which is virtually a spring-balance. The clutches ease their hold, and the heavier the pistons are, the more they weigh the balance pan down. They are then fixed again in this position by the tenacious fingers of the clutches. Again a turn of the table—the fourth station. Here cutters mill some metal off the weight lugs. The quantity cut off depends on how far each piston weighed the balance pan down at the previous station, that is, on how heavy it is. One more turn of the table, and the pistons, whose weight is now within the permissible limits, are turned over on to their sides and roll down a chute on their way to subsequent treatment.

Automatic controllers are used not only for the mechanical operations, but for the chemical processes as well.

During the process of tin-plating, the alkalinity of the solution gradually increases. Theoretically it may eventually reach a point where spoilage will result.

But at the automatic factory this can never happen: the tinning tank is under the vigilant supervision of automatic control devices. As soon as it becomes necessary to neutralize the alkali, an automatic “control chemist” adds the required amount of acetic acid to the tank and the tinning process goes on normally.

There is a very interesting automatic just before the packaging machine. Encased in a housing of unbreakable glass, it does not even resemble a machine outwardly. It looks more like some fine, fragile and very intricate laboratory apparatus, entirely out of place in a factory where metal is cast and machined.

This automatic, which is the final control station, fulfils so many tasks that it would ordinarily take a whole team of experienced workers to do them. The machine does a great deal: it checks the quality of the mechanical treatment, sorts the pistons into groups, brands them accordingly, and to make it more manifest what group each piston has been assigned to, it marks it with paint - green, red, white or black.

The pistons go through it in single file. Without interrupting their progress, the sensitive “fingers” of this automatic run lightly over the finished parts. It takes them but a few moments to feel and measure each piston all around.

To make sure that the finished pistons conform with all requirements, the controller and sorter machine checks the perpendicularity of the cross-hole axis to that of the piston, measures the piston skirt diameter in several cross-sections; in order to decide which group to assign the piston to, this measurement is made with an error not exceeding 0.0025 millimetres (2.5 microns).

Such are the wonderful accurate and reliable automatics installed in the AZ. It would seem that in the field of control, too, machines have completely replaced manpower. But this is not so.

The very best automatic controller is nevertheless inferior to man.

At the AZ the hardness of the castings made by an automatic machine is, checked automatically. The precision of the pistons, turned, milled and ground by automatic machines, is also checked automatically. But there are defects which an automatic cannot notice. The rough castings may have other flaws: blowholes, tears, cracks, etc. For this reason they must be inspected very carefully at the junction of the foundry and the machine shop.

Of course, it may have been possible to invent an automatic which would reject castings with cracks or blowholes. This machine would be able to do so, however, only if the cracks or blowholes occurred always in the same place on the casting. But how is it possible to determine beforehand in what plant of the casting the defect will occur!

It was finally decided that even a fully automatic enterprise could not get along without the human eye.

And so, in order to keep defective castings from passing on to the machine shop, each of them is examined by a special controller. This is the only person who does the work of a controller at the AZ.

REAR ORGANIZATIONS OF THE FACTORY

When you see the Soviet automatic factory, the first of its kind in the world, in action, you experience a feeling of great joy.

Each time the minute hand of the electric clock clicks one more cardboard box comes out of the packaging machine, containing 6 neatly packed pistons. This makes an output rate of 6 parts per minute.

Not far from the tail conveyer stands the control desk, which looks like an office secretary with a high front and sloping top. The front part is a screen with an illuminated mimic diagram of the whole factory. If there is any trouble with any machine or device, the engineer at the control desk will know about it at the same instant as the fitter.

The engineer sees before him not only the condition of the machines. He knows also how the process of production is going on. This information is conveyed to him every minute by the instruments mounted on the panel, which register the work of almost every machine.

He even knows the temperatures in the melting and annealing furnaces, which are checked by special automatic recording instruments.

Mechanical counters show how many aluminium ingots have been used up by the end of each minute, the number of castings made from this quantity of metal, and the number of rejects.

But it is only a saying that the automatic factory does everything by itself. To secure uninterrupted operation, its work must be organized. The electric melting furnace has to be kept well supplied with aluminium ingots, and the mechanic shop with coolant; the tools have to be kept well sharpened and so forth and so on! And the AZ, just like any other enterprise, has its rear organizations.

The bright large main room contains only the production units. Besides them there are the secondary, auxiliary sections and units. They do not take up much space, however, are well designed and efficiently organized, They include two storerooms, one for materials and one for finished products, an express laboratory, a coolant unit which prepares the fluid for lubricating and cooling the cutting tools and hot workpieces.

A special place among the factory's rear organizations is held by the tool sharpening and distributing room. In their time the technologists and designers took great pains to secure high durability in the tools used at the AZ. Prolonged and elaborate experiments were carried out to find the best working regimes and cutting angles.

The number of tools is immense: there are 150 tools, cutters, drills and grinding wheels working simultaneously on the machine line.

Only if they are well sharpened and honed can the equipment of the factory be expected to work efficiently.

Replacement and precise indexing of such a large number of tools under ordinary conditions would take up too much time. At the AZ this problem has also been thought out beforehand in full detail. The tools are replaced in blocks, each of which holds a group of tools of the same type. The machines are equipped with rapid damping devices for fixing them in place.

The tool blocks are assembled beforehand and accurately adjusted according to the dimensions required. This is done quickly and reliably by means of special instruments.

Sharpening and honing of the cutting tools has also been centralized.

PAGES FROM HISTORY

That day there was an especially large gathering around the wall newspaper “Avtomatizator.”

Before passing over to other entries, everybody would first read the feuilleton by Engineer Kolner. The feuilleton was entitled “The Autobiography of a Piston,” and was the satirical history of a “life full of suffering and adventure.”

“For a long time they kept shifting me from place to place,” complained the piston. “I was shaved and shorn, milled, turned land ground. And the machines would stop about twenty-five times a day. I froze for hours on the conveyer plate under a terrible rainstorm of coolant, chilled to the marrow by a cold wet wind from the blower.” Reading this old newspaper now, you somehow find it hard to believe that things were ever like that.

But the factory did not immediately become such as we see it today. We are reminded of previous strenuous fighting days with their victories and set-backs by the "Flash" papers of the time. Two kinds of "Flashes" were current at that time as weapons of propaganda: encouraging "Flashes" and denouncing "Flashes."

Clear of purpose, accurately addressed, sometimes furnished with appropriate cartoons, these "Flashes" never missed their mark. Warm words of approval and severe direct rebukes aimed in person at those to blame, would strike home with equal swiftness. The criticism was operative, direct and honest, without reservations or apologies, and therefore efficacious.

In only an hour or an hour and a half after the occurrence of a delay or after the exposure of an obstacle the entire personnel knew exactly who was to blame for it. Addressing the one at fault, the latest "Flash" sheet would say: "YOU are the one who is holding up the adjustment of the world's first automatic piston factory!" or "YOU have been resting on your laurels, and this has caused a delay!" Phrases like this, said right out loud, had a swift and unfailing effect.

It took a large collective to create the automatic factory—this wonder of modern engineering. And the fundamental condition for fruitful work in any collective body of Soviet men is extensive application of criticism and self-criticism. Only if this condition is observed can successful work be ensured.

The Party unit of ENIMS taught not only Communists, but all the members of the collective, exigency towards themselves and others, and unflinching criticism of shortcomings, continually warning them against self-delusion from their achievements. And indeed, to be honest, there were a few who thought that those working on the construction of an automatic piston factory ought to be kept under hothouse conditions, protected from the sharp changes of temperature and the draughts which are so common in life.

The time allotted for the construction of the automatic factory was exceedingly short, and the task, quite a new one, breath-taking for boldness and grandeur.

A great thing has been done by the makers of the automatic factory. But the AZ should not be considered an isolated chance phenomenon in the development of Soviet engineering. It is simply one of the current steps taken by Soviet science towards complete automation of industrial processes, a step prepared by the entire previous development of socialist industry.

In selecting and developing the equipment for the automatic factory the designers were able to fit it out to a considerable extent with units which had already stood the test of time and practice.

Vladimir I. Dikushkin, Corresponding Member of the Academy of Science of the U.S.S.R., Stalin Prize winner, Alexander P. Vladzievsky, the director of ENIMS, Arkady E. Prokopovich, the chief engineer of ENIMS, Anatoly G. Gavryushin, head technologist of the project, Ariy A. Levin, head designer of the project, and their assistants began with a thorough study of the existing methods of piston manufacture.

The engineers visited the factories in Moscow. Then they went to Gorky and Rostov. They examined all the processes closely, remembering all they saw, and brought back with them drawings and necessary data.

Then “at home” they thought over all they had seen to decide what was still imperfect, what could and should be improved. So it was, for instance, with the process of casting. At the piston factories they had visited this process went as follows: casting-cooling-re-heating-annealing. The engineers of ENIMS showed that the cooling and re-heating was superfluous and costly.

But before they could be eliminated it was necessary to solve the problem of trimming pistons at a temperature of 400-500°C. And this problem was solved.

The engineers of ENIMS visited not only automobile factories but others as well, for instance, an electric light bulb factory. At this factory the designers were interested in the automatic packaging of the fragile glass bulbs with their tungsten filaments.

The engineers visited numerous plants in groups and individually. They even went to see men very far removed from machine building-candy and perfume manufacturers. At the "Krasny Oktyabr" Candy Factory they observed the work of a machine which deftly wraps chocolate bars in foil. Possibly, it was at this factory that the first idea for the design of an automatic piston packaging machine was born.

At one of the plants of the glass industry they were shown a semi-automatic machine for casting pretty perfume bottles of various shapes. That was in the days when the designers were poring over the problem of automatic hatching and pouring the metal into the dies of the casting machine.

Casting the perfume bottles was somewhat easier: the globule of dough-like glass overhanging the die was cut off with shears. But you cannot cut a stream of molten aluminium with shears. And yet, both the machine and the shears, which were of no use at all to the casters, were a sort of initial position, from which they could launch their offensive.

The designers' success in coping with the very difficult task of all-round automation was largely due to the fact that the scientific and engineering experience of the whole country was at their disposal. This is only natural: Soviet workers have no industrial secrets locked behind the iron doors of patent laws. They do not conceal from anyone their craftsmanship which used to be handed down as a secret from generation to generation, mostly from the deathbed.

The very essence of the socialist social order is such that any Soviet person has the right and the opportunity to make use of all the precious knowledge land information accumulated by the whole of society. This is one of the many advantages of the Soviet order over that of capitalism. There each capitalist keeps the patents that belong to him well concealed.

In capitalist countries the designer is often compelled to invent what has already been invented. But, on the other hand, those designers in capitalist countries who create guns and other means of destruction, work under the splendid conditions of so-called "mutual information." Certainly—war preparations is a superprofitable business.

* * *

Of course, the large amount of information the creators of the AZ were able to extract from the treasure-house of Soviet science and engineering was of great help to them in their work. But in order to make all-round automation of metal working stop being a problem, it was necessary to find many new solutions which had no precedents.

The designers had before them virgin soil, as yet untouched by engineering thought.

Now that the automatic factory is already in operation, all doubts as to the technical possibility and economical feasibility of constructing such enterprises have disappeared.

Hundreds of investigations were carried out by the workers of ENIMS in search of correct solutions. They have upturned the soil with their bold experiments. Some of these researches are of great importance for the further development of automation in general, and not only for metal-working enterprises.

The solution of such problems with many unknowns (automatic casting technology, automatic heat treatment, control systems, electrical and hydraulic automatic systems, inter-operation storage and handling, chip removal, etc.) helps to accelerate the automation of many branches (Insert Picture: The Centreless Grinding Machine) of Soviet industry. The casting machine, the measuring instruments, the automatic machine line, which has combined widely different machine-tools into an integral unit, the centreless grinder, the tinning unit, the packaging machine—all these are the invaluable results of bold solutions of designing problems.

This complex task set by the Party and the Government would have been too much for a single organization, even for such a large one as ENIMS, which has a good, lavishly equipped industrial base—the “Machine-Tool Construction” Pilot Plant.

Two more scientific establishments took part in the creation of the automatic factory—the All-Union Tool Research Institute and the Bureau of Machine Part Interchangeability Research—and also several plants and factories: the Krasny Proletary Plant, the Orjonikidze Plant, the Kalibr Plant, the Dmitrov Milling Machine Works, and the Electropech Trust.

Casters, chemists, toolmakers, electric-furnace builders specialists in technical measurements and control metal-cutting experts, past masters in metal plating—thousands of engineers and workers combined their efforts in making this wonderful factory a reality of our days.

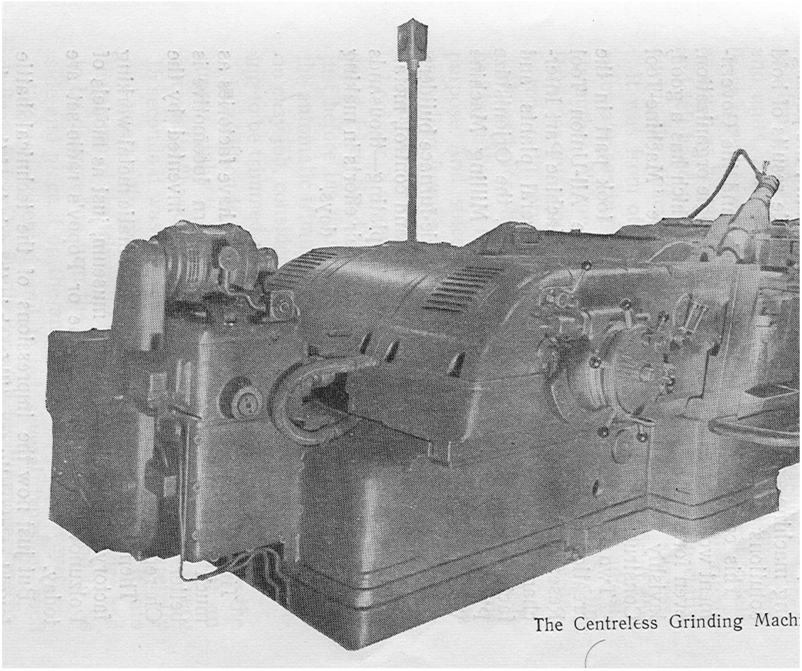
* * *

Time will pass, and the U.S.S.R. will have factories as much better than the AZ as the modern locomotive is better than the first steam locomotive invented by the Cherepanov Brothers.

Then the equipment of the first automatic metal-working factory will be displayed at a museum, just as models of Polzunov's first steam engine or Popov's radio-set are today.

But just now the impressions of the technical battle fought so recently are still fresh in the minds of those who took part in it. These people remember in full detail how enthusiastically and industriously they perfected the first models of the various units, how afterwards they put up and adjusted whole sections, and finally, how they aligned and tuned up the whole factory, all its machines, lathes and units. And now they speak with animation about these recent events, and each of them does his best to tell as much as he can, not about himself, but about his right and left-hand neighbours who were so active, especially during the difficult moments of the struggle for success. It was from others that I found out how difficult the automatic casting trimmer had been to design and adjust. Its author, Yakov Loginov, who was awarded the Stalin Prize for this machine, tells about the difficulties he had to cope with very scantily.

Never before had piston castings been trimmed hot. It had been thought necessary to cool them specially for



The Centreless Grinding Machine

this purpose. And since the piston was to be treated in the annealing furnace after trimming, it had to be re-heated. This meant loss of time and money.

Loginov, a comparatively young engineer, who graduated from the Evening Institute of Machine Building just before the war, was assigned the task of designing the automatic trimming machine for the AZ. But this was no easy job, considering that the temperature of the casting to be trimmed was almost 500 degrees.

In addition to the two-cutter machine for trimming the runner stubs it was necessary to invent and adjust an automatic "hand," with quite a difficult job to do. Every 15 seconds it was to extract a hot brittle casting carefully and unerringly from the casting machine and put it into the damp of the trimming machine. Besides, a device had to be designed to turn the trimmed piston over on to its side and place it on the annealing furnace conveyer.

Loginov invented and tested several types of such devices before he finally created his "turnover mechanism." Not one of the previous devices had been fully reliable: at least one out of a thousand pistons would go into a wrong position. This was enough to break up the general rhythm and cause a delay.

In other production processes a short shut-down is not so very terrible a thing. In automatic casting, however, it is more than undesirable. It means not only a loss of time, but a loss of quality as well, which is the main thing. Therefore, at the AZ even a short shut-down is a serious accident.

But the "turnover mechanism" was irreproachable: each piston in turning over went through exactly the same trajectory with mathematical precision.

"The quick place—four pistons per minute—kept us on the jump," Loginov told me. "They offered to step it down to two per minute, which would have made it much easier. But we decided we could manage all four. And then, you know, the more difficult an engineering problem is, the more interesting it is to solve."

I asked: "I've been told you had an especially hard time making the cutters stable enough. Is that true?"

"It is. Turchaninov did have a hard time of it. He's one of the engineers from our institute's laboratory of tools and metal cutting. A clever and persistent fellow. And Naryshkin and Gerasimov helped him."

Loginov went up to the desk and fingered the papers on it for a moment, then he sat down on a chair and continued in a perceptibly agitated voice:

"That was a period of feverish searching. The days seemed vexingly short to us. Food and rest were forgotten. Those cutters took away our appetites and kept us awake nights. They would trim fifty castings and then go out of commission. After twelve and a half minutes the teeth would clog with hot metal. We tried changing the shape of the cutters and the working regimes, but in vain. We were declared a 'bottleneck.' We were holding up the adjustment of the entire factory. Imagine what we felt like?"

Loginov got up and again began to pace the room.

"When we suggested trimming the castings hot, so as to eliminate cooling and re-heating," said he, walking up and down, "there were those who rose up against us. But we held our own. And now it seemed we would have to give in. But is that possible when you feel you are right? In the midst of the battle Turchaninov suggested a new shape for the cutters, after which they began to trim twenty-five hundred pistons a piece. The hot-trimming method was approved. But Turchaninov was hot content to stop at this. He thought up two more original designs of trimming cutters. Both had mechanically attached carbide alloy cutting edges. They trim tens of thousands of pistons without resharpening.”

* * *

The three of us were seated around a small table in the office of the factory, having a chat together. Engineer Vasily Shcherbakov, a broad-shouldered man with a high prominent forehead and resolute features, had unbuttoned his leather overcoat and, with his eyes fixed upon the floor, was forcing desultory words through set teeth. At my side sat Sergei Chinenov, a fitter, beating a tattoo with his fingers on the table.

Many people had told me: “Be sure to write about Shcherbakov. George Zuzanov will tell you about him. They shouldered all the hardships together. And don’t forget to speak to Shcherbakov himself, too. He is probably the youngest of our Stalin Prize winners.”

The son of a Tulia peasant, he went to work after seven-year school at the Podolsk Machine Shops, where his elder brother was a turner on a precision job—the manufacture of thread gauges. Young Shcherbakov worked during the day together with his brother, and in the evenings attended technical school. Then he entered the Stalin Machine and Tool Institute in Moscow. He graduated during the war and went to work at ENIMS.

“You designed and adjusted the machine section, didn't you?”

“No, I only participated,” answered Shcherbakov. “Tell me, please, how you participated.”

He stroked his soft flaxen hair and said slowly in a muffled voice:

“How I participated? Did some designing... some adjusting.... Worried a bit...

overworked a bit....”

“You talk about it so unwillingly, that one might think there was nothing interesting to tell.”

Shcheribakov immediately livened up and replied:

“That’s it. I didn’t do anything extraordinary. I told you I was no good for a story.”

“Well, now, Vasily Ivanovich, you’re being over-modest,” interrupted Chinenov. “I could tell you a thing or two,” he continued, turning to me, “but it's inconvenient to praise a man to his face. One does not talk of those present, you know.”

“That’s right,” exclaimed Shcherbrakov delightedly. "Let’s talk about those absent. I could tell you about Zuzanov.”

“Vasily Ivanovich is right,” agreed Chinenov. “You won’t have a chance to see Zuzanov. He’s in Leningrad on commission. The Stalin Prize he received for the AZ was his second one. He got the first in ‘45 for his share in making an automatic machine line.”

From this moment on our conversation became lively and interesting. Vying with each other, Shcherbakov and Chinenov began to talk about Zuzanov, one of the authors of the machine shop project for the AZ and one of the oldest workers of ENIMS, who took part in the construction of the very first combined machine-tools of Soviet make.

“If only you knew how much effort he put into the conveyers!” exclaimed Shcherbakov, leaning over a little towards me. “You see, he was always trying to simplify the design. Complicated designs are not always reliable. Those are his very words. And achieve maximum reliability he did. You’ve seen how our line works, haven’t you!”

“You wrestle and wrestle with some conveyer that’s too slow,” Chinenov interrupted, “but it just won't go any faster. Then Zuzanov comes up and is sure to say: ‘Don’t you get flustered, Sergei Petrovich, use your brains. Now, then, just tighten up the valve on that pump.’ And he turns out to be right: the conveyer begins to run at normal speed. Or else, he’ll come up and stand behind you watching and watching, and then: ‘Let’s have your wrench, Sergei Petrovich.’ And he begins to rummage himself; day or night, but he is sure to find what he’s looking for. I remember once, after a breakdown…. I mean that time the hydraulics on the base machine went out of order,” he explains rather to Shcherbakov than to me. “We fussed with it all day and all night, and then the boys and I laid off to get a bit of sleep. About three hours later we came back, only to find Zuzanov still there: he hadn’t even left. I says: ‘Go and have a rest; you ought to take more care of yourself.’ And he answers gaily: ‘Don’t waste your breath, Sergei Petrovich. Better tell me what caused the spoilage in the rough grinder?’ I was taken aback at first: ‘I don’t know.’ ‘Well, I just stayed here in the shop, and now I know. The lifter has to be raised a bit, and then the piston will be ventilated as it rotates.’”

“Yes, Zuzanov is remarkably persistent,” chimed in Shcherbakov, following up Chinenov’s thought. “He has never been disconcerted by failure; it just makes him set his teeth all the harder. And he works away with his T-square, and his slide rule, and his screw driver. Now, I remember once. . . .”

Becoming more and more enthusiastic, Shcherbakov told very interesting things about Zuzanov. And there came up before his listeners the image of a Communist engineer, putting all his efforts, knowledge and his no small talent into the very important cause of automation.

Chinenov could not contain himself, and made use of every opportunity to put in remarks: “And remember how glad he was when the shop worked through a whole shift without stopping!”

“And the trouble he had with those chips! Tell him about the chips. That ought to be interesting for our friend here.”

All this time, on the other side of the wall of the office where our conversation was going on, under the high roof of the AZ, all the tools, cutters and drills of the automatic line had been working away smoothly and steadily. Every hour these tools were taking off 75 kilograms of chips, which during the adjustment period caused the personnel of the machine shop so much trouble. A tiny chip of metal filling on a locating plate would be enough to put the piston out of alignment and thus to make the work of many men worthless.

But now all the chips, to the last speck, are blown and washed out through ports cut in the frames of the machines on to a scraper conveyer which passes underneath them. After coming clear of the automatic line the chips are washed of coolant, put through a crusher and conveyed to a storage hopper outside the factory premises.

LONG-LIFE NEEDLES

Many a difficult problem had to be solved by the designers of the AZ. For instance, the batching device, at first sight so simple and artless, turned out to be very difficult to design.

The batching device links the melting furnace with the casting machine. Therefore its dimensions must be as small as possible. Hence, the lining, that is, the refractory coating on its inner surfaces, and the electric heaters for keeping the metal in the device from freezing must also be of the least dimensions permissible.

The batching device must measure out portions of metal as accurately as if they were weighed out on prescription scales.

Why not install a special signaller in each die to “watch” over the amount of metal poured in and to stop the batching device at the right moment? This seemed to be the simplest and most reliable method. But it turned out that the signaller, a low-voltage contact, would have to be placed for this purpose on the piston skirt, which made the idea impracticable.

There was, of course, a still simpler way from the point of view of design: to use a time relay, which would start and, stop the batching device alternately in strictly definite time intervals.

But would the quantity of metal flowing out of the device in these equal intervals be exactly the same each time? It must be remembered that all the parts of the device get hot and expand, changing their dimensions....

Again endless experiments. But one day the technologist working together with Zakharov, Victor Semyonov, using a stop-watch, found that Mikhail Novikov turned the pneumatic manual control lever of the batching device exactly every 5 seconds.

But maybe the human hand and eye do not catch the end of the process exactly?

Feverishly they installed a time relay. A disk was mounted on one of the shafts of the machine with constant rotation, and a contact pin fitted to it. A wire was run from this pin to a terminal box, and thence to an electro-magnet. Now the latter would substitute the human hand in starting and stopping the batching device.

Success! For joy! Precise batching had been accomplished, and by the simplest means, into the bargain!

This happened late at night. The whole factory was lost in silence. Semyonov and Zakharov, as happy as schoolboys, stood by the machine listening to the click of the valve coil as it closed the batcher at the exact moment you began to stretch out your hand to close it yourself, for fear the metal would fill the die and begin to overflow.

Now that the batcher did not freeze, and automatically measured out the exact amount of metal needed, it seemed that a long automatic cycle could be resorted to.

Far from it! It turned out that the batcher needle was not “willing to comply.” While there was still trouble with the machine and casting was done in small batches, the needle performed its duty faithfully; but when it came to non-stop work, the needle gave out.

This needle is a rather long rod with a truncated cone tip for closing the outlet of the batcher device. It has to be stable so as not to yield to the molten metal in which it is submerged day and night. It has to be a long-life needle. It cannot be made of steel, because steel dissolves in molten aluminium like sugar in water.

Soviet metallurgists have invented a carbide alloy which does not dissolve in aluminium. At 800 degrees Centigrade it is almost as hard as at 20 degrees. And so the part of the needle that is submerged in the metal was made of this alloy.

But carbide alloys have a number of essential shortcomings—they are brittle and lack flexibility, whereas the part of the needle which stops up the outlet works under great stress. It is washed on all sides by a swift stream of molten metal, and when it closes it comes down hard upon its seat in the outlet aperture.

Carbide alloys cannot be welded to steel, and so the two parts of the needle had to be soldered together. But after working for some length of time, the carbide part would come away from the steel holder.

Despite all the binders they tested, despite all the methods they tried in the effort to join the two parts of the needle together, very often a dismal picture could be observed in the test shop of ENIMS: an idle casting machine around the batcher device, a gathering including the entire personnel of the current shift-fitters Sorokin, Kubyshkin and Nazarov—and, beside them, Zakharov and the head metallurgist, Bobrov. Sadly would they watch Mikhail Novikov pour the metal out of the batcher and extract the piece of broken needle from the bottom.

Then a new piece would be soldered on. But after a few hours' work the same dismal picture would be observed again.

At last, however, this problem was also solved. It is a pity it did not occur to anybody to count up the number of different methods tried. The resulting figure could have served as eloquent evidence of the persistency and diligence of the designers.

The best needle was the one suggested by Alexander Kuptsov, Stalin Prize winner, in which the steel holder was shortened and the part cut off replaced by mica washers. But although this needle worked well, it was very difficult to make. For this reason it finally also had to be improved.

Who the main "needle-tamer" was is impossible to determine. The designer of the casting machine, Zakharov, advised me:

“Speak to Bobrov. He’s the one who helped us.” Bobrov agreed:

“Yes, you bet it was a difficult job. Semyonov, the technologist, will tell you all about it.”

Semyonov, in his turn, said:

“You’d better see Yelena Mitrofanovna Morozova about that. It was her sorcery that did the trick.”

Morozova obligingly sent me off to . . . Zakharov.

This is characteristic of the circumstances under which the factory was created. It took the combined efforts of many people to make the batcher device the simple-looking but technically perfect apparatus it is today.

WHY PISTONS?

There is hardly a more complicated branch of industry than machine building.

It would take more than one hour to read over the list of products put out by machine plants. But it is not only the length and diversity of this list.

Machine builders’ wares are of widely different shapes sizes and weights, from watches small enough to fit into a vest pocket to gigantic mechanical shovels which take up more than a whole train.

Hundreds of brands and grades of metals, alloys and plastics are used for the manufacture of machines. And almost everyone of them has its own requirements as to working temperatures, machining tools and control devices. But probably the main thing that makes machine building such a complicated branch of industry is the high precision required.

Machine building is one of the most difficult branches of industry to mechanize, and the automotive piston -one of the most difficult parts to manufacture automatically. I asked Anatoly G. Gavryushin, the Head Technologist of the AZ project, a question quite natural for a visitor: why they hadn't picked on a simpler part for the first experiment.....

"There are several reasons," replied he. "The piston is a standard part. Not a single automobile, tractor or any other internal combustion engine can get along without it. Hence, it is needed in great numbers. Besides, pistons have to be produced mainly as spare parts. Therefore, according to the principles of good engineering practice and for the sake of economy they should be manufactured at specialized plants. But there are other reasons, too. More important ones."

The Head Technologist stopped for a moment to collect his thoughts, and then went on:

"It is our aim to mechanize the entire machine-building industry, and not merely the manufacture of pistons. The piston is but a part of the task. But it is a part which made us solve many fundamental engineering problems of a general nature. This is why we chose neither an easier nor a simpler part for our first experiment."

Yes, one of the main traits of the men who created the AZ was persistency, the striving to overcome all obstacles met with in achieving their ultimate aim, and by no means the desire to take the easiest path.

For instance, here is how the designers came to a decision concerning the timing of the factory as a whole. The machines in the previous automatic lines of Soviet origin are timed to work simultaneously. The pace is set not by the fastest, but by the slowest operation. Only after the machine doing the longest job finishes its work, does the handling equipment go into motion all along the line and move the parts from unit to unit.

Naturally, different operations at the AZ also take different time. “Inspection” of the piston by the controller and sorter machine takes only 10 seconds. This is the fastest process. Milling the piston to constant weight takes 20 seconds. And grinding, the slowest operation, takes 40 seconds. Stepping it up would spoil the quality.

If the engineers had taken the path of least resistance and ready-made solutions, the AZ would be putting out only 1 piston every 40 seconds. Its output rate would be four times as small as it is.

But the “bottleneck” was not made the pace setter. The entire AZ except the foundry shop works at a rate of one piston per 10 seconds. In practice this was accomplished as follows. Milling to constant weight takes 20 seconds; therefore, the machine has to work simultaneously on two pistons. Grinding takes 40 seconds, and, consequently, four pistons must be ground at a time, etc. Thus, the pace of weight milling and grinding also becomes one piston per 10 seconds. The machines installed at the AZ were remade into high-capacity units.

But the operation time in each individual machine has remained unchanged. The grinder puts out 4 pistons, but only once every 40 seconds. On the other hand, all these machines with their different operation times form an integral whole. This greatly complicated the design of the handling and loading equipment.

The AZ differs from ordinary plants equipped with automatic machines, first of all, in the fact that automatic machines are used here for all technological operations without exception; secondly, production control, operations control and the main auxiliary processes have also been mechanized. These are, however, problems which have been solved to a greater or smaller degree at all modern enterprises. Hence, this difference is but of a quantitative nature.

But the AZ has one more distinguishing feature, essential and fundamental, which makes it qualitatively different from other enterprises: at this factory all handling and loading operations are also fully automatic. Automation of handling and loading has linked up all the units into an integral whole, has given the factory an even pace, determined by the duration of the fastest operation, viz. 10 seconds per piston.

A great variety of devices are used at the AZ for transporting workpieces from machine to machine and for indexing them in each. These include ordinary chain and scraper conveyers, original loading and unloading mechanisms, inclined chutes, down which the pistons roll by gravity, and belt conveyers along which the pistons are conveyed by quite another force-by friction.

It must not be thought, however, that the pistons running along the chutes or belt conveyers are left to themselves. They are guarded here also by means of special automatic devices. Some of these, called “set-makers,” are installed at various points along the automatic line. It is their duty to change the number or parts running parallel. This is done to make simultaneous treatment of the right number of parts possible in each machine. Others, pivoting devices, change the position of the part as it goes into or comes out of the unit. The “hands” of these devices “take hold” of the rolling pistons with measured movements, and place them in the position necessary for treatment; after the operation is completed the “hands” again carefully place the pistons on the chute.

All these devices link up processes of widely different nature and duration—casting and machining, chemical treatment and packaging- into an integral, automatically actuated flow.

IMPROVING THE DESIGN

The achievement of the builders of the AZ has been certified by three official deeds: the factory was approved by three commissions. There were three tests, each of which was preceded by an adjustment, during which everything was aligned, measured to precision and polished to mirror-like finish. The commissions included men who clung stubbornly to their doubts as to the practicability of such an enterprise, and others who had sympathized with the idea from the very first. They studied and checked the work of the factory for many months, examined everything closely, measured, calculated. And in the end they all said: "decidedly yes!"

After this came the hearty thanks of a whole people: the government awarded the makers of the automatic factory the Stalin Prize, First Degree, for their work.

These happy tidings found the personnel of ENIMS at work on a new project which was to be a further development of and improvement on the first, the one just approved. This was the project of a second automatic factory.

Like the first, it puts out 11 types and sizes of pistons to be used both for assembling new automobile engines and as spares. They are also made of the same aluminium alloy. And the output rate is the same-one piston every ten seconds.

Consequently, the second AZ might have been made a copy of the first, which had already shown its excellent qualities. But the engineers of ENIMS took a different path—the path of men who do not rest content with their achievements. A number of alterations were made in the construction of the machines. Improvements were made in machines that seemed good enough without them; but after these alterations they became still better.

The head conveyer was altered: it was made longer. Now the conveyer can be loaded with a larger number of ingots at a time. The second AZ has a hopper at the beginning of the head conveyer, which loads the ingots on to the conveyer automatically.

At the first automatic factory a mechanical device was employed to index the piston for hardness control. There were no complaints about this device. But a still better method has been found, involving the use of a photo-electric cell. The "electric eye" guarantees higher reliability.

Not only new details, but new machines as well have appeared at AZ II: the hopper installed after the foundry is of an absolutely new design. It no longer resembles a bookcase. It looks more like a cinema film box, magnified about a hundred times.

This "magazine," which is more often called adapter now instead of hopper, is much more convenient than the old type. Its design permits it to be easily lifted by a bridge crane: This will come in handy when the casting and annealing section is shut down for annual repairs. The foundry will be idle for two weeks, but the output of pistons will not be discontinued: every time an adapter is emptied, it will be replaced by means of the crane with a new one, filled with castings beforehand.

* * *

From the very first days of its birth on the drawing boards, the AZ bore in itself the elements of the future plants of communist society. The four basic tasks which had to be accomplished in designing this factory were: elimination of hard, strenuous labour; high output rate; unimpeachable quality, and wise economy based upon accurate calculation.

How the first of these tasks was fulfilled we have already seen: hard physical labour has been completely eliminated at the AZ. Not only industrial processes, production control and spoilage prevention have been mechanized. Strict accounting is also done automatically.

The control panel, with its mimic diagram of the whole factory, shows not only how each machine is working. It is equipped with computers which continuously calculate the results of each operation throughout the entire process. They show at any moment the number of pistons cast, the number tin-plated, the number sorted and packaged.

The second task has also been fulfilled; the output rate of the AZ is incommensurably higher than that of ordinary enterprises.

The gradual transition of the U.S.S.R. from socialism to communism is being effected on the basis of ever-increasing labour efficiency. As far back as 1919 V.I. Lenin in his work "A Great Beginning" pointed out that:

"In the last analysis, productivity of labour is the most important, the principal thing for the victory of the new social system."* Besides high labour efficiency the AZ ensures excellent quality.

All heat processes at the AZ are carried out with the lowest possible expenditure of electric energy. Foundry

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* V.I. Lenin, "A Great Beginning," p.32.—*Tr.*

waste is returned automatically to the melting furnace. The AZ takes up much less industrial floor space than ordinary enterprises. The labour expenditure is altogether insignificant: on the average, one fitter tends 5 high-capacity machines. It is not surprising, therefore, that the over-all cost of automatic piston production is lower than at one of the best piston factories in the country—that of the Stalin Automobile Works. The annual savings effected by the AZ in comparison with this factory amount to almost 2 million rubles.

* * *

The designers, whose task it was to create the best possible labour conditions at the AZ, this wonder-factory, were instructed, in particular, to make provisions for a lunch hour.

A lunch hour for automatic machines? Isn't this a joke? No. The lunch hour is planned at the Soviet automatic factory not for machine inspection. This, like tool replacement, is done at night. The lunch hour is not for the machines, but for the men who tend them. The machines do not need a lunch hour. The men do.

Throughout this hour, while the men are in the restaurant having their lunch, the machines are idle. They wait while their masters have a rest. Only in the foundry are the automatic machines not shut down: in this shop operations must be kept stabilized, and go on continuously without interruption.

This little detail in the life of the fully automatic enterprise—the lunch hour—reveals the good and warm-hearted idea which underlies the mechanization and automation of the socialist national economy, the idea that machines are for men, and not men for machines. The lunch hour was taken into account, together with many other measures aimed at making labour safe and easy, before the designing was ever begun. These measures were taken as a starting point in determining the working pace of the factory.

nd now the conclusion comes of its own accord, that the wonder-factory is no wonder, but a logical, planned, wonderful consequence of the entire policy of the Communist Party of the Soviet Union, whose ultimate aim is the building of a communist society in the U.S.S.R.

ACROSS THE OCEAN

Entirely different are the aims pursued by automation in capitalist countries. Derivation of maximum profits—such is the basic aim of the capitalist. In capitalist countries man is subject to merciless exploitation. The worker becomes but a live appendage of the machine.

The very essence of engineering infers that it should be aimed at making the work of man easier. But capitalism perverts, mangles and disfigures it, just as it does with everything it touches. Automatic engineering in the hands of the capitalists becomes a curse for the working people. This is confirmed, for instance, at the semi-automatic plant of the John Barnes Co.

The U.S. press made a lot of fuss about this plant. The proprietors were called not otherwise than the guardian-angels of the workers, and from the newspaper pages gazed the smiling faces of pretty girls standing at smart and showy machines.

“They come here as they would to a dance-hall,” shouted the papers with all their might. “Work here is easy and agreeable. It’s a pleasure to work in this plant.”
Various office representatives who visited the plant, also saw workgirls of rare grace, with fashionable hair-

dresses, who, judging by their external appearance, knew how to use powder and puff.

But then the whistle blew, and on went the machines which had to be controlled with great rapidity and dexterity by means of long rows of push-buttons. The unemployed model-girls from fashion shops whom the company had given jobs at this plant, began their working day.

Remember how the musician standing over the xylophone has to strain all his muscles to keep up the tempo of a major-key piece. That is just about how the American women employed at the much praised plant of the John Barnes Co. have to work. After 10 or 15 minutes of such playing the musician lowers his tired arms with a feeling of relief. But the American "model" workgirls "play" their push-buttons not for a few short minutes, but for long hours.

To finish with the plant of the John Barnes Co., it remains only to answer two questions.

"Why are most of the workers here women?" "Because they can be paid less than men."

"What do they produce?"

"Shells."

These two answers reveal the substance of modern imperialism, lay bare its soul, thirsting for gain and robbery. Its supreme ideal is profit. And the most profitable business is murder.

The Americans, however, have not given up the idea of making a fully automatic metal-working enterprise. This question has brought up animated discussion on the pages of technical periodicals in the U.S.A., Britain and other countries.

"No one doubts that the world of tomorrow will be much more mechanized than the world of today," declares *American Machinist* in an editorial entitled: “How Soon the Automatic Factory?” And immediately afterwards adds optimistically: “Even the fully automatic metal-working plant is closer than many managements suspect.”

It would be a mistake to think that to confirm this assertion the magazine refers to the fact that the world’s first fully automatic metal-working factory had already been built in the Soviet Union in 1950, for the production of automotive pistons.

No, as proof of progress in the field of automation the magazine points out one of the Ford Co. plants, equipped with an automatic machine line, which, according to the same editorial, “all but does away with manual labour.”

American workers are well acquainted with the labour conditions on Ford Co. automatic machine lines. They are the same at Ford’s as at the John Barnes Co.: the worker who tends the automatic has to work like an automaton himself.

Telling about the Ford “automatic conveyer,” the magazine affirms:

“Here, in practice, is a near approach to the automatic factory.”

The editorial referred to was printed in *American Machinist* for November 1951. But the London edition of this magazine (*The Machinist*) returned to this problem twice again, in March and in April 1952.

What is it that makes the capitalists so persistent in the attempt to create a fully automatic metal-working factory? The magazine states the reason:

“Labour rates,” it writes, “are sky-high and will go higher. More output per man-hour is the only way to make those rates palatable and tolerable.”

It is general knowledge that in capitalist countries real wages keep falling catastrophically, that the living conditions of millions of workers keep going from bad to worse. Just the same, the magazine shamelessly asserts that labour rates are... high. Between the lines written in black and white, however, there is no difficulty in reading that in reality quite another thing is meant, viz., an even greater increase in superprofits for business men.

American Machinist states that:

“A group of students at Harvard Business School, aided by several industrialists ... have designed an automatic piston factory and have worked out actual operating sheets for machines.

“The automatic factory is not just a figment of one’s imagination. It can be made a reality,” the magazine goes on to say, but immediately warns its readers: “Even so, don’t jump to the conclusion that the automatic metal-working factory is here.”

As proof of the difficulties that stand in the way of making the automatic factory a reality, *The Machinist* (London edition) quotes John T. Diebold, Harvard group leader, who said:

“Most manufacturers do not know what is technologically possible in the way of automatic production. Nor do they realize in what terms they must think in order usefully to apply this technology to industry.”

The American engineers not only allow themselves plenty of time to realize the automatic factory. The engineering tasks they set themselves in this connection are far more modest, besides, than those successfully accomplished long since in the Soviet Union.

Here is what the magazine says about how the American automatic piston factory (termed “fabricator”) will work:

“Automotive pistons are received in the form of castings by the piston fabricators…. The piston manufacturer must turn this casting into something similar to the drawing…. The final stage is to tin-plate the entire piston for better wearing characteristics.”

Consequently, at the American factory, which “may become a reality,” the industrial process includes only machining of ready-made piston castings. The American engineers do not envisage automatic casting at the factory.

But when is it expected that this automotive piston factory will be erected in the U.S.A.? Rather, this machine line plus automatic tin-plating unit? The answer is given in *American Machinist*:

“… Perhaps before 1960 rolls around the automatic metal-working shop will be running full blast.” But the automatic factory which the Americans intend to have running by 1960, has long since become a reality -a Soviet reality.

IN OUR DAYS

The period of transition from socialism to communism is marked by a hitherto unprecedented growth of the productive forces of society. The Communist Party and the Soviet Government have always attached great importance to the mechanization of labour, which helps to increase output rates, making work easier and raising the proficiency of the workers at the same time.

With the development of engineering mechanization of labour grows into and then fully coincides with automation of industrial processes. In our days technical progress is no longer conceivable without extensive automation, which is the highest stage of mechanization.

Acceleration of technological processes, mechanization of basic and auxiliary operations have made it necessary to apply automatic operation and production control.

Even before the Great Patriotic War—the U.S.S.R. was already producing all kinds of automatic lathes machines, apparatuses, instruments. These high-quality instruments are used for a great variety of purposes: they make continuous records of processes taking place at ultra-high pressures, temperatures, speeds and voltages; they measure the flow of liquids and gases; batch out ice-cream and molten metal; control the production of hydrochloric acid, the water level in reservoirs the machining of shafts, and the temperature in the working chamber of open-hearth furnaces.

In our days a great deal has been done not only by way of partial automation of industrial processes, but also by way of all-round automation. The Soviet Union has many almost fully automatic enterprises: power stations with remote control; chemical plants where men need only keep watch over automatic units, and others.

A great deal is being done in the U.S.S.R. for all-round automation of hydroelectric power plants and thermal stations. Many power plants are not only fully automatic, but are controlled remotely, besides, from central control rooms, often several score kilometre distant. In accordance with orders received from the control room engineer, automatic devices start and stop the units, check their work, lubricate them, etc.

Some hydroelectric power plants are so highly mechanized that they do not require the constant presence of man at all. Instruments automatically start and stop the turbines, send the power to the consumers, regulate the water input. The machine rooms of such hydro-stations are normally under lock and key.

By the end of 1952 all units of all operating hydro-electric power plants under the administration of the Ministry of Power Stations had been equipped with automatic control apparatus. Moreover, a large number of plants, accounting for over 50 per cent of the total power produced by hydro-stations, were put under remote control.

Automation is used extensively also at thermal stations. Several large thermal stations have introduced all-round automation for boiler shops, including automation of all the main operations, remote control, checking and signalization.

Automation has found an especially wide field of application in Soviet metallurgy. As far back as 1951, 95 per cent of all the pig iron and 87 per cent of all the steel was smelted in automatic blast and open-hearth furnaces. Automation of rolling processes has improved quality and stepped up output rates.

In metallurgy all-round automation makes it possible not only to regulate processes automatically, but also to introduce remote control, which is of great importance in improving labour conditions for workers in the metallurgical industry.

The automatic blocking systems designed by Soviet engineers for railways have increased their capacity, ensured safe traffic and made the work of railway workers much easier. A great deal has been done to prevent railway accidents. Many different automatic devices guard the safety of the traffic. Even if the driver should pass a red light, an automatic train stop will immediately bring the train to a standstill. The same will happen if a broken rail should appear in front of the moving engine. Thousands of railway stations are equipped with electrical centralized control systems, which guarantee absolutely correct switching.

But automatic devices are used for safety purposes not only on the railways. Industrial processes at chemical plants may often be dangerous and detrimental to the health of the workers. For this reason technological processes in the nitrogen and aniline dye industries, in the manufacture of soda, synthetic rubber, hydrochloric acid are controlled automatically. Automatic devices check the expenditure of fluids, keep their levels from rising above or falling below fixed marks, keep temperatures and pressures normal.

In the coal industry of the U.S.S.R. a number of mines have been equipped with remote and automatic control for machines working below the surface. By the end of 1952 this progressive method of control was being used for about 2 thousand coal combines and coal cutters and for over 1,600 conveyer lines.

At food industry enterprises automation, aside from its other merits, helps to keep conditions scrupulously sanitary. At these plants and factories human hands do not touch the products. Automatic machines make chocolate bars, package ice-cream and sugar, proportion the fillings for candies and meat dumplings, box biscuits, wrap margarine blocks in parchment paper, wrap candies, mix dough.

Automatic machines hooked up in production lines wash millions of bottles specklesly clean, dry them, fill them with beer, milk, liqueurs and cap them. Automatics make tins for canning food, fill them with sardines, mullet, stewed beef, caviare, condensed sweet cream.

Automatic devices are used to regulate and check the processes of sugar refining, alcohol distillation, bread baking and many others.

In the course of 1953, for instance, new, improved and more efficient automatic lines were set up in the U.S.S.R. for pouring, sealing and wrapping food products, new types of equipment were designed for the production of sausages, for freezing and stacking fresh fish; automatic machines were installed for weighing and packing various kinds of food products.

Automation is working its way into all branches of industry. It now helps to make paper, print films, manufacture building materials. It occupies an especially important and honoured place in the Soviet machine-building industry, which grows faster and faster from year to year. Only in the course of 1953 Soviet machine builders designed about 700 new types and models of important machines and mechanisms, ensuring further technical progress of the national economy. They include new designs of automatic and semi-automatic machines, and new automatic machine lines.

Whereas between 1936 and 1946 only a few individual automatic lines were put into action, there are now scores of them in operation.

Automatic lines have already freed workers from machining such difficult parts as engine cylinder blocks and heads, automobile gear casings, piston pins and rings, etc. More and more work is being done on the construction of automatic lines. Recently a new line of original design was put into operation for the automatic fabrication of rake teeth for agricultural machines. A second line for the same purpose is nearing completion. Automatic lines are now employed for assembling steel anchor and other chains, and the carcasses of large reinforced concrete columns. There is a line in operation for automatic welding and assembling of automobile wheels. The personnel of Soviet machine-building plants in collaboration with designing bureaus are completing a number of new automatic lines. Automatic machines combined into integral lines will produce track links, coupling valves and other mass-production machine parts, such as ploughshares and mould-boards. Several automatic lines for the production of nuts and bolts are nearing completion. Work has begun on automatic line projects for the production of generator housings and shafts, and other machine parts.

However, automatic lines were but the jumping-off point from which Soviet engineering has already passed on to fully automatic enterprises, and it is gathering more and more speed in this direction.

The first automatic automotive piston factory was built not so long ago, and yet, a second, still better than the first, is already in operation, and projects of several more of the same type have been launched. An automatic ball-bearing plant is nearing completion.

The number of automatic plants is growing and will continue to grow. Such is the general trend of Soviet engineering. The construction of more and more automatic enterprises is a vital necessity for the people building communism.

Next in line are automatic plants in which the entire process of electric light bulb fabrication will be accomplished automatically, and others, in which the manufacture of such complex units as gear-boxes will be fully mechanized from beginning to end.

We have not long to wait before automatic plants will be putting out all the electrical equipment for automotive engines and such complex machines as electric motors.

Specialists hold that this is not even the morrow, but already the today of Soviet industry.

THE NEAR FUTURE

Many of the things created today are to last more than one day. They must inevitably become a part of tomorrow, of the bright communist tomorrow. And the approach to such permanent objects must comply with the high requirements of tomorrow. Examples of construction projects approached by engineers, designers and workers from the standpoint of such high requirements, are the Volga power giants—the Kuibyshev and Stalingrad hydroelectric power stations. And, of course, automation will take the leading position it deserves in these mighty creations of man’s genius.

Automatic devices will form inseparable parts of the immense units. Unerring, high precision instruments will control temperatures, pressures, water levels and oil levels. Automatic safety appliances, emergency and preventive signalization systems will protect the remotely controlled units from accidents of all kinds.

The powerful generators of the hydro-stations, fed with “white coal” from the Volga, will give an enormous amount of energy. The total annual output of the Kuibyshev and Stalingrad hydroelectric stations, the largest in the world, will be 20,000 million kilowatt-hours. More than half of this tremendous amount of energy will go to Moscow.

Nowhere in the world has the voltage on electrical transmission lines ever exceeded 287 thousand volts. Now the figure will reach the hitherto unheard-of magnitude of 400 thousand volts. The longest transmission line in the world so far is 430 kilometres long. Now this distance will have to be more than doubled: the length of the electrical transmission line from Kuibyshev to Moscow will be 925 kilometres, and from Stalingrad to Moscow over 1,000 kilometres.

Soviet scientists have immense and very complicated tasks to cope with. Not only do they have to accomplish transmission of colossal amounts of electricity under unprecedented pressure over super-long distances. They have to develop methods and means for automatic and remote control of the entire power system, and of its individual plants and units; they have to design automatic safety appliances and devices which will automatically determine the most efficient working regimes and make the stations follow them. All these problems are now nearing their final solutions.

This gigantic transmission line must transmit electricity unfailingly and ceaselessly regardless of any circumstances. It is up to automation to make the line work stably and absolutely reliably, and to protect it from accidents. There will be automatic devices to protect it from lightning supertensions and to keep the frequency constant by controlling the r.p.m. of the generator rotor. They will regulate the pressure and the load distribution among the stations. If there is a deviation from fixed conditions anywhere, automatic controllers will immediately signal the automatic regulators to make adjustments.

Organizing control of the Moscow grid system which will be, is a very difficult and fascinating engineering problem. There will be a central control room in Moscow. This room will control directly all the lines and units of the Kuibyshev and Stalingrad hydroelectric stations sending their power to Moscow, as well as the largest of the stations and high-voltage lines.

The control room engineer at the joint centre in Moscow will not have to send his orders down through intermediate stages. Having at his disposal all the necessary means of remote control, he can, whatever the distance, automatically cut the high-voltage lines in and out, fix and regulate the working regime of each station and that of each of its units.

In present-day remote-control units electrical messages take 1-2 seconds to be transmitted, received, deciphered, checked and returned. This is by far too long for remote control of such immense hydro-stations as those on the Volga. The remote-control units designed for these stations will fulfil commands and report on the results in tenths of a second.

The control room engineer will send his commands not directly to the machine, but to an “automatic operator.” This device will distribute the load among the units itself. If the “automatic operator” “finds” that the machines in operation are overloaded, it will cut in auxiliaries. Moreover, this will be done in such a way as to guarantee highest efficiency.

The control room will be equipped with one more automatic. This is a unique machine which will automatically compute and determine the most economical working regime for each station and automatically communicate this regime to the self-acting units.

Automation is employed extensively not only at the Volga power giants. Self-acting mechanisms are already in use for accelerating locking operations on the Lenin Volga-Don Ship Canal. Automatic equipment is used for signalling on canals, reconstructed rivers and new seas. Fully automatic pumping stations, kept closed under lock and key and remotely controlled, will pump water not only for locking, as they do already at the Volga-Don Canal, but for irrigation and other purposes as well.

Hooking the Kuibyshev and Stalingrad hydroelectric stations into the Moscow grid system is not an end in itself. It is but a gathering of momentum, a great step forward towards a unified All-Union high-voltage grid system.

And there will come a time when the entire vast territory of the Land of Soviets will be covered with a network of high-voltage lines connecting up all the power stations of the Soviet Union into a single unit-those that derive electricity from fuel, those that derive it from the swift waters, from the wind, and from atomic energy. Then the question of full automation of all industrial processes will arise.

This is a thing of the near future. It has acquired especially clear and distinct outline, has become almost tangible since the day when the world's first industrial atomic power station was put into operation in the U.S.S.R. This day, June 27, 1954, will go down in history as the date of the first practical application of atomic energy for peaceful purposes, for the good of mankind.

The Soviet atomic power station, which supplies the neighbouring factories and villages with electricity, produces it from the heat generated in nuclear reactions. In the uranium pile of the industrial power station the fragments of the split nuclei give up their energy to graphite and certain other substances, called moderators, thus heating them. The heat obtained in this way is used to vaporize a working fluid. This vapour, in its turn, is passed through a turbine, which turns an electric generator. Thus, nuclear energy is transformed into electrical energy.

Though this transformation seems so simple, it would be impossible, if Soviet science and engineering had not created special automatic devices for controlling, regulating and checking the processes that take place at the nuclear power station. Automatic equipment can do what is beyond the power of man, although he has succeeded in liberating nuclear energy, in unharnessing the swift processes of nuclear reactions. These processes are held in check by automatic devices, which regulate the heat transfer rate and supervise the removal and collection of nuclear fission products.

At present Soviet scientists and engineers are working on the design of industrial atomic power stations of 50-100 thousand kilowatt capacity. Such a power station of 100 thousand kilowatt capacity will consume daily 200-250 grammes of uranium, while a thermal station of the same capacity would require hundreds of tons of coal per day. This circumstance is of great importance when building power plants in regions far removed from sources of fuel and water power.

Harnessing the mighty forces of the atomic nucleus not only greatly boosts energetics. It brings with it also a qualitative change in engineering as a whole. The exceedingly high concentration of nuclear energy makes it possible to make engines of enormous power, capable of working for unusually long periods without re-fuelling.

Radio-active emission causes profound changes in the biological, chemical and physical properties of substances. Therefore, the powerful sources of radiation produced by the nuclear reactors will lead to the birth and development of new branches of industry-the radio-active technology of metals, plastics and other materials.

It is noteworthy that the Soviet Union is the country where the enormous energy of the atomic nucleus has been turned to a wise and good cause, is being used for peaceful purposes. In practice, it is already serving the cause of the building of communism.

The discovery by modern science of the practical means and methods of utilizing subatomic energy, brings up new boundless opportunities for engineering progress. Under the conditions of modern capitalism, however, the greatest discoveries of science are used only for preparations for a new war. The American monopolies are against the peaceful application of the discoveries of science and engineering. They are afraid that the technical revolution brought about by the utilization of atomic energy in industry will devaluate their investments and decrease their profits.

In the U.S.S.R. development of the productive forces meets with no such obstacles. Socialist society knows no social-economic contradictions which might limit the application of scientific discoveries and tend to retard technical progress. The application of atomic energy for peaceful purposes in the Soviet Union is an especially vivid illustration of this fact.

The practical possibility of producing tremendous quantities of energy at atomic power stations enables automation to stride forward at an unprecedented pace. Automation, which greatly increases labour efficiency, and leaves to the worker only highly proficient control of complex machinery, will help to shorten the working day. This will give the workers of the Land of Soviets unlimited opportunities for all-round development of their capabilities, and enable them to make the utmost use of all that modern culture has to offer.

All this is not far off. It can be sensed in the daily work of millions of toilers of the U.S.S.R. as they stride confidently forward on their way to communism.