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THE DEVELOPMENT OF NON-FERROUS METALLURGY

(1959-1965)

by A. Kh. Benuni

USSR -

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FOREWORD

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THE DEVELOPMENT OF NON-FERROUS METALLURGY
(1959-1965)

-USSR-

Following is the translation of a pamphlet by A. Kh. Benuni
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INTRODUCTION

The 21st Congress of the CPSU has summed up the great successes of the Soviet people and has marked out a grandiose program for further construction of communism in our country in the coming Seven-Year Plan.

Our country has entered into a new, important period in its development - a period of the extensive constructing of a communist society.

"The main task during the Seven-Year Plan for the development of the national economy in the USSR between 1959-1965 is to make further powerful advances in all branches of the economy based on the primary growth of heavy industry and to strengthen the economic potential of our country so as to provide a continuous rise in the people's standard of living.

When this plan has been completed, a decisive step forward will have been taken in providing the material-technical base for communism and in fulfilling a basic, economic task of the USSR which is catching up with and surpassing the most highly-developed capitalist countries in per capita industrial production."¹

(¹Materials from the XXI Congress of the CPSU, 7 Gospolitizdat, 1959, p. 181)

The Seven-Year Plan for developing the USSR national economy is based on the tasks which have been set before our people by the Communist Party of the Soviet Union between 1959-1965. The main problem of the current Seven-Year Plan is to make maximum use of time in the world-wide economic competition with the most highly-developed capitalist countries, especially the USA. To solve this problem, the Seven-Year Plan envisages an accelerated tempo and essential proportions in the development of our country's national economy.

Following are the important tasks of the Seven-Year Plan: intensive use of the rich, natural resources in our country, improvement in distribution of industrial forces throughout the country, and closer proximity of industry to raw material sources and of fuel to regional needs.

The current Seven-Year Plan will be characterized by enormous technical progress in all branches of the national economy, by the introduction of complex mechanization and automation of industrial processes, the transition to continuous processes, by more widespread use of new modern equipment and technological processes, by the production of polymer materials, and by the use of atomic energy for peaceful purposes.

The June Plenum of the CPSU Central Committee placed great stress on the fact that the struggle for technical progress is of decisive importance in successfully fulfilling the Seven-Year Plan.

An increase in productivity of social labor is the most important requisite for successful fulfillment of the Seven-Year Plan. An accelerated tempo in increasing labor productivity, the predominance of socialist organization in the economy, widespread introduction of new technology, and the growth of skilled cadres are the main factors

contributing to the growth of industrial and agricultural production in the current Seven-Year Plan.

Fulfillment of the tasks set forth by the Party and the government for the current Seven-Year Plan will have enormous political and economic significance in further growth and expansion of our country's power.

Successes in economic construction in the USSR attest to the predominance of socialism over capitalism and confirm the magnetic power of the great ideas of Marxism-Leninism.

1. DEVELOPMENT OF SOCIALIST INDUSTRY AND THE ROLE OF NON-FERROUS METALS IN THE NATIONAL ECONOMY

The control figures for development of the USSR national economy between 1959-1965 envisage accelerated development and great absolute increase in production in all branches of industry, especially heavy industry. As compared with 1958, it is planned that the gross industrial volume will increase by 80% by 1965, while in group "A" (production of the means of production) there will be a 86-88% increase, and in group "B" (production of consumer goods) there will be a 62-65% increase. The increase in industrial production during the Seven-Year Plan will equal the production growth of the last 20 years.

Greatest acceleration will be in the most important branches of heavy industry - machine construction, metallurgy, chemistry, energetics, and the fuel industry.

Non-ferrous metallurgy will occupy an important role in the general development of industrial production.

Non-ferrous and rare metals are necessary for achieving technical progress in all branches of the national economy. At the present time there is not one branch of industry, transportation, or agriculture whose development does not entail the use of non-ferrous and rare metals.

Electronics, machine construction, and qualitative metallurgy could not be developed without these metals. Non-ferrous and especially rare metals play a decisive role in the development of electronics, aviation, atomic and rocket technology.

The necessity of increasing rapidly both the volume and type of non-ferrous and rare metals is of great importance in carrying out the tasks set forth by the directives of the 21st Party Congress for continuous technical progress, especially in aviation, machine construction, energetics, qualitative metallurgy, mechanization and automation of industrial processes, and the development of electronics, rocket technology and radio technology, and atomic energy for peaceful uses.

Rapid development of technology has led to the fact that at the present time almost all the non-ferrous and rare metals which are found in nature are used in industry.

Sixty-three of the 102 elements in Mendeleev's periodic system belong to the branch of non-ferrous metallurgy.

Non-ferrous metals have found wide application due to the following properties: (1) high resistance to corrosion (tin, lead, nickel, zinc, aluminum); (2) high electro- and thermoconductivity (silver, copper, aluminum); (3) capacity to form many alloys with ferrous metals. These alloys generally have higher properties than the components making them up. Thus, for example, one may be relatively hard (alloys of aluminum and magnesium), another may be extremely hard (tungsten carbides, molybdenum), a third may be highly resistant to friction (alloys of lead, tin, copper, and antimony), a fourth may be highly resistant to heat (alloys of magnesium, titanium, chromium, tungsten, molybdenum, etc.), and a fifth may melt easily (alloys of lead, zinc, tin, antimony); (4) plastic deformation capacity, i.e., change in form with forging or lamination (copper, lead, tin, aluminum, zinc, nickel, magnesium and their alloys); (5) many non-ferrous and rare metals have properties which are necessary for the development of special branches of the most modern technology (radio, jet, atomic technology, etc.)

Non-ferrous metals can be used in their pure form, in the form of alloys which are alloying additions for coverings in the aim of protecting various chemical compounds, and in the form of powders in various branches of industry.

On the basis of data from capitalist countries, non-ferrous metals are used in the following forms (%):

| Non-ferrous Metals | Pure Form | Plating for Other Metals | Alloys | Chemical Compounds | Other Forms |
|--------------------|-----------|--------------------------|--------|--------------------|-------------|
| Copper | 50 | - | 38-40 | 3 | 7 |
| Lead | 48 | 9 | 18 | 16 | 9 |
| Zinc | 15 | 30 | 36 | 18 | 1 |
| Tin | 9 | 48 | 38 | 3 | 2 |
| Nickel | 8 | 4 | 85 | 2 | 1 |
| Aluminum | 26 | - | 64 | 2 | 8 |

The forms in which any of the metals are used are not constant. They change with the development of the economy and the introduction of new technology in all branches of industry.

In recent years the forms in which non-ferrous metals are used have changed a great deal - the proportion of alloys and chemical compounds which are used has increased.

In pre-revolutionary Russia, non-ferrous metallurgy was a backward branch of industry. In 1913 the production of non-ferrous metals was limited to the output of copper, lead, zinc, mercury, and precious metals (gold, silver, platinum). With the exception of precious metals, the proportion of these metals in world production was quite small, and their production was far behind that of the main capitalist countries.

Copper production in 1913 in Russia was 33.7 thousand tons, or 3.3%; zinc (including Poland) was 10.8 thousand tons, or 1.07%; lead was 1.5 thousand tons, or 0.14% of world production. In 1913 in Russia 49.2

tons of gold was extracted, 14 tons of silver, and almost 100% of world platinum output.

The following were not produced at all in pre-revolutionary Russia: aluminum, magnesium, nickel, tin, cobalt, tungsten, molybdenum, and other non-ferrous and rare metals.

The reserves that were explored in the resources of non-ferrous metal ores were insignificant. Our country which possesses inexhaustible natural resources was considered at that time poor in non-ferrous and particularly rare metals.

The production of non-ferrous metals was centered in the hands of foreign capital, the proportion of which in the total stock of non-ferrous metallurgy in 1913 was 81%, among which was 76% in the copper industry, 87% in the polymetal, and 80% in the metal-treating industry.

Confining non-ferrous metallurgy to their own hands, the foreigners exploited our land, making use of only the richest ores.

The production of non-ferrous metals did not meet even the low requirements of our country, which comprised 0.24 kg of copper per capita as opposed to 3.34 kg in the USA; lead - 0.33 kg compared to 4.13 kg in the USA; and zinc - 0.18 kg compared to 2.07 kg in the USA. The import of non-ferrous metals from other countries comprised about 30-35% for copper, 70% for zinc, 98% for lead, and 100% for tin, nickel, and aluminum.

In the period directly preceding the Great October Socialist Revolution, non-ferrous metallurgy in Russia was in a state of decline, while the imperialist and patriotic wars led to almost complete shutdown in extraction of non-ferrous metals. The mines were flooded, factory management destroyed and much of the personnel lost.

The Communist Party and the Soviet government, recognizing the importance of non-ferrous metallurgy in the Socialist development of the country, set forth the task of a planned and rapid development of non-ferrous metallurgy, and also of developing new branches of industry for production of non-ferrous and rare metals. In matter of fact, non-ferrous metallurgy was developed in the Soviet Union during the industrialization of the country, and is a result of Soviet Five-year Plans.

Throughout the years of Soviet rule, prospecting and geological research were carried out to study the raw material resources of non-ferrous, rare, and precious metals.

Prospecting and surveying encompassed whole number of new regions for the ores of non-ferrous and rare metals. As a result, new locations for these ores were discovered and developed in the Kola Peninsula, the Urals, in Kazakhstan, in Siberia, in the Far East, in Central Asia, in the Caucasus, and in many other regions. In particular, the following large deposits were discovered and developed: copper (in Dzhezkazgan, Central Kazakhstan, and in the Uzbek SSR), lead (in south Kazakhstan oblasts, and a group of deposits in the Tadzhik SSR), zinc (in the Tadzhik SSR), nickel (in the Kola Peninsula, in the Krasnoyarskiy kray, and in the southern Urals), aluminum raw materials - bauxite from the Urals and the Kazakh SSR, and nepheline (in the Krasnoyarskiy kray), and also deposits of rare metals.

On the basis of its resources for the majority of basic, non-ferrous metals, the USSR occupies a leading position in the world.

The Soviet Union is very rich in niobium, tantalum, lithium, beryllium, strontium, and many other rare metals and dispersed elements.

During the years of the Soviet Five-Year Plans, non-ferrous metallurgy was changed into a powerful branch of heavy industry, putting out wide assortment of non-ferrous and rare metals and alloys which were necessary for the development of the national economy of the Soviet Union. New branches of industry were formed: aluminum, magnesium, nickel-cobalt, tungsten, molybdenum, titanium, and others. The copper, lead-zinc industry and the industry of precious metals were completely renovated and further expanded.

By 1940 the production of non-ferrous and rare metals in the USSR had reached large proportions, and even by then our country occupied one of the leading world positions.

The Great Patriotic War required that the entire national economy meet the needs of the front. The development of a war industry increased the needs for non-ferrous metals, but during the first years of the war the productive potential of non-ferrous metallurgy was decreased, since regions, which had produced a large amount of aluminum, magnesium, zinc, molybdenum, and other metals, were occupied by the Germans. Before the beginning of the Second World War, these regions produced 60% of total aluminum output in our country, 49% of the magnesium, 58% of the zinc, 75% of the molybdenum, and 99% of the mercury.¹

(¹ S.A. Pervushin, S. Ya. Rachkovskiy, and others. Ekonomika tsvetnoi metallurgii SSR /Economics of USSR Non-ferrous Metallurgy/, Metallurgizdat, 1956, p. 38.)

A large amount of new construction was carried out in the eastern sections of our country under the stringent war conditions. In a very short period of time, factories were built for producing non-ferrous rolled metal by making use of equipment which had been evacuated and space which was not in use in factories already existing in the Urals and in Kazakhstan.

During the Great Patriotic War, the production of non-ferrous metals increased considerably, with the exception of copper, lead, and zinc. These advances in the development of non-ferrous metallurgy were possible due to the enormous advantages of a socialist economic system, which provided for rapid reorganization of the entire USSR national economy, and non-ferrous metallurgy in particular, during the war years. In the postwar years it provided for rebuilding of factories concerned with non-ferrous metallurgy which had been destroyed.

The production of non-ferrous metals in our country has developed at a very rapid rate, considerably surpassing the growth rate of non-ferrous metallurgy in capitalist countries. This position, which is characteristic of all periods in our Five-Year Plans, characterized the postwar years in particular.

The average yearly growth rate for production of non-ferrous metals

in the USSR is much higher than in the USA.

Thus, in the postwar period from 1946-1956, the production of copper in the USSR increased by 2.8 times, in the USA - 1.4; production of zinc rose by 5.9, in the USA - 1.3; production of lead rose by 5.6, in the USA - by 1.3 times. The growth rate for aluminum production is also higher in the USSR than in the USA.

One should also note the qualitative improvements, along with the quantitative production growth, in non-ferrous metallurgy. The methods of extracting metals and complex utilization of raw material components have qualitatively improved; processes have been intensified, and the level at which they have undergone mechanization and automation has risen; equipment has been used more efficiently in terms of time and power; and output of high-quality metals has been established.

Our factories in non-ferrous metallurgy are at a high, technological level; they are equipped with modern equipment and use modern technological processes, thereby providing for a high technical-economic level. Science and technology, which are developing at an enormous rate, are opening up limitless vistas for the further modernization in production of non-ferrous, rare, and precious metals, as well as enormous domestic production reserves which must be developed by each factory and pressed into service for the national economy.

2. DEVELOPMENT OF BASIC BRANCHES OF NON-FERROUS METALLURGY DURING THE SEVEN-YEAR PLAN

Control figures for the development of the USSR national economy between 1959-1965, which have been set forth by the 21st Congress of the CPSU, plan for considerable increase in production of non-ferrous and rare metals in order to meet the rapidly-growing needs of the national economy. As compared with 1958, by the end of the Seven-Year Plan, the production of aluminum should have increased by 2.8-3, and of refined copper - 1.9 times. Production of nickel, magnesium, titanium, germanium, silicon, should have increased considerably, and also the output of other non-ferrous and rare metals should have increased.

On the basis of the Seven-Year Plan, the gross production of non-ferrous metallurgy should have increased by 1965 to more than twice that of 1958, and its average yearly growth should be 10-11%.

The growth rate of separate branches of non-ferrous metallurgy is varied and depends on the changing needs for non-ferrous metals, and also on the possibilities and economic properties of their production. At the present time, with a high growth rate throughout non-ferrous metallurgy, the interests of the national economy demand more rapid production of aluminum, magnesium, titanium, and copper, along with rare metals.

In comparison with the preceding Seven-Year Plan from 1952-1958, the yearly production growth between 1959-1965 will be as follows: twice as much for aluminum, copper, and nickel; nine times for magnesium; 14 times for titanium; the production of lead, zinc, and tin will increase

somewhat more slowly.

The average yearly growth rate for the production of the most important non-ferrous metals is higher in the USSR than in the USA. Comparative data on development of non-ferrous metallurgy in the USSR and USA from 1946-1956 were set forth above.

By 1965, completion of the Seven-Year Plan for non-ferrous metallurgy should close the gap between production volume of the most important metals in the USSR and the USA.

Production of light metals grows the fastest, out of all the non-ferrous metals which exist here and abroad. In the leading capitalist countries, the output of aluminum has surpassed the output of abundant non-ferrous metals, such as lead and zinc, and has equalled the production of copper. On the other hand, in the USA, beginning with 1955, the absolute production of aluminum has surpassed the production of copper already, not only as a primary metal but also in the aggregate of smelting of the primary and secondary metal. The production of magnesium has risen considerably, and production of a new metal - titanium - is also rising. Aluminum is the most important of all the light metals, since it is one of the most important elements in the supply of metals for all industrialized countries.

In the first half of the 20th century, if the growth of aluminum production throughout the world, especially during the Second World War, was primarily due to utilization of this metal for war purposes (airplane industry), then in recent years aluminum is of great importance as a metal with varied uses in industry and construction. Machine construction and tractor construction, railways and aviation, shipbuilding, electronics, optics, photography, housing and industrial construction, consumer goods -- this is a partial list of the varied uses for aluminum and its alloys.

Based on the control figures for the development of the USSR national economy between 1959-1965, it will be necessary for the aluminum industry to have an output twice that of the last 25 years. As opposed to the preceding Seven-Year Plan, the average yearly production of aluminum must increase by three times.

Intensive development of the aluminum production is due to the fact that at the present time this metal has a great economic effect on the national economy as the substitute for many other non-ferrous metals, such as: copper, lead, zinc, tin, etc.

This can be explained by the fact that raw material resources for aluminum are much greater, and by the fact that its content in the basic raw material is much higher than in the ores of other non-ferrous metals. All of this leads to considerable reduction in outlay for aluminum production, in comparison with copper and lead-zinc production. At the same time, the net cost of a ton of aluminum is less than that for a ton of copper, lead, or tin.

In many cases, aluminum can be used as a substitute for steel in the automobile industry, and the use of aluminum in automobiles, instead of steel, saves fuel and rubber. Aluminum is being used more widely all the time as a construction metal in many branches of industry.

At the present time, aluminum holds a leading position in technology, and its importance continues to grow. The increase in aluminum production during the Seven-Year Plan will be achieved by expanding and intensifying production in existing factories and by building new ones. In accordance with directives of the 21st Congress of the CPSU, the aluminum industry will be developed further primarily in the eastern regions, on the basis of electric energy from the Bratskaya and Krasnoyarskaya power stations, and also from thermo-electric plants run on inexpensive coal.

World production of aluminum oxide is at the present time primarily based on bauxite. In our country there are large deposits of bauxite; however, there are other new types of raw materials for aluminum production such as nephelines and alunites, whose reserves are enormous. Complex processing also produces soda products, sulfuric acid, and cement.

The needs of the national economy require the rapid development of the magnesium industry. The formation of a powerful magnesium industry, capable of meeting the rapidly-growing market for this metal, is one of the most important tasks facing non-ferrous metallurgy during the current Seven-Year Plan.

In the USSR the production of magnesium is growing rapidly.

The great market for magnesium can be explained by the successful results achieved in the postwar years by manufacturing magnesium alloys, which have the great physico-chemical and chemical properties required for construction materials. The addition of thorium, cerium, zirconium as components increases the thermal stability, the plastic properties of magnesium, durability, and its resistance to corrosion. Articles from magnesium alloys are 20-30% lighter than the aluminum ones. All of this expands the uses for magnesium, especially in the airplane industry, where lightness is extremely important. The use of magnesium is growing in the consumer goods industry.

In the coming years another light metal will have wide, industrial use - titanium, which combines durability with heat and corrosion resistance.

The development of the copper industry will be greatly accelerated during the Seven-Year Plan; it must increase by 1.9 times over production in 1958.

As compared with the preceding Seven-Year Plan (1952-1958), the average yearly growth of the copper industry in 1959-1965 will be trebled. This can be explained by the large role played by copper in the national economy, especially in development of the electric energy and electric radio-engineering industries.

The construction of new ore concentration combines in Kazakhstan, in the southern Urals, and in the Caucasus (in the Stavropol'skiy krai) is planned for the current Seven-Year Plan, which will considerably increase the output of copper and other types of concentrates.

As compared with other heavy metals, the more rapid development of copper production is due to Lenin's idea regarding the electrification of our country. By the end of the Seven-Year Plan, production of electric

energy will be 500-520 billion kw-hours. In order to provide the country with this amount of electric energy, it is necessary to construct powerful thermal and hydroelectric stations and to accelerate development of electric grids. During the Seven-Year Plan, work will be carried out on creating a single energy system for the European part of the USSR and Central Siberia, and also energy systems for the regions of Transcaucasus, Central Asia, Kazakhstan, the Northwest, and the West will be combined.

Electrification of railway transportation will be widely developed. Approximately 20,000 km of railway lines will be electrified. The most important trunk lines will be electrified: Moscow-Kuibishev-Irkutsk-the Far East; Moscow-Gor'kiy-Sverklovsk; Moscow-Kazan'-Sverklovsk; Karaganda-Magnitogorsk-Ufa; Moscow-Khar'kov-Mineral'nie Vodi, and others. Electrification of the railroads will require a large amount of rolled copper, on the order of 200,000 tons. A number of sections of the railroad will be adapted to deisets which requires a great deal of copper (for example, the amount of copper needed for a TE-Sh diesel is about 20 tons).

During the current Seven-Year Plan, agriculture and all populated areas will be electrified, along with electrification of industry and railway transportation.

The enormous growth in production of electric energy will require acceleration of the electrical engineering industry, which uses large amounts of copper and aluminum.

In our country about 200,000 tons of copper are used yearly only for cable and wire. During the current Seven-Year Plan, the consumption of aluminum for just electrical systems will be more than one million tons; in addition, a large amount of aluminum will be used instead of lead for producing cables and encased wires.

The machine construction industry has great need for aluminum and copper, particularly the automotive-tractor industry which has increasing demands for aluminum alloys and various copper and copper-zinc alloys. During the current Seven-Year Plan, the demand for aluminum and other alloys will double in the automotive-tractor industry.

The production of zinc and lead occupies a very important position. By 1965, production of lead must increase by 1.4-1.5 times, and zinc must increase by 1.6 times, as compared with production of these metals in 1958. As compared with other non-ferrous metals, the slower growth rate of lead can be explained by the fact that the basic consumer for lead - the cable and battery industry - will use aluminum, nickel, and plastic materials, especially polychloro-vinyl and polyethylene, to a very great extent. If these plastic materials and aluminum are used in the cable industry alone, it will be possible for the electrical engineering industry to save about 10 billion rubles, and more than 400,000 tons of lead and 400,000 tons of copper during the Seven-Year Plan.

The savings in the demand for lead for batteries is caused by the expansion of using alkaly batteries which use nickel instead of the acid on the lead base. Economically such a change is expedient since the life of the alkaly batteries on an average is 2.5 times more than for the lead ones and they require less servicing.

The growth rate of the lead industry can be determined by zinc

production, because it is obtained along with lead during the processing of polymetallic lead-zinc ores. The somewhat greater extraction of zinc is due to its secondary recovery during processing of copper-zinc ores in the Urals.

The greatest increase in production of lead and zinc will be carried out by the expansion of existing factories.

Expansion and re-equipping of existing factories on the basis of modernizing technological processes, complex mechanization, and automation makes it possible to reach a planned production level for these metals in a shorter period of time and at a comparatively small expense. Kazakhstan occupies the leading position in lead and zinc production, and during 1959-1965 its role will be even greater, particularly in connection with construction of the Karagaylinskiy Mining Enterprise in Northwest Lake Balkhash area. Production of lead and zinc will be carried out in the Uzbek SSR, where lead and zinc factories are being built. The construction of a lead-zinc factory is also being planned in Siberia.

Widespread introduction of new technological processes in all branches of the national economy is planned for the Seven Year Plan. To a great extent the production and quality of alloyed steel, heat-resistant alloys and high-melting metals determine further development of technological processes in machine construction, the introduction of processes carried out at high pressures, high temperatures, and in aggressive media in the chemical industry and others, development of aviation at supersonic speeds, and the development of jet technology. Production of special steels for instruments, construction, heat-resistant, magnetic, and cold-resistant is impossible without the use of non-ferrous metals. In this connection, there will be a considerable increase in production of nickel, cobalt, molybdenum, tungsten, vanadium, zirconium, titanium, and other metals in the form of ferro-alloys and in pure form.

Production growth for nickel and cobalt will be due both to the expansion and improvement of existing enterprises in the Kola Peninsula as well as the construction of new combines mainly in the southern Urals, but also in the Ukraine. Tungsten-molybdenum enterprises and factories producing hard alloys will be greatly expanded.

The directives of the 21st Congress of the CPSU provide for the electrical engineering, the radio engineering, and the instrument-making industry to include production of semiconductor rectifiers, to expand the practical application of semiconductor apparatuses, to increase the manufacture of calculating machines and computers, and also to build and produce automatic, rapid computers for solving complex, mathematical problems and computers for automatized control of industrial processes.

A large amount of germanium, silicon, selenium, tellurium and other rare metals is necessary in order to carry out these tasks. Copper is finding a new use in production of electronic computers.

Technological progress based upon the recent achievements in science and engineering such as radio electronics, ultra-short waves, high pressures and speeds, the use of semiconductors and polymer materials, nuclear energy, etc., makes it requisite to expand the production of rare

metals (zirconium, beryllium, lithium, boron, and others) and also to carry out production of rare metals of extra-high purity.

During recent years, methods have been developed for obtaining metal of extra-high purity: germanium, silicon, niobium, titanium, rhenium, gallium, thallium, indium, antimony, zirconium, bismuth, and vanadium. The basic properties of rare metals appear in certain cases only when the amount of permissible admixtures amounts to thousandths, millionths, or even less of 1%.

At the present time, there are 32 elements which are classified as rare metals. One of the most important tasks of non-ferrous metallurgy during the Seven-Year Plan is the production of all the rare elements which are necessary for industry.

Rare metals are opening up a new era in the development of technology. For example, germanium in pure form can be used to build a radio tube smaller than a match and which will operate much longer than an ordinary tube. In radio and television sets, in automatic instruments and in measuring technology-- everywhere one encounters electron tubes. A modern airplane has more than 200 electron tubes and thousands of such tubes are used in calculators.

During 1959-1965, diamond mining will be greatly expanded. As compared with 1958, the output of diamonds by 1965 must be 15-16 times greater. During the current Seven-Year Plan an enormous center for mining diamonds will be built in the Yakut SSR. The properties of diamonds have made them irreplaceable in modern technology.

The various hard alloys which are used today in industry have caused a technical revolution, increasing the speed of processes by 2-5, and sometimes even 10 times. However, not one of the materials presently being used can compare with diamonds on the basis of their physico-mechanical properties, especially in terms of hardness, resistance to high temperatures, and chemical inertness. In particular, diamonds are 150 times harder than corundum, and almost 1000 times harder than quartz. When processing hard steel, cutters from the best extra-hard alloys become dulled after two hours, while diamond cutters last approximately 8000 hours. Thus, diamond cutters make it possible to produce a surface of high-grade purity which does not require either grinding or polishing, which are very expensive and difficult operations.

Diamonds are the best instruments for trimming and processing abrasive and hard-alloyed tools and punches. Experiments which were made in several Moscow factories on processing a cutting and measuring tool with diamonds, showed that it was possible to increase the durability of the cutting tool with hard alloys by 2-3 times, and of the measuring tool by 15-20 times, as well as improving the quality of the tool.

The use of diamond tools has been particularly advantageous in automatic assembly lines employing many tools in machine construction. The great durability of diamond tools provides for continuous operation of the automatic assembly lines. The effectiveness of diamond tools is so great that they pay for themselves in several days, and sometimes hours.

Extensive use of diamonds increases labor productivity and improves the quality while lowering the net production cost in such important

branches of the national economy as aviation, electrical engineering, the automotive-tractor industry, optics, ship building, and machine construction.

The use of diamonds is even of exceptional importance for drilling in the oil and mining industries, and also in geological work. The use of diamonds makes it possible to increase drilling time by 2-3 times, and reduces the cost of drilling operations.

The use of industrial diamonds is economical in other branches of industry; thus, for example, the use of diamond draw plates in factories laminating non-ferrous metals, instead of hard-alloyed draw plates, makes it possible to increase productivity of drawing equipment by 25-30%, and increases the durability of the draw plates from 275-375 times.

It is difficult to over-estimate the effectiveness of using industrial diamonds extensively. Each diamond carat which is used in industry produces a saving which exceeds the extraction cost by 6-8 times. American industry uses yearly 11-12 million carats of diamonds, i.e., approximately 50-60% of the yearly world output of diamonds in the capitalist countries.

In the USSR the development of the Yakut diamond deposits has created a basis for many branches of industry to make extensive use of diamonds.

During the Seven-Year Plan, it is planned that there will be a considerable increase in production and in the variety of products in factories processing non-ferrous metals. The development of electronics, electrical engineering, and many other branches of industry demands that rollers handling a non-ferrous metal use new shapes and new alloys. Rolled metal from extra-pure metals is in great demand, as well as from tungsten, molybdenum, tantalum, zirconium, niobium, beryllium, and other metals. There will be a significant increase in the volume of production for bimetals in the form of sheets, ribbons, wires and tubes.

The production increase for heavy, non-ferrous metals between 1959-1965 will occur primarily in already-existing factories due to the fact that modern equipment has been introduced along with mechanization, automation, and modernization of technological processes.

New foundries and electrolyte works will be built in existing factories; the existing departments will be expanded and modernized, and new ones will be organized.

Under the Seven-Year Plan, it is planned to increase production of aluminum foil by putting three new plants into operation and by stepping up existing production. Aluminum foil is a valuable material for many branches of industry, particularly in building condensers for radio engineering. The uses for aluminum foil are constantly expanding. In the electrical engineering industry, it can be used for insulating purposes; in the shipbuilding and railway industries - for thermal insulation; in construction - for water insulation.

As a result of planned measures, the output of factories producing rolled non-ferrous metals will be almost doubled.

One of the most important tasks in the field of non-ferrous metallurgy during the Seven-Year Plan is further expanded production of

secondary non-ferrous metals, along with primary non-ferrous metals.

At the present time, secondary metals provide a great source for increasing production of copper, zinc, lead, tin, and aluminum.

In the USA, secondary non-ferrous metals are of great importance and are even called their "primary mine" of non-ferrous metallurgy, while in production volume secondary non-ferrous metals comprise 40-60% of that of primary non-ferrous metals.¹ Thus, for example, in 1957 secondary copper production in the USA was 68% of that for the primary metal (1240 thousand tons of primary and 844 thousand tons of secondary copper), while in 1956 secondary lead production was almost 90% that of primary lead (511 thousand tons of primary and 453.5 thousand tons of secondary lead). During these same years secondary aluminum production was 20-23% that of primary (308 thousand tons of secondary and 1523 thousand tons of primary aluminum). Altogether, in the capitalist countries in 1957 the ratio of secondary metal production to primary was as follows: copper 62%, lead 47.4%, tin 34.4%, zinc 28.4%, and aluminum 24.6%. (Note 1 See Byulleten' tsetnoy metallurgii /Bulletin of Non-Ferrous Metallurgy, from the TsIIN TsM, Central Scientific-Research Institute for Non-Ferrous Metallurgy, 1959, No 17.)

The role of secondary non-ferrous metals will be constantly growing. With every year there is an increase in the return of depreciated scrap as a result of the replacement of various types of worn out and out-dated equipment and articles from non-ferrous metals, as well as from the tailings of production.

A metal obtained from a secondary source leads not only to an economy in the ore but also to a savings in producing non-ferrous metals, as there are no great expenditures for extraction and dressing the ores. In addition, to obtain one ton of metal it is necessary to extract and process several tens or hundreds, and sometimes thousands, of tons of ore, while the scrap to be smelted and the tailings contain up to 45-85% of the given metal.

The production level of secondary non-ferrous metals depends mainly on their collection and storage in industrial enterprises. During the current Seven-Year Plan, the problem of improving the collection and modernizing the reprocessing of tailings from the production of non-ferrous metals will be given a great deal of attention.

The accelerating growth of all branches of the national economy every year increases the demand for non-ferrous metals. The great economic and strategic importance of non-ferrous metals require that special attention be given to development of their production.

The Soviet Union, which has tremendous natural resources for non-ferrous metals, is constantly developing non-ferrous metallurgy.

The demand for non-ferrous metals exceeds their production growth. Therefore, fulfillment and over-fulfillment of the Seven-Year Plan for expanding non-ferrous metallurgy is a task which is of great economic importance to our country.

3. TECHNICAL PROGRESS -- THE BASIS FOR DEVELOPING NON-FERROUS METALLURGY DURING THE SEVEN-YEAR PLAN

General Trends of Technical Progress

Our Seven-Year Plan is a plan for constant technical progress in all branches of the national economy and a plan for progress in the fields of science and culture.

Only by the widespread introduction of a new technology and by the growth of labor productivity can the historic resolutions of the 21st Congress of the CPSU be fulfilled; they are: to take a decisive step forward in creating a material-technical basis for communism, in providing a basis for the economic tasks of the USSR, and in a very short period of time to equal and surpass the most highly-developed capitalist countries in per capita production. Rapid technical progress in all branches of the national economy fully meets the needs of the people and contributes to a further increase in their material and cultural level.

Under the conditions of a socialist planned economy, technical progress throughout the entire economy and in separate branches of industry can be effected on the basis of a nation-wide plan for technical development.

The main paths leading to technical progress in industry are applicable to all branches of the economy and are comprised of the following, four main trends which are characteristic of non-ferrous metallurgy: mechanization and automation of production, electrification of production, chemicalization of industrial processes, and use of atomic energy for peaceful purposes.

These trends are interconnected and interdependent; they can be carried out in concert.

Non-ferrous metallurgy has attained great successes in the field of the mechanization, automation, electrification, and chemicalization of production. Large mines and open pits have been developed; there are highly-mechanized dressing plants and large metallurgical plants - all of which have the most modern equipment. However, the production level which has been achieved is not enough. Rapid technical progress and subsequent introduction of it into production is one of the most important tasks of communist construction at this stage.

The question rises in connection with this, on the solidifying of technical progress trends in non-ferrous metallurgy between 1959-1965 in the separate stage of raw material processing and in specialized production: copper works, lead-zinc works, etc. In order to carry out the plan for technical development, it is necessary to start with the characteristics of a particular branch of industry, the level of technical development, and the tasks facing non-ferrous metallurgical plants during the Seven-Year Plan.

Non-ferrous metallurgy has characteristics which find expression in developing its technical base.

Let us consider three of the main properties characterizing the majority of plants producing non-ferrous metals, which determine the most

important tasks and trends of technical progress.

The First Particular Feature — the Raw Material base: The ores for non-ferrous metals, as a rule, contain a very low percent of usable component. The normal metal content in ores for several heavy non-ferrous metals, such as lead, zinc, and copper, is 0.5-2.0%; in ores for rare metals - 0.5-0.05%; and diffused metal content is even less. This explains the necessity of testing, extracting, and processing from tens to several thousand tons of ore to obtain one ton of metal. This property determines the leading role of the mining industry, the immense number of loading and unloading operations, and also the great difficulty of producing non-ferrous metals. Therefore, complex mechanization and automation of the industrial processes is a basic trend of technical progress, without which further growth of labor productivity would be impossible.

The Party and government place great importance on mechanization and automation. This is attested to by the June Plenum of the CPSU, which envisaged measures for effecting the resolutions of the 21st Congress in the field of technical progress.

During the Seven-Year Plan, measures will be taken to provide for further complex mechanization and automation of industrial processes in non-ferrous metallurgy. All technological processes in open-pit operations will be fully mechanized. The level of mechanization in underground mining operations must be much higher, in particular the mechanization for ore extraction at trimming works will reach 94.5% in 1965 and the mechanization of removing the ore mass with the sinking of shafts for ore extraction by 91%.

Mechanization of loading and unloading operations, and introduction of some mechanization into auxiliary operations in mining and dressing plants and in metallurgical factories will be given great attention. Along with an absolute rise in the level of mechanized operations, a qualitative change in mechanization methods is planned by the widespread introduction of highly-productive mining and metallurgical equipment and by modernizing existing equipment.

During the Seven-Year Plan, it is planned that complex mechanization and automation will be carried out in 24 mines, 23 dressing plants, and in 32 metallurgical plants, not counting many separate technological processes.¹

(¹ Promyshlenno-ekonomicheskaya gazeta (Industrial-Economic Newspaper), March 4, 1959, I.A. Strigin "Basic Trends in Development of Non-Ferrous Metallurgy.")

The economic effect which may result from introduction of these measures throughout non-ferrous metallurgy is enormous. This may be exemplified by the example of individual plants, in particular the Noril' Mining-metallurgical Combine and the "Elektrozink" Factory. If complex mechanization and automation is carried out in the plants of the Noril' Combine and it is supplied with highly-productive equipment, by 1965 labor productivity in the combine can be raised by not less than 60%; in the open-pit operations by 2.4 times, in the dressing plant and nickel

factory by approximately 1.5 times, and in the cobalt plant by 2 times. Mechanization of loading and unloading operations in the Combine's plants will be 90%, and mechanization of heavy and difficult construction operations will be 95%. Large capital expenses for mechanization and automation of the combine's plants will be required for less than two years, and the working force will decrease by 1965 by several thousand men, while productivity rises. In the "Elektrozink" Factory, introduction of complex mechanization and automation of basic technological processes will make it possible to increase the output of zinc by 44% by 1965, of sulfuric acid by 2.2 times, and of lead 10%, without increasing the working force, while mechanization and automation expenses will last for less than two years.

Complex mechanization and automation of processes and supplying non-ferrous metallurgical plants with highly-productive equipment will make it possible to increase labor productivity considerably and to increase the output of consumer goods.

The Second Particular Feature of Non-Ferrous Metallurgy: Closely connected with the first is the complex, polymetallic composition of the ore, which contains, as a rule, many valuable components. Thus, for example, copper ores from the Urals contain: copper, zinc, sulfur, gold, silver, cadmium, selenium, arsenic, and other rare elements. The following are found in polymetallic lead-zinc ores: lead, zinc, cadmium, copper, gold, silver, bismuth, sulfur, and other rare elements.

There is a strong connection between non-ferrous and rare metals. Thus, for example, bismuth is always a partner of nickel; molybdenum is connected with copper; electric refining of lead produces bismuth. Such diffused elements, such as indium, thallium, germanium, and rhenium exist in copper-zinc and lead-zinc ores.

Abroad 100% of the production of cadmium, indium, thallium, rhenium, germanium, selenium, and 90% of the bismuth are obtained completely from copper and lead-zinc plants. As a general rule, it can be stated that the main source of production growth for rare metals is complex utilization of many non-ferrous metals. This is constantly being developed in Soviet non-ferrous metallurgical plants. In many of our plants, up to 8-12 and more valuable components are extracted from the ore which is to be processed. However, the reserves in this field are still very great, and they must be pressed into the service of the national economy. Thus, for example, in the Urals the cost of extracted components in reprocessed ores is 56-58% (for copper, zinc, and sulfur) that of the original ore. The interests of the national economy demand that complex ores of non-ferrous metals be reprocessed not only to extract non-ferrous metals but also rare elements which they contain. In many non-ferrous metal ores, there is a considerable proportion of side elements.

During the current Seven-Year Plan, complex utilization of the raw material will be widespread in non-ferrous metallurgical plants, and this will have the resultant effect of improving the economic indexes, increasing labor productivity, lowering net cost, and increasing production quality. In many cases, for example, if the sulfur gases from metallurgical production are used, working conditions will be improved and

the harmful effect of these gases on the areas surrounding the plant will be eliminated. Complex utilization of the raw material is directly connected with modernization of technological processes, with the introduction of new technological systems, and with utilization of the newest achievements in science and technology. The extent to which complex utilization of the raw material is made is one of the main indications of technical progress in non-ferrous metallurgy.

The Third Property of Non-Ferrous Metallurgy: Stemming from the first two is the multiplicity of phases in technological processes. In the metallurgy of non-ferrous metals, the technological process for obtaining the finished metal goes through several stages as a rule, which causes considerable loss of metal during production. The total loss for the entire technological cycle is 20-30% the amount of metal contained in the ore. Extraction of rare metals during the production process is even lower. The degree of efficient extraction of metals is the most important indicator of technical progress and has an effect upon the production volume, on labor productivity, and on net production cost.

This indicates the need for careful selection of technological processes, the introduction of new and constant modernization of existing processes, with the purpose of increasing the extraction coefficient both in the dressing stage and during metallurgical reprocessing. Under the Seven-Year Plan, it is planned to increase extraction of non-ferrous metals, especially copper, lead, zinc, and nickel, by 3.5-5% by means of modernizing the dressing and metallurgical processes.

The most important technical problem in non-ferrous metallurgy at the present time is the further improvement of existing, and creation of new, technological processes, machines, and apparatuses for reprocessing ore containing metals, improving the optimum parameters for carrying out a technological process, increasing the effective operational time of the units, and producing metals and alloys with a high degree of purity, thus meeting the demands of machine construction, electronics, and radio engineering.

Studies have shown that our ideas regarding the properties of different metals have been inaccurate and distorted by the presence of various sorts of admixtures which are unavoidable under the existing technology for their production. It has been established that metals with a fairly high purity, and alloys derived from them, have other, greater properties than do metals and alloys with a smaller degree of purity.

Out of the 63 elements which non-ferrous metallurgy encompasses, many have a purity of "four ninths" and above, i.e., with a 99.99% metal content. Aluminum, copper, molybdenum, magnesium, nickel, tin, mercury, lead, zinc, germanium, and others belong to this class of metals.

Production of pure metals is directly correlated with the modernization of production technology, with the development of scientific-research work, and with evolving new methods for determining the purity of a metal. At the present time, it is necessary to calculate the admixture content in a metal of up to 30-40 elements with a content of each of them not over 0.001%, and in some cases - 0.00005%.

For the development of non-ferrous metallurgy, it is generally assumed that increasing production output not only results from increasing ore extraction, but also from making better use of the raw material and from increasing the number of components which are extracted by reprocessing complex ores.

Along with increasing the scale of production for the basic and rare metals, new production and mining is being created for new types of non-ferrous, rare and dispersed elements. It can be concluded that an important indication of technical progress is the amount of work carried out by scientific research institutes, and the creative development of science and technology in close connection with the actual practice of communist construction.

It is necessary to carry out measures for strengthening the material-technical base of scientific research institutes and institutions of higher learning in the field of non-ferrous metallurgy. It is necessary that scientists, in conjunction with their co-workers, arm non-ferrous metallurgy with new theoretical discoveries, with recommendations, and, putting them into practice, speed up technical progress in non-ferrous metallurgy and thus contribute to the successful fulfillment of the Seven-Year Plan.

The June Plenum of the Central Committee of the Party, heeding the resolutions of the 21st Congress of the CPSU, has worked out a program for technical progress in all branches of the national economy, particularly in non-ferrous metallurgy. We have all the successful requirements to fulfill this program successfully, and to raise higher the technical production level of non-ferrous and rare metals. Introduction of a new technology in non-ferrous metallurgical plants must necessarily lead not only to an increase in production output, but also to a growth in productivity, to the improvement of working conditions, and to an increase in the quality of production, while lowering the net production cost. The Seven-Year Plan sets forth concrete directions for technical progress in the various branches of non-ferrous metallurgy, which will be subject to adjustment, greater itemization, and modernization while the plan is in progress.

Technical Progress in Mining Plants

The high rate of growth in the extraction of non-ferrous metals requires the extraction of up to 400 million m³ of ore by the end of the Seven-Year Plan. It is also necessary to provide for a large yearly yield by opening up and developing resources.

These tasks must be fulfilled on the basis of technical progress. During the Seven-Year Plan, the main trends for the development of technology in mining plants are: widespread introduction of the open-pit method, a change-over to highly-productive systems for underground ore extraction, complex mechanization and automation of industrial processes, use of highly-productive machinery, modernization and replacement of old equipment, the least possible extraction of ore, and the greatest possible amount of safe and healthy working conditions.

During 1959-1965 the open-pit method utilizing the newest technology will be widespread. The growth in the extraction of non-ferrous metal ores (by 77%) will take place primarily due to the open-pit method. The amount of ore extracted by this method will increase more than 2.8 times, and by 1965 will make up 65% of the total extracted ore. In many branches of non-ferrous metallurgy, such as nickel, titanium, molybdenum, and others, 80-100% of the ore will be extracted by this method.

During the Seven-Year Plan, immense open pits for copper, aluminum, lead-zinc, and other branches of non-ferrous metallurgy will be put into operation. The majority of them will have a yearly productivity running in the tens of millions of cubic meters. All the technological processes will be completely mechanized in open-pit operations; thus, a qualitative change in mechanization methods will be carried out.

More productive equipment will be used in the open pits: excavators with a capacity of 4, 6, and 8 m³; rotor and pitch excavators; automatic dump trucks with capacity of 25-40 tons; electric trains weighing 100-150 tons; bulldozers; self-discharging dump cars with a capacity of 90-120 tons and powerful machines for rotary drilling. Great attention will be given to introduction of thermal (fire) drilling and complex mechanization, and automation will be developed widely.

The use of highly-productive equipment, complex mechanization and automation increases the efficiency of the open-pit method for ore extraction and expand the operational field to working deposits up to a depth of 300-400 m and more.

The great advantage of the open-pit method is the decreased loss of ore, and also the possibility of expanding productivity in a short period of time.

Widespread development of the open-pit method does not exclude the underground method. The ratio of ore extracted underground will fall during the Seven-Year Plan from 52% to 35%; however, the absolute amount of ore extracted by this method will also increase.

Under certain stratification conditions of the ore, the underground method may be more expedient.

To decrease the outlay of labor and materials for underground extraction, efficient highly-productive systems for underground operations are being used extensively.

During 1959-1965, many mines will turn to more productive systems, and by 1965 the extent to which these new methods are used in underground operations will reach 70%. First of all there must be the development of the following systems: a system of stage and sub-stage forced collapsing, with the sub-stage drifts using new drilling techniques; the chamber-columnar system for extracting ores with the introduction of efficient self-propelled equipment, and a system for the storing and the breaking down of the ores with long bores, etc.

Such a conversion to more productive systems will make it necessary to increase the speed of preparatory and main mining operations. The existing average operational speeds do not provide normal conditions for developing cleaning-up work, and therefore one of the tasks of the current Seven-Year Plan is intensification of the operations by using new

technology and improving upon work organization.

Both with the open-pit method and with underground operations, the most important trend in technical progress is complex mechanization and automation of the productive processes.

At the present time while there is a generally high level of mechanization in the basic processes in underground mining, such work as the conveying of ores from the cleared excavation and the removal of waste rock during the sinking and deepening of the shaft column remains insufficiently mechanized. Mechanization of auxiliary processes is very unsatisfactory. During the current Seven-Year Plan, it is planned to take significant steps toward the complex mechanization of productive processes, along with automation of them.

In addition to development of mechanization, it is planned to make qualitative changes in the means of mechanization due to widespread introduction of new, highly-productive equipment for drilling, conveying, removal, and hauling.

Technical progress in the field of drilling primarily turns on increasing the power of drills. Recently, builders in our country and abroad have developed a new way of increasing drill productivity by increasing the number of strokes, i.e., by using rapid-stroke drills. These drills have greater power and, consequently, a higher drilling speed (2-2.5 times greater than the OM-506 drill, and also have resolved the problem of decreasing the weight of the machines. However, these drills do have drawbacks; some basic drawbacks are the fatiguing (for the operator) vibration of the machine, and the great amount of noise from the exhaust and these drawbacks must be eliminated.

Each year new types of drills come but with the usual number of strokes, and existing drills are modernized. Thus, for example, the new PR-30K drill has a drilling speed 1.5 - 1.7 times greater than the OM-506 drill.

The designers in drilling technology along with increasing the specific capacity of the drills are confronted with the task of improving the design of the autofeeds for telescopic and columnar drills and the creation of an easy and convenient control of the autofeeds for hand drills.

A very important factor in drilling is the regulation of the axial feed force for drills, depending on hardness of rocks and the drill being used. Under optimum feed force for the drill, drilling takes place at the fastest speeds.

In order to decrease the time required for preparatory and finishing operations, it is necessary to modernize the regulating devices for the drills (drilling carriages not on rails, hanging equipment, etc.). Operational conditions must be improved in the construction of new drills, both with normal and with increased number of strokes: exhaust noise must be decreased, recoil from the drill must be reduced, and the possibility of drilling not only with water but also with dry elimination of dust during drilling.

A very good way of increasing drilling speed and decreasing expense in auxiliary operations is to locate new types of hard alloys for reinforcing the drilling tool. Modern technology has made it possible to

change the physico-mechanical properties of alloys, adjusting them to conform to differing operational conditions. We employ different types of drilling in terms of kinetic energy of the stroke and number of the strokes, and we have only two types of hard alloy machines in operation, BK-15 and BK-8, which do not meet all operational requirements. In addition, new boring bits must be designed which make it possible to increase drilling speed. Modern drilling technology raises the question of increasing the yield strength of steel used in boring bars, and on the other hand, the power of the drills must be increased.

During the current Seven-Year Plan, oil well drilling will be widely developed, and therefore tremendous importance will be given to further modernization and designing of new, highly-productive equipment for percussive and rotary drilling suitable for rocks of varying hardness, and also automatic feed control for the drilling tool used at great depths.

An important trend in the progress of technology in the field of drilling and blasting work in the mining industry is the improvement of the applied parameters in the production of the work, thus: the transition to a smaller diameter in the bore hole for increasing the speed of drilling under the conditions of using more effective blasting compounds, increasing the depth of the bore holes in the aim of decreasing the loss of time on auxiliary operations; the correct placement of the bore holes and the choice in the type of cross-cutting in the aim of increasing the bore's usefulness; the mechanization of bore charging and types of charges.

Ore conveyance at the mine sites will be completely mechanized. The main way of mechanizing ore conveyance from the clearing sites to the ore chutes is the use of scraper hoists, and a series of them will be introduced, handling all the various underground processing systems. In addition to mechanization of ore conveyance, remote control of the hoists will be widely used, and is already being used in the copper mines of the Urals. Remote control makes it possible to increase productivity by 20-25%, to mechanize the most difficult of operations, and to lighten the work of the hoist operators.

With automatic control, a shuttle operation is carried out from the place the ore is produced to the ore chutes and back.

The first installations for automatic control of the scraper hoists have been tried in the Krivoy Rog mines, and will be widely used throughout the mining industry.

During the current Seven-Year Plan, mechanization of ore loading and shipping will be done by machines on tracks with continuous operation and by excavators. The use of self-propelled equipment will cause a significant growth in labor productivity in these processes.

Transportation is one of the main processes in mines, and the success of the operation depends on its efficient and continuous operation. A primary task is the installation of a rational type of wagonettes and electric locomotives by using modern technical solutions: lightening the dead weight of the car's body (the introduction of low alloy steels, light alloys and plastics), the improvement of the

undercarriage of the wagonette, the equipping of the electric locomotives with electromagnetic brakes and the introduction of automatic couplers for the heavy ore cars.

A general trend in mechanized transportation operations is the change-over to more powerful electric locomotives, utilization of larger-capacity cars, and a considerable strengthening of the upper structure of railway tracks. A more powerful, mobile structure is of considerable significance for miners operating systems with massive destruction which leads to a significant increase in the amount of non-gauge ore pieces. Ore dimensions which are used at the present time of 300-400 mm demand a considerable outlay of labor in secondary breaking down processes. A change-over to large-capacity wagons makes it possible to increase the dimensions of ore to be transported up to 800-1000 mm, with subsequent breaking down in underground crushing machines before loading into skips. This type of equipment will be used in many mines (Leninogorskiy, Tekeliyskiy, Dzhzhkazganskiy, and others).

There is envisaged also the working out of a rational type of pushers dumpers measuring checking devices, and also auxiliary equipment for controlling chute closing devices (pneumatic closing devices), and flooring and ballast for the rail lines in the mines.

Centralized remote control of switches and signals, installation of high-frequency systems, and also remote control of electric locomotives at loading and unloading points will be widely introduced.

The introduction of STsB (signalling, centralization, and interlocking systems) and of a high-frequency, loud-speaker system for engineers on the electric locomotives will provide for an increase in carrying capacity of the tracks, an increase in productivity of the electric locomotives by 15-20%, and will eliminate switchmen and signalmen.

Introduction of remote control of electric locomotives in loading and unloading operations will make it possible for the engineer to regulate the movement of the locomotive and the unloading-loading operations from a stationary point. As a result, a large number of loaders and signalmen will be set free. Thus, the Degtyarskiy Mine in two of its shafts has been able to free 75 underground workers with a yearly savings of 825,000 rubles, while installation expense comprised about 500,000 rubles.

During the Seven-Year Plan, mining plants will carry out a large volume of sinking operations such as sinking and deepening shafts. Our coal mines have enormous experience in rapid sinking of mine shafts, and have established a world's record for sinking 264 m. of shaft per month. Mines in the Urals (bauxite and copper mines) have reached horizontal sinking speeds of 312 m. per month. A very important task of our mining plants is that of utilizing the experience of these establishments.

In order to increase the sinking of horizontal shafts, complex mechanization has been developed; particularly, loading machines with interchangeable units have been built (scoops with differing capacity, suspended equipment) along with engines (electric and pneumatic) for improving operation of the machine.

The "Giprorudmash" Institute has developed a project for the complex mechanization of mine shaft sinking. This project plans to make use of a drop panel which will replace temporary supports, drilling carriages for the drills, mechanical control of rock loaders, hydro-elevators for drainage, complete mechanization of the process raising concrete supports, and mechanization of rock unloading at the surface. All of this makes it possible to sink a shaft rapidly. By way of an experiment, a mine shaft will be sunk by the drilling method making use of equipment made in the Uralmashzavoda. By making use of this equipment to sink a shaft, a considerable increase in sinking speed with lowered costs should result.

In mining enterprises, many workers are occupied with auxiliary operations. In order to decrease the number of these workers, great attention will be given to minor mechanization of auxiliary operations in mines: processing of wood and preparing supports, loading and unloading of supports, reinforcing operations, delivery of materials and tools to mining site, etc. New materials and types of reinforcement will be used.

During the Seven-Year Plan, a great deal of attention will be directed towards automation of stationary mining equipment: water drainage, ventilation, heaters, compressors.

Automation of skip equipment, as the Degtyarskiy Mine has shown in practice, increases productivity by 15-20% and decreases the number of workers.

Under the plan for automation of lifting devices by a cage operator, there will be automatic starting, signalling, and transference of the wagons to receiving platforms and levels from the cage.

On a given level, the cage operator will control all operations dealing with moving the wagons from a stationary control board.

When the cage is transferred to another level, the cage operator will move in the cage to this new level and will again direct movement of the wagons.

Such mechanisms for raising the cage as well as the fists and the grates will be operated automatically from track signals with the transfer of the cage to the new level. All of this will provide for a reduction in the staff of machinists on the lifting equipment and the top cagers and their assistants. In the Degtyarskiy Mine, the change-over to automation of operations in the mine shaft, in a complex with a two-way high-frequency connection between the cage, the engine room, and the receiving platform, made it possible to operate with two workers in the shaft, instead of eight per shift. The total amount of capital expense for automation of the lifting cage was 600,000 rubles, and the total savings in operational expenses was 354,000 rubles. It took 1.7 years to pay for itself.

The automation of the work of pumping water from the mines provides for the desired work of pump assemblies without service personnel.

In recent years in non-ferrous mines of the Sverdlovskiy Rayon, 25 water drainage apparatuses have been fully automated, which eliminated a large number of workers and provided for a large yearly savings.

Automation of the ventilation system is of great importance in

mine operation, along with remote and automatic control of the main ventilation devices, remote control of the ventilators for partial ventilation, automatic control of the ventilation louvres and of the heating equipment for the shafts.

Equipment for remote control of the main ventilators, automatic heating equipment and ventilation louvres are already in operation in mines in the Urals and Krivoy Rog, and other mines should make use of their experience.

One aspect of automation is that of regulating and controlling the operation of compressors. Automation of compressors joined with underground hydro-pneumatic batteries makes it possible to maintain constant air pressure of 6.5 atm. at the most remote points. Constant condensed air pressure during a shift increases productivity, helps to increase ore output, and decreases the proportional expenditure of compressed air by 8-10%.

With automation of the mining equipment, there is no need for constant supervision of the personnel. Under these conditions, it is especially important to protect the electric motors from overheating of the winding - and for the other units, from overheating of the bearings.

By way of an example, the experience of the Degtyarskiy Mine in automating thermal control of the compressor units can be cited. Introduction of automation made it possible to check the working order of the pumps, the lubricating system, temperature of the main bearings and the electric motor, and temperature of the air after the first and second compression ratio. This apparatus was used in this mine for protecting the ventilating motors used in local ventilation.

Introduction of automatic thermal control in the Degtyarskiy Mine made it possible to decrease the personnel on duty by six, whose yearly salary was almost double the sum spent on automation thermal control.

Operation of a modern mining plant is impossible without centralized dispatching control. Introduction of television at a more rapid rate should be planned in order to increase operation and control over the most important technological operations of mining equipment.

At the present time, several scientific research institutes (Tsvetmetavtomatik, NIGRI, Yuzhmetallurgavtomatik, Unipromed¹) have already solved many problems dealing with automation in mining enterprises. Therefore, it is necessary to determine the minimum amount of automation for different categories of existing mines and those being built which must be carried out in the very near future. In order to mechanize and automate successfully the productive processes in non-ferrous metallurgical plants, it is necessary to improve the material-technical equipment, to increase productivity, to develop experimental work on the operation of new machines by mechanization and automation, to expand the design and research cadres dealing with new machines and equipment for automation, and to manufacture experimental models, putting into use new machines and equipment which have been tested.

Technical Progress in Dressing Ores of Non-Ferrous Metals

The dressing of ores is of great importance in the production of non-ferrous metals. Almost all ores of non-ferrous metals (95%) undergo dressing before metallurgical reduction.

Dressing makes it possible to use ore with low content, and in this way contributes to the expansion of the raw materials base for non-ferrous metallurgy.

Complex utilization of all valuable components existing in the ore results from the dressing process, and this makes it possible to lower the net cost of concentrates because expenses for the raw materials and processing are distributed among several types of concentrates.

Ore dressing makes it possible to lower the net cost of non-ferrous metals also, due to the savings resulting from transporting and processing concentrates instead of ore.

The development of ore dressing for non-ferrous metals has a great effect on the most efficient geographical distribution of metallurgical factories.

All of the advantages in ore-dressing have caused the necessity of constructing many dressing plants, at which tens of millions of tons of copper, lead-zinc, molybdenum, tungsten, mercury, tin, and other non-ferrous metals are processed in order to obtain concentrates from them.

Technical progress in the field of ore dressing must be accompanied by an increase in the most important technical-economic indexes, especially the extraction coefficient for the metals, the degree of complex utilization of the raw material, quality of the concentrates, labor productivity, and decrease in net cost for ore processing. A Resolution of the June Plenum of the Central Committee of the CPSU, 1959, calls for widespread use of progressive ore-dressing processes, modernization of equipment which is being used, introduction of high-productive crushing-grinding and dressing equipment, conversion to complex mechanization and automation of productive processes, and use of more effective reagents.

Development of progressive dressing processes during the Seven-Year Plan will occur in several directions.

One of the main trends in modernizing the flotation process is more extensive use of stage technological processes for selective and collective flotation of non-ferrous metal ore.

The stage process of dressing provides for crushing and flotation of the ore by stages. This has great advantages, first of all because the minerals are extracted at the same time, thereby not undergoing excessive crushing, and, secondly, because part of the material being processed is taken out after each stage of the process, due to which a savings in electric energy results, and less equipment is required for the dressing operation.

Stage dressing is especially important for ore finely impregnated with minerals in barren rock. Introduction of stage flotation increases metal extraction. Thus, for example in the Mirgalimsayskiy Plant, the use of two-stage flotation during processing of lead ores made it possible

to increase lead extraction in the concentrate by 15%, as compared with the previous one-stage dressing process, and a change-over to three-stage dressing, according to laboratory data, increased lead extraction by several more percent.

In the Zolotushinskiy Dressing Plant (Altayskiy Sovnarkhoz), the introduction of two-stage dressing raised lead extraction by 2.26%, copper by 1.5%, and zinc by 5.3%. Thus, productivity in the crushing section of the plant rose by 7%, while the consumption of flotation reagents decreased by 17%. In addition, net cost of processing one ton of ore decreased by 35%.

Stage flotation has many technological and economic advantages for complex ores which are finely impregnated with minerals in waste rock. This process makes more complete use of available components in the ore, increases labor productivity, decreases electric energy consumption, and lowers net cost of processing the ores and concentrates.

One important trend in technical progress for dressing non-ferrous metal ores is the use of combined dressing and metallurgical processes, thus ensuring more complete utilization of the raw material components. This type of combination can take place in many different combinations and is used for complex ores.

One type of such combination process is the use of technological processes of dressing plants for obtaining two types of concentrates: similar concentrates which are rich in the basic metal, and collective concentrates (intermediate products), which will be processed by special equipment (pyroselection, Welsh process, fuming process, electro-thermal processing).

This combination process provides metallurgical plants with high-quality, uniform concentrates and makes it possible to increase productivity of existing plants along with metal extraction. Production and processing of collective concentrates (intermediate products) by special equipment produces an additional amount of metal for the national economy.

Technical-economic figures show that output of minerals which are difficult to dress in the form of collective concentrates (intermediate products) makes it possible to increase total extraction of basic metals, throughout the entire technological cycle from ore to metal, by 3-10%, along with an increase in plant productivity.

Out of all the combination methods for processing ore, the most widely used method is that of Professor M. Ya. Mostovich for copper oxidized ores. By this method, oxidized ores undergo crushing, leaching with a weak solution of sulfuric acid, precipitation of the cement copper, and then the pulp undergoes flotation. This type of combination dressing and hydro-metallurgical process makes it possible to use lean and mixed oxidized ores, which would not be adaptable to simple flotation methods. Other combination dressing processes are also used, such as Professor P. N. Maslyanitskii's method for complex copper-nickel and tungsten-molybdenum ores.

Other combined schemes for dressing metals are finding application especially the method of Professor P. N. Maslyanitskiy for complex copper-zinc and wolfram-molibdenum ores.

One of the modern trends in dressing processes is that of collective flotation with subsequent selective flotation of the collective concentrate. Recently, this method has been used for dressing copper and lead-zinc ores. A collective-selective flotation process was introduced in the Karabashskiy Dressing Plant in the Copper Works Combine for obtaining copper, zinc, and pyritic concentrates, and as a result copper extraction was increased by 1%, zinc by 8.5%, and a great yearly savings was effected.

In the Krasnoural'skiy Dressing Plant the introduction of a collective-selective flotation process for treating copper-zinc ores from the Mine imeni III International greatly increased the extraction of zinc. At the present time, zinc extraction has increased by 47%, as compared with the pre-war period.

Collective flotation methods can be used for dressing lead-zinc ores in every instance where this makes mineral impregnation possible, in order to separate out the group of minerals which have great natural flotation activity and thus to effect selective separation with a minimum expense.

The collective flotation process for lead-zinc ores, after the collective concentrates has been crushed by selective flotation, has been used recently under industrial conditions. At the present time a plant in the Leninogorskiy Combine in the Altai is using this process. Introduction of this process has made it possible to decrease metal loss in the shafts, to lower the cost of reagents by 38%, to increase productivity of the crushing section by 20-30%, and to lower the required number of flotation machines by 15-20%.

The collective flotation process with subsequent selective flotation of the collective concentrate for many complex ores has many technological and economic advantages. This process makes more complete utilization of the ore components, increases labor productivity, lowers production costs, and decreases electric energy consumption along with capital expenses.

However, this does not mean that this process can be used universally for dressing all complex ores. In many cases, the most effective process is ordinary selective flotation, but for certain ores the consecutive selective flotation process, with consecutive selective extraction one may use of each mineral.

During the current Seven-Year Plan, dressing processes in heavy suspensions, particularly in combination with hydro-cyclones, will be widely used. This method makes it possible to discard up to 50% of the non-mineral rock before the flotation and crushing process and thus to increase considerably the technical-economic indexes for the plant. This is particularly important since preliminary ore dressing in heavy suspensions makes it possible to expand the uses for highly-productive systems of mining operations, which can work out the ore more completely than can less productive systems which are now being used. In addition this permits a significant increase in the processing of ores at existing production areas and on the equipment of dressing plants.

In the Kumyshkanskaya Plant, the introduction of a dressing process

in heavy suspensions of polymetallic ores has made it possible to increase plant productivity by 30-40%, to increase production output by 15-20%, and to decrease significantly the net cost of the ore processing. Laboratory and industrial experiments have indicated the applicability of the dressing process in heavy suspensions for many non-ferrous metal ores.

Positive results have been achieved from tests run on ores from the Zyryanovskiy, Zmeinogorskiy, Tekeliyskiy, Kumyshkanskiy, Karagaylinskiy, and other poly-metallic deposits, and also tungsten-molybdenum ore deposits.

The ore dressing process in heavy media is extremely important in fulfilling the Seven-Year Plan for the development of non-ferrous metallurgy.

The fact that the dressing processes mentioned above have widespread uses makes it possible to increase metal extraction and in particular copper by 3.5% and lead by 4% and to improve complex utilization of the raw materials. For even greater utilization of the raw material and reduction in processing cost, the selection and properties of the flotation reagents which are used is of great importance.

At the present time in the USSR, 30-50 types of reagents are used in dressing plants for non-ferrous metallurgy, while in the USA this number is much greater. During the current Seven-Year Plan, improvement will be made in the properties of reagents which are used while their number will be increased, and the production of new, high-quality reagents will be organized.

Synthetic frothers are finding widespread use. These frothers are highly-frothing, while their consumption for flotation of one ton of ore is twice as low as that of the best pine oils. Use of frothers makes it possible also to produce purer concentrates with a high selection coefficient. At the present time, the use of ordinary frothers (pine oil, pyridine, creosol, etc.) costs much more per ton of ore than alcohol-based frothers.

The number of collectors will be expanded considerably, resulting from new production of amyl and other xanthogenates, cation collectors, and many other new collectors. The use of new collectors will produce more successful flotation.

An increased number of reagent-depressants and reagent-activators will be of great importance.

An increase in the number of reagents and an improvement in their quality will lead to additional metal extraction, will improve the quality of selective concentrates, and will expand utilization of the raw material.

Apart from the quality of the flotation reagents, their quantitative consumption has a great effect on the flotation indexes. One of the main conditions for obtaining high indexes with an established process is a minimum consumption of reagents, particularly frothers. An excessive consumption of reagents has a negative effect on the qualitative flotation results, which has been confirmed by many industrial tests and by research.

Thus, in the Kirovgradskiy Dressing Plant they tried out a new reagent plan, lowering the proportionate consumption of basic reagents of butyl xanthogenate by 52.8%, of flotation oil by 59.5%, and also other

reagents such as depressants, activators, sulfatizing agents, and media regulators. A decrease in reagent consumption increased copper extraction in the copper concentrate by 1.98% and zinc in the zinc concentrate by 7.9%. In the Leninogorskiy Plant the consumption of forthers was lowered from 150 to 20 g/t, and as a result lead extraction increased by 2.27%. The same thing was observed in the Mizurskiy Plant where they reduced reagent consumption and raised flotation indexes.

In carrying out the process of selective flotation, it is essential that one works for a strict adherence to the established pattern since all of the parameters are interrelated.

As is well known, with one and the same reagent consumption per solid unit (g/t of ore), the amount of reagent in the unit volume of pulp will be higher with more solid pulps. This is very important for the flotation process, since the action of the reagent is proportional to its concentration in the pulp. Along with a decrease in reagent consumption during flotation, in more solid pulps flotation productivity is increased in proportion to the degree of solidity. Thus, in the Lyangarskiy Plant, an increase in solidity of the flotation pulp, with all other conditions being equal, from 35 to 45%, made it possible to decrease reagent consumption by approximately 1.2 times. At the Dzhilaysskiy Plant by increasing the pulp solidity from 30 to 38% it was possible to decrease expenditures of reagent by 1.2 times.

The proportionate consumption of reagents depends to a great measure on their being introduced into the process at the correct spot, and also on the length of time the reagent is in contact with the ore.

It is necessary to explore the possibilities more completely, and to put into practice in dressing plants, of reduction in reagent consumption during flotation dressing of non-ferrous metal ores.

It should also be noted that flotation reagents comprise a considerable portion of expense in the economy of dressing plants. The copper works plants in the Urals, alone, which form part of the Sverdlovskiy Sovnarkhoz use a total of more than 100 million rubles a year on reagents. Cost of reagents in copper dressing plants comprises about 20% of the net cost.

During the current Seven-Year Plan, great attention will be given to the problem of modernizing equipment and setting up more powerful crushers, sorters, flotation machines, and conveyors. Changing to more powerful and productive equipment makes it possible to increase considerably labor productivity and to reduce capital expenses on the construction of dressing plants.

Figures have shown that for large dressing plants, when more powerful dressing equipment was used, labor productivity rose by 55%, the number of buildings decreased by 35-40%, and capital expenses were reduced by 20-24%. Along with improving and modernizing equipment, new types of equipment will be introduced. In recent years, hydro-cyclones operating in conjunction with mechanical sorters and by themselves have been widely used in dressing plants. Use of hydro-cyclones in the crushing cycle of the original ore in combination with mechanical sorters, and also their use as independent sorting machines instead of mechanical sorters in the

pre-crushing cycle, has made it possible to expand sorting, to increase plant productivity, and to increase metal extraction.

In spite of the high level of mechanization throughout the entire technological process, several auxiliary processes are still insufficiently mechanized. Therefore, there is a real problem regarding further mechanization of auxiliary processes and automation of dressing processes.

During the current Seven-Year Plan, complex mechanization and automation of the crushing, grinding, and flotation processes will take place in 23 large dressing plants.

Automatic pulp regulators, mechanization and automation of selection of free-flowing materials, and automatic feeding of reagents in proportion to the amount of incoming ore or concentration of reagents in the pulp must be widely introduced in dressing plants.

The use of pulp regulators in conjunction with regulators for feeding flotation reagents makes it possible to economize, due to a decrease in reagent consumption and an increase in extraction of non-ferrous metals, by tens of millions of rubles.

Depending on the nature of the technological process and the level of mechanization, dressing plants should be ready not only to automate individual machines but also the entire plant. This will make it possible to increase sharply the quantitative and qualitative operational indexes of the dressing plants, and, consequently, during the Seven-Year Plan it will be possible to have plants operated by one person.

As figures have shown, with widespread introduction of automation in 8-10 dressing plants, it is possible to free about 2000 men, to save up to 10 million kw/hours of electric energy, to increase ore processing by approximately one million tons, and to have additional production of 10-20 thousand tons of non-ferrous metals.

During the Seven-Year Plan, the "tails" of dressing plants must be used more widely, as they often contain, apart from basic metals, rare metals (cadmium, thallium, germanium), and other mineral components.

Thus, for example, the tails from the Balkhashskiy Dressing Plant can be used as a raw material for alumina; tails from the apatite plants of the Kola Peninsula (this is a particularly rich nepheline concentrate) are suitable for alumina production on a very large scale; tails from lead-zinc dressing plants can serve as a raw material for gold, rare metals, and barite.

Processing of these valuable tails from dressing plants is very important for the national economy. Development of dressing technology is based on theoretical and experimental research carried out continuously in scientific research institutes, studying the material composition and dressing potentiality of the ores, and on scientific generalization on operation of existing dressing plants.

This research could point out new, more modern technological methods for ore dressing, which would make full use of ore components, increase the quality of the concentrates, decrease the difficulty of the operations, and lower net cost of non-ferrous and rare metals.

Technical Progress in the Field of Metallurgy

Technical progress in non-ferrous metallurgy must tend towards increasing the most important technical-economic indexes, and especially the metal extraction coefficient and the degree of complex utilization of the raw material, intensifying the processes, increasing metal purity and labor productivity, and lowering net production cost. A Resolution of the June Plenum of the CPSU Central Committee sets forth the following technological processes as the main trends in technical progress which must be used extensively in non-ferrous metallurgy: the "boiling layer" method for drying, annealing, sublimation, and calcination of materials and charges; use of oxygen and active admixtures in pyro- and hydro-metallurgy; electrolysis, electrothermics, and electrosmelting; complex use of the raw material.

A majority of technological processes in non-ferrous metallurgy, connected with reprocessing of raw material and semi-finished products (ores, concentrates, etc.), are carried out by interaction of solid and gaseous products.

The most progressive way of intensifying these processes is that of the "boiling layer" method.

The boiling layer method has been widely introduced in non-ferrous metallurgy, particularly in the USSR zinc industry.

At the present time every zinc electrolyte factory has completely changed over to calcining zinc concentrates in a boiling layer. As a result, productivity of roasting kilns has increased by 3-4 times, as opposed to productivity of multi-hearth roasters; zinc extraction has risen by 2-3% and cadmium by 1-1.5%, concentration of sulfurous anhydride in the roasting gases has risen to 8-10%, as opposed to 4-5% with multiple-hearth roasting. Raising the concentration of sulfur dioxide increases the output of sulfuric acid plants by 30% and more. Roasting of zinc concentrates in a boiling layer improves working conditions, makes it possible to decrease the required number of workers, provides conditions for complete mechanization and automation of preparation and roasting processes, and lowers net production cost.

Roasting in a boiling layer has begun to be introduced in many branches of non-ferrous metallurgy. In the "Elektrotzsink" Factory, molybdenum concentrates are roasted in a boiling layer, and as a result molybdenum extraction has risen, the process has been intensified, and the net processing cost of the raw material has decreased. Successful results were obtained in roasting antimony ore in the Combine imeni Frunze; in decomposition of alunites in the Sumgaitskiy Aluminum Plant; and in the oxidizing roasting of copper batches in the Sredne-Ural'skiy Copper Works Plant. On the basis of scientific research which has been carried out, it has been found that it is possible to successfully introduce the boiling layer method in many processes which are used in the metallurgy of aluminum, magnesium, titanium, and also that there are many possibilities for using a boiling layer in extracting lead and zinc encrustations from oxidized lead and zinc ores and from certain types of lead-zinc intermediate products.

There are tremendous possibilities for many non-ferrous inherent in the method of processing the raw material and intermediate products in a boiling layer.

During the Seven-Year Plan, the boiling layer method will be introduced in the copper, aluminum, gold, tin, mercury, cobalt, and nickel industries. In addition, scientific research will be carried out on the problem of more complete utilization of this process' potentialities. It is essential to solve the task of fully using the heat from gases by boiler-utilizer units.

In the aluminum industry, where roasting in a boiling layer is widely used for reprocessing large masses of materials, calcination and cooling of alumina and, the caking of nepheline batches must be tried out under experimental, industrial conditions, and alunite roasting in a boiling layer must be introduced at the Sumgaitskiy Aluminum Plant.

The process of roasting in a boiling layer must be further improved upon and intensified in order to determine the best use of air which has been enriched by oxygen, granulation of the concentrate, etc.

Figures have shown that widespread use of this progressive method in reprocessing raw materials and intermediate products will save hundreds of millions of rubles during the Seven-Year Plan and will produce a considerable amount of additional production.

One of the main trends in technical progress in non-ferrous metallurgy is the use of oxygen in technological processes.

The use of oxygen accelerates the operation of many oxidizing, reducing, and mixed processes, along with intensifying the burning of fuel and increasing its temperature. As a result of research and experiment work in lead-zinc, nickel, and copper industries, the advantage of using oxygen or air, enriched with oxygen, in many non-ferrous metallurgical processes has been established.

Experimental work was carried out in the lead-zinc industry on melting of lead agglomerate, on roasting zinc concentrates in a boiling layer, on converting mattes, and on refining crude lead, and also on hydrometallurgical processes.

The use of oxygen intensifies considerably the technological processes, increases the melting, and reduces fuel consumption. Thus, for example, in the Ust'-Kamenogorskiy Lead-Zinc Combine, when a blast of air enriched with oxygen was used, productivity of the ovens rose by 20-25%, and coke consumption decreased by 12%. In addition, working conditions were improved, the melting process became stable, and metal loss decreased.

Work done by the Ust'-Kamenogorskiy Plant shows that the use of oxygen not only improves the technical-economic indexes, but in many processes it can serve as the basis for a fundamental improvement in the processes themselves.

Data on the use of a blast air enriched by oxygen, during melting of an agglomerate of oxidized nickel ores in the Yuzhno-Ural'skiy Nickel Combine, indicate a significant rise in oven productivity and a decrease in proportionate coke consumption. Thus, for example, with a 31% oxygen content in the blast of air, agglomerate productivity rose by 31%, and

coke consumption decreased by 18%, as compared with normal melting in an air blast.

With the problem resolved as to using air enriched with oxygen, the necessity arises of finding an expedient way of enriching air with oxygen. Optimum enrichment of air with oxygen depends on the cost of obtaining oxygen at the plant.

Oxygen should be widely used in reprocessing slags by purging them of coal dust. Foreign practice (Trail Factory) has shown that if slag is purged with coal and air, enriched with oxygen up to 23-25%, oven productivity rises by 22%, and metal extraction increases.

Oxygen can be used successfully in melting copper and copper-zinc concentrates in a suspended state, with conversion of mattes. Experimental work carried out in the Krasnoural'skiy Copper Works Factory on the use of oxygen has shown that the length of the operation is reduced proportionately to the increase in oxygen content, the sulfur content in the gases emitted increases, there is a greater possibility of reprocessing a large amount of gold-containing fluxes, and working conditions are improved.

Oxygen has been widely used in subliming processes in reprocessing any sort of low grade lead-zinc, tin, antimony and other intermediary products via the method of the boiling layer.

Recently, processes using pure oxygen under high pressure, so-called autoclave processes, which produce high complexity and complete extraction of valuable raw material components, have been widely used.

Up until recently, there has been limited use of oxygen in non-ferrous metallurgy due to its high cost.

As production of oxygen is expanded and its cost is lowered, the economic efficacy and area of use for oxygen will be rapidly expanded.

Between 1959-1965, plans have been made for constructing several oxygen installations in non-ferrous metallurgical plants.

An important task of the Seven-Year Plan is the use of electric power in the technology of production for non-ferrous and rare metals.

Electric smelting, electrothermics, and electrolysis are the main trends in use of electric energy in technological processes. In electrothermics, electric energy is used as a source of heat (for example, in electric smelting), and in electrolysis - it is used for making the necessary chemical changes in a substance by decomposition of the more complex raw materials into their elements.

Electrolysis can find widespread use in non-ferrous metallurgy in the production of aluminum, magnesium, zinc, copper, and nickel. These processes can be used further for obtaining many rare metals. Electrolytic production of metals will be greatly improved and intensified.

In every new aluminum plant, there will be electrolyzers with a power of 120-130 thousand amperes, instead of the 42-64 thousand amperes now being used, which will make it possible to almost double labor productivity in the plants, to reduce electric energy consumption, and to reduce net unit cost of the metal. In magnesium plants, the projected growth in the power of electrolyzing baths will be twice that of other baths, and it is planned to increase metal extraction by 40% per square

meter of production area.

A basic trend in development of zinc production is the changeover from the pyrometallurgical method of obtaining zinc to the electrolytic method. This latter method makes it possible to increase labor productivity considerably, to lower the net cost of zinc, to make greater utilization of the raw material, to increase zinc extraction, to obtain a purer zinc, to save on coke consumption, and to improve working conditions.

The main method presently being used for obtaining zinc in our country is that of electrolysis. New zinc plants in the USSR will be built only for the use of electrolysis. The Belovskiy Zinc Plant, using the distillation method, will be redesigned.

Electrolysis is widely used in non-ferrous metallurgy due to the fact that metals with a very high degree of purity are produced. Thus, for example, the use of electrolysis in copper production makes it possible to produce a cathode copper with a high conductivity and to separate out precious metals in the sediment for subsequent extraction. Electrolysis is widely used to obtain very pure nickel. During the Seven-Year Plan steps will be taken to intensify the electrolysis process for zinc, copper, and other metals.

The second trend in the use of electric energy in technological processes, in the form of electric smelting and electrothermics, is still not widely used.

Widespread introduction of electrothermics and electric smelting in non-ferrous metallurgy as a basic method for obtaining many metals has been restricted due to the high cost of electric energy. As the power from electric plants grows, furnishing cheap electric energy, electric smelting will be widely used in non-ferrous metallurgy for smelting ores, concentrates, slags, and agglomerates.

The most important advantages of electrothermic processes are as follows: their universal use as a fusible and infusible charge; increased metal extraction from the raw material; great reduction in gas volume, and improvement in working conditions.

Electric smelting is widely used in the metallurgy of lead, zinc, and nickel. Results of experimental work in the Leninogorskii Lead Plant on smelting lead agglomerates and in the Belovskii Factory on resmelting zinc concentrates have shown the great advantages of electric smelting.

Electric smelting of a lead agglomerate makes it possible to increase lead extraction of 3%, to reduce sharply flux consumption, to improve working conditions, and to create more favorable conditions for automatic regulation of the technological process.

Between 1959-1965, several lead plants, located in rayons supplied with cheap electric energy, will be redesigned, replacing shaft ovens by ovens for electric smelting.

Electric smelting of nickel concentrates and liquid converter slags will be widely introduced, which will increase metal extraction by 3-5%.

Electric smelting also has great advantages for copper concentrates. As compared with reverberatory smelting, electric smelting is a more progressive and improved process. Electric smelting makes it possible to

reprocess infusible charges, to increase copper extraction due to decreased metal loss, to increase oven productivity, and to decrease the volume of gases liberated during the smelting process.

Electric smelting of copper concentrates must primarily be carried out in plants located in areas with tremendous resources of cheap electric energy. Electric smelting of copper concentrates is a basic process in the Almalyksk Copper Works Plant. There are great possibilities for using electrothermic processes in aluminum and magnesium production.

During the Seven-Year Plan, electrothermic processes for obtaining aluminum and magnesium will be widely developed. In two aluminum plants, construction of special equipment for this purpose is planned. The use of carbon and silicon thermic methods for obtaining magnesium will be very effective in the eastern rayons.

An important task in the metallurgy of non-ferrous metals is complete and complex utilization of the components existing in the raw material.

Technical policy on this question is to extract the maximum amount of valuable components from the raw material being processed.

A complex nature in the raw material being processed in metallurgical plants is typical for all branches of non-ferrous metallurgy.

Every year complex utilization of the components increases; however, the problem of improving complex utilization of the raw material in metallurgical plants is decisive in completing the Seven-Year Plan.

As is well known, considerable numbers of components are concentrated in the slags, gases, dusts, and other waste and intermediate products of metallurgical production.

Waste gases in many plants of non-ferrous metallurgy contain a considerable amount of sulfur, which has not yet been utilized sufficiently for obtaining sulfuric acid. During the Seven-Year Plan, over a billion rubles will be expended on constructing sulfuric acid plants utilizing the waste sulfur gases from metallurgical plants of the copper, lead-zinc, and nickel industry. As a result, gases from all roasting and conversion sections will be used in addition to some gases from electric smelting ovens and agglomerate machines. Output of sulfuric acid in these plants will rise almost 4 times and will comprise more than 30% of its total national production.

The use of slags from the copper and lead-zinc industries, with the purpose of extracting metal which they contain, will be of great importance in increasing complex utilization of the raw material. About 70-75% of the zinc contained in the original raw material passes into the waste slag from reverberatory ovens of copper plants. The total amount of zinc, passing into the waste slags only in the copper plants of the central Urals, comprises more than 40,000 tons yearly, and will increase as the copper output increases during the Seven-Year Plan. Waste slags contain many other metals also.

The same situation exists in lead plants, where waste slags contain a considerable amount of zinc and some copper, tin, lead, and rare metals.

In order to extract and use these valuable components and to increase the basic metal extraction in lead plants, equipment for carrying

out a fuming process will be increased in lead plants, and in several copper plants this equipment will be built.

If slags from only the lead plants of Kazakhstan and the copper plants from the Urals are processed, it will be possible to produce tens of thousands of tons of zinc per year, thousands of tons of lead, and a large amount of copper and rare metals.

Economic figures on one lead plant, which still does not have slag-sublimating equipment, show that the net cost of processing one ton of slag is about 40 rubles, and the value of extracted metals per one ton of slag is 130 rubles.

The correct use of dust from metallurgical ovens is one of the main problems in the field of complex use of the raw material.

During the metallurgical processes in lead, zinc, and copper plants, a large amount of dust is formed, which contains a considerable amount of rare metals in addition to the main metals.

The great value of the dust indicates the necessity of keeping loss to a minimum and of solving the problem of the most efficient way to process it.

During the Seven-Year Plan, the technology of dust-collection will be improved, and new technological processes will be introduced for extracting the components from dust and encrustations.

An extensive program for improving metallurgical production in non-ferrous metallurgy would make it possible to improve sharply utilization of raw materials. At the factories copper extraction will increase by approximately 25% and zinc by 5-6%. Tens of thousands of tons of copper, lead, zinc, and a large amount of other non-ferrous and rare metals must be additionally produced in order to increase metal extraction.

Scientific research and design institutes and workers in factory laboratories are constantly striving to increase complex utilization of raw materials.

The problem of replacing discontinuous and semi-discontinuous processes by continuous processes is an important part of technical progress in non-ferrous metallurgy. Conversion to continuous processes would effect an enormous savings and would increase production output.

Thus, if continuous leaching were introduced in alumina plants, communication systems could be curtailed, conditions would be created for automation of the process, the required number of workers would be reduced, and production output would increase.

Economic figures calculated for an aluminum plant have shown that as a result of the change-over to continuous leaching, net cost of alumina was reduced by 21 rubles.

A continuous output of smelting products in lead production would increase oven productivity along with metal extraction, decrease fuel consumption by 2-3%, improve working conditions, and decrease water consumption on granulation. On the basis of calculations made in one lead factory, change-over of the shaft ovens to a continuous output of smelting products would provide a savings of about two million rubles.

Conversion to continuous processes has enormous possibilities which must be exploited during the Seven-Year Plan.

The most important task of technical progress in non-ferrous metallurgy is complex mechanization and automation in controlling industrial processes.

Resolution of this problem would make it possible to improve technical-economic indexes and to raise labor productivity considerably. During the Seven-Year Plan, it is planned to automatize completely technical control of such processes as roasting, agglomeration, shaft and reverberatory smelting, conversion, leaching, electrolysis, electric smelting, and other processes.

The use of radioactive isotopes is of great importance with regard to controlling production.

Great attention will be paid to widespread introduction of automatic control over technological processes, which will furnish a basis for complex automation of individual aggregates and sections.

At the present time, automation of productive processes in non-ferrous metallurgy is being studied by special organizations.

In addition to the main trends in improving non-ferrous metallurgy which have been mentioned, during the Seven-Year Plan many other known and essentially new, technological processes which will raise the production level will be widely used.

Smelting in a hot blast, zonal smelting, processes using high pressure and low vacuum, are among those new technological processes for processing ore.

Along with the new methods which have mentioned for improving technological processes, in order to increase productivity and complex utilization of the raw material, there is the important task of creating apparatus to produce metals with high purity, the demand for which is constantly growing in the modern development of technology.

The introduction of technical improvements, of new processes, and of new apparatus has a real effect on production results and on technical-economic indexes.

Growth in production output, extent to which raw material is utilized, total capital expenses and their amount per unit of finished production growth, decrease in net production cost, growth in labor productivity, working conditions, and period of time in which capital expenses are paid off are the basic economic criteria for the efficiency of a new technological process.

In addition to the main indexes which have been mentioned, it is necessary to consider many additional indexes (proportionate material and energy expenses, etc.).

The efficiency of any process, new apparatus, or other technical improvements requires concrete, comparative technical-economic calculations.

4. DEVELOPMENT OF CONCENTRATION, SPECIALIZATION, COOPERATION AND COMBINATION IN NON-FERROUS METALLURGY

The continuous growth and improvement in production of non-ferrous

metals on the basis of advanced technology is directly connected to the improvement and further development of such organizational forms of social production as concentration, specialization, cooperation, and combination.

In the USSR, where socialist control of the means of production predominates and the national economy develops according to a single plan, the advantages of concentration, specialization, and combination can be used to the greatest possible extent.

Development of concentration, specialization, cooperation, and combination contributes to engineering progress and advanced technology; provides for a great savings in outlay, in working power and materials; and leads to the maximum utilization of productive forces and raw materials, to the most complex utilization of the latter, to increased quality in production, and to reduction in net production cost.

In the same way, development of the forms of social organization of production mentioned above helps create a material-technical basis for a communist society.

During the Seven-Year Plan, it is planned to develop further concentration, specialization, cooperation, and combination in non-ferrous metallurgy to ensure high economic efficiency of plant operations.

Concentration of non-ferrous metal production will be carried out according to plan. Already at the present time we have a high degree of concentration. Judgment can be made regarding the degree of concentration in non-ferrous metallurgy in the USSR by the fact that individual copper plants at the present time smelt more copper than was smelted by the total number of copper plants throughout Russia in 1913. Enormous plants for production of lead, zinc, aluminum, nickel, and other non-ferrous metals have now been built in our country.

During the Seven-Year Plan, there will be further concentration of smelting of many non-ferrous metals in the existing plants, and those being built, production output of which will run to the hundreds of millions, and sometimes more than a billion rubles. Aluminum plants which will be built in the East will have productive power greatly exceeding that of existing plants.

Modern mines will be built with yearly output of 2.5-5 million tons and several open pits which will produce 12-16 million m³ of ore yearly.

Expansion and redesigning of many existing plants will further increase the level of production concentration.

Along with enormous plants which will be built during the Seven-Year Plan, average-size and small plants will be built, particularly plants in the rare metal industry, since in non-ferrous metallurgy the size of such plants is to a great extent determined by the size of the deposits. The construction of plants of varying size makes it possible to achieve a more equal industrial distribution throughout the country. It is well known that one of the most important tasks in new construction is the creation of industrial plants in the national republics and the poorly-industrialized rayons in order to provide for economic and political development in these rayons. Construction of average and small plants helps bring about a successful solution of these problems.

The use of average and small deposits of non-ferrous and rare

metals, and construction of corresponding plants, is particularly expedient under the conditions of a tight balance between one or another metal. However, with a favorable balance, the working of average and small deposits is also efficient with a high metal content in the ore and also with the presence of reserve power from metallurgical plants in the rayon where the deposit is located. With a high technological level, exploitation of average and small plants can have a very advantageous result for the national economy.

One advantage of average and small plants is that they can be put into operation in a short period of time.

In the resolutions of the 21st Congress of the CPSU, great attention was given to the problem of developing specialization and cooperation in the national economy. The enactment of the June Plenum of the Central Committee of the CPSU pointed out that one of the most important conditions for successfully fulfilling the tasks of the Seven-Year Plan is the further development of specialization and cooperation in all areas of the national economy. Planning organizations and the sovnarkhozes should work out plans for the organization of rational cooperation in production which will provide for a bettering in the economic indices in the work of enterprises and the liquidation of non-rational procedures. Further development will be given to specialization not only in industry but as well in construction, repair and other work. There will be considerable expansion in the output of goods which are used widely in industry such as normal reductors, metal working tools, electrodes, fittings, industrial accessories and other units. Rayon enterprises will be set up for the repair of factory equipment as well as the production of spare parts for all types of equipment and machinery used widely in industry.

Specialization of production in non-ferrous metallurgy will be widely developed. Technological, object, and stage specialization will be the main trends in specialization. Object and technological specialization are characteristic for mines, dressing plants, and for the majority of metallurgical plants. Metallurgical plants are specialized according to the basic metals which are produced, in accordance with which they are called copper, aluminum, lead, zinc, nickel, and other plants. This trend in specialization will continue in the Seven-Year Plan.

As technological processes are developed and improved, and also the complex utilization of the raw material in dressing plants, many additional types of concentrates will be produced, in addition to the basic metal. Side metals or their intermediate products will begin to be produced in a constantly increasing amount; however, in this case, specialization of the different sections and divisions will continue. Stage specialization is also being developed in non-ferrous metallurgy. One type of stage specialization is the construction of special electrolyte plants for producing electrolyte copper, refining plants for refining precious metals, etc.

Plant specialization has many economic advantages. At the present time, plants processing non-ferrous metals are the least specialized, but during the Seven-Year Plan their specialization will be developed. It will be done by establishing a specific type of casting and rolled stock for individual plants, planned so as to meet the requirements of the rayons

closest to them. Special plants for producing aluminum foil will be set up. This will make it possible for plants processing non-ferrous metals to raise the level of technology.

Widespread specialization of metallurgical plants makes it necessary to organize efficiently cooperation (intra-branch) between all of the metallurgical plants.

In non-ferrous metallurgy, inter-branch cooperation primarily means delivering ore and concentrates to specialized metallurgical plants. As production of side metals and intermediate products increases, cooperation must be further developed. Many intermediate products used in metallurgical production will serve as an object of cooperation between metallurgical plants. This cooperation makes it possible to concentrate the reprocessing of intermediate products at separate plants with technical-economic indexes and to avoid the necessity of constructing small, special divisions at each plant.

At the present time, both inter-rayon cooperation (production relations exist between plants within one economic rayon) and intra-rayon cooperation (production relations between plants in various economic rayons) are widely developed in non-ferrous metallurgy.

Further development of non-ferrous metallurgy requires a considerable increase in cooperation. There are cases of inefficient intra-rayon cooperation, which can be explained by a lag in the ore base in the different economic rayons. In some plants - such as copper, zinc, and lead - the concentrates and even the ores are brought from very far away.

Inefficient cooperation increases the length of the productive cycle from the raw material to the finished product, produces a lack of rhythm in plant operations, and leads to an increase in net production cost.

In order to eliminate these deficiencies during the Seven-Year Plan, great attention will be directed towards improving intra-rayon cooperation.

Thus, for example, the Chelyabinskiy Zinc Plant will be supplied with zinc concentrates from dressing factories of copper plants in the Urals, and thus it will not be necessary to bring zinc concentrates from distant rayons.

Cooperation between the copper plants of the Sverdlovskiy Economic Rayon and the dressing plants of the Bashkirskiy and Orenburgskiy Economic Rayons will eliminate long-distance supply and will make use of the reserve capacities of the copper plants. Reprocessing of encrustations, produced in copper plants, will be carried out in one of the plants in the Urals.

Cooperation between copper and gold plants in the Urals will be expanded. Gold-containing quartz ores, from which gold is extracted during the smelting of crude copper, will be used as flux. As a result, expenses for producing flux will drop, and the extraction coefficient for gold will rise.

During the Seven-Year Plan, inter-branch relations in the copper industry must be regulated as a result of the creation of rayon complexes in Kazakhstan, the Urals, Central Asia, and the Caucasus; this will provide for the mining of the ores and the extraction of metal from them.

within the limits of a feasible gravitation of the mines to the factories.

The changes in distribution of the lead-zinc industry, as noted above, will reduce the amount of inefficient, long-distance supply.

New plants in non-ferrous metallurgy which will be built during the Seven-Year Plan primarily in the East due to the rich resources of raw materials, fuel, and electric energy, will improve the distribution of non-ferrous metallurgy, will contribute to complex development of the economy in the economic rayons, and will considerably lower expenses for non-ferrous metal production.

During the Seven-Year Plan there will be widespread inter-branch cooperation between plants in non-ferrous metallurgy and those in ferrous metallurgy, in chemistry, and other branches of industry. This cooperation will have a definitive economic effect.

The reorganization of industrial management has raised the question of inter-branch cooperation in auxiliary production such as water supply, repair work, electric power supply, transportation, etc; this will enable an improvement in the use of the productive capacities in the auxiliary enterprises, raise productivity and lower the net cost of production.

The correct organization of inter-branch, inter-rayon, intra-branch, and intra-rayon cooperation is one of the great tasks in building up the national economy at the present time.

One of the most important trends in production organization is further development of combination in non-ferrous metallurgy. This form of organization of public production will be widely developed during the Seven-Year Plan.

At the present time, the majority of plants in non-ferrous metallurgy are organized in a combine on the basis of raw material processing. Ore dressing and smelting it and concentrates are carried out at these combines.

A combine brings together mines, dressing plants, metallurgical production, subsidiary and secondary works. This type of combination is characteristic of the copper, lead-zinc, nickel, and other industries. Combination on the basis of complex utilization of the raw material is also widespread. A combine also encompasses chemical plants using the "waste" from non-ferrous metallurgical production. Hundreds of thousands of tons of sulfuric acid will be obtained from the waste sulfur gases along with other types of production with a lower net cost than production obtained from the usual raw material. In the aluminum industry, special works have been constructed for reprocessing wastes containing cement (tails) and for producing cement, along with chemical "branches" for producing products containing soda, potash, etc.

A great number of new metallurgical productions will be incorporated into combines connected with complex utilization of the raw material.

The possibilities of combination and cooperation in non-ferrous metallurgical plants are far from exhausted, and there are still great possibilities in this field.

The efficient development of production organization in the form of concentration, specialization, cooperation, and combinations, as mentioned above, will produce a significant economic effect, will increase

production output, make complete use of the raw material, and raise the technical-economic indexes of plant operation in non-ferrous metallurgy.

5. PROBLEMS IN THE DISTRIBUTION OF PRODUCTIVE FORCES AND CAPITAL CONSTRUCTION DURING THE SEVEN-YEAR PLAN

The Communist Party and the Soviet Government, in working out the Seven-Year Plan for developing the national economy of the USSR between 1959-1965, have stressed the necessity of correct distribution of productive forces throughout the country in order to have the greatest economic effect and to effect a rise in the economy of every republic.

The unprecedented scope of construction during the Seven-Year Plan has demanded that special attention be given to a plan for distributing the productive forces.

Based on the rules for distribution of socialist industry and following Lenin's nationality policy for economic increases in all republics and autonomous oblast's, the following plans are forecast for the Seven-Year Plan:

1. Greatest possible exploitation of natural resources, especially in the eastern rayons.
2. Complete utilization of labor resources combined with industrial experience in the different rayons and in all the republics.
3. Closer location between industry and the raw material source, fuel-energy resources, and the rayons needing the production. If this is done, there will be no inefficient long-distance supply, net production cost will be reduced, and labor productivity will rise.
4. Further rise in the economy and culture of all republics. This will lead to a material-economic consolidation of the republics, to the formation of national cadres, and to the growth of culture among the population.
5. Further specialization and complex development of the economy and industry both in the republics and in the major economic-geographic rayons. This will make it possible to utilize local sources of raw materials to the greatest extent, and to eliminate inefficient, long-distance supply.
6. Development of specialization and cooperation in industry, improvement in inter-rayon economic bonds, and efficient utilization of all types of transportation.
7. Further cooperation among countries in the socialist camp on the basis of socialist international division of labor.

Distribution of non-ferrous metallurgical plants, as well as plants in other branches of industry, is determined by the general rules for the distribution of socialist production. Distribution of plants in each branch of industry has its own requirements which are considered during planning. Thus, plants in the copper, lead-zinc, nickel industry must be located close to the sources of the main metallurgical raw material. Concrete distribution of the plants is determined by utilization of one

or another deposit and by considerations of the national economy.

The industry of light, non-ferrous metals (aluminum, magnesium, titanium) should be distributed in rayons with rich energy resources, and with a low electric energy cost.

Each type of non-ferrous metals has its peculiarities which must be taken into account when the location of the plant is being determined.

Technological progress has a real effect on the distribution of non-ferrous metallurgical plants. Thus, for example, introduction of ore dressing has an effect on the location of copper, zinc, and lead plants, making it possible to convert them into centralized plants handling several deposits in the rayon. The unification of the energy system in the nation will make it possible to move the high-energy consuming industries away from the sources of electric power. Thus progress in technology also have a basic influence on the location of enterprises.

According to the plan for distributing non-ferrous metallurgical plants between 1959-1965, new plants will be built primarily in the eastern part of the country, where a large portion of the ore reserves for non-ferrous metals are located and where there is cheap electric energy.

The eastern rayons (including the Urals) are not only preserving but are also strengthening their leading position in the production of almost all types of non-ferrous metals; in particular, their proportion in production of refined copper is approximately 88%, and 71% for aluminum.

An increase in aluminum production during the Seven-Year Plan will primarily be due to construction of new plants in Siberia and Kazakhstan. In these rayons, the Krasnoyarskiy, Irkutskiy, and Pavlodarskiy aluminum plants will be built on the basis of cheap electric energy from hydroelectric plants and powerful thermal stations.

Bauxite deposits in the Urals, the cis-Urals, and Kazakhstan, as well as nepheline deposits in Siberia, are the main sources of raw material for the increased production of aluminum. The proportion of alumina obtained from nepheline is playing an increasingly important role in alumina production. Complex utilization of this raw material makes it possible to obtain a considerable amount of potash and products containing soda, along with the alumina. As a result of the Seven-Year Plan, the main rayons for aluminum production will be Siberia and Kazakhstan. In addition, existing aluminum plants in other rayons will be expanded, and new types of raw materials will be developed, such as: alunite in Azerbadzhan and nepheline in Armenia, with complex utilization of the components.

Planned changes in the distribution of the aluminum industry will lead to a reduction in shipping volume and in net cost. Transportation of raw material, materials, and fuel as calculated per one ton of aluminum produced, has been reduced by not less than 30% as compared with 1958.

Reduction in transportation of raw material, materials, and fuel, as well as use of more economical energy resources, will reduce the average net cost of aluminum by approximately 20%. The main rayons smelting copper at the present time are Kazakhstan, the Urals, and Armenia.

Growth in copper smelting must be obtained primarily by expanding

the amount of ore extracted and smelted in existing plants in the copper industry.

In Kazakhstan, copper plants in Dzhezkazgan will be expanded and redesigned. Underground ore extraction will be increased considerably. A new dressing plant and a copper plant with a full cycle are being constructed. By the end of the Seven-Year Plan, the Kazakh SSR will be an enormous center for non-ferrous metallurgy; two dressing plants will be built on the basis of the Nikolaevskiy and Boshchekul'skiy deposits.

Copper production in the Balkhashskiy Metallurgical Combine will be expanded.

The copper industry in the Urals will be greatly expanded. An enormous dressing combine will be put into operation on the basis of the rich Gayskiy Deposit, and the construction of the Bashkirskiy and Uchalinskiy Dressing Combines will be completed.

The copper industry in the Urals has a powerful, raw material base. Existing copper plants will be redesigned, and construction of the Sredneural'skiy Copper Plant will be completed.

The Seven-Year Plan calls for an increase by five times in copper production in Armenia due to the expansion and technical reconstruction of mines and dressing plants at many copper and copper-molybdenum deposits; also construction of the Urupskiy Dressing Combine will be completed. Redesigning of the Alaverdinskiy Copper-Chemical Combine is also planned.

In the Uzbek SSR, construction of an enormous dressing combine is being carried out, and a copper plant will also be built here.

It is planned to construct at several copper plants during the Seven-Year Plan, and to put into operation, installations for obtaining encrustations of non-ferrous and rare metals from intermediate products, and also to organize the construction of sulfuric acid works.

As a result of the development and improvement in the distribution of the raw material base in the copper industry, rayon complexes will be formed in Kazakhstan, Central Asia, the Urals, and the Caucasuses, which will eliminate intra-rayon discontinuities in extraction of the ore and smelting, and, consequently, will reduce the volume of long-distance shipping. The volume of long-distance shipping of raw material per ton of copper to be smelted will be reduced by 25% during the Seven-Year Plan.

The rising importance of Kazakhstan and Central Asia in copper production will lead to considerable savings in capital expenses and to a reduction in net production cost. Capital expenses per one ton of annual copper production in Kazakhstan is 25%, and in Central Asia 40%, lower than in the Urals.

The growth of metal smelting in the lead-zinc industry will be achieved primarily in existing plants; in order to do this, considerable expansion of the raw material base is planned. Production of lead and zinc will be organized in the Uzbek SSR. Construction of the Karagaylinskiy Dressing Plant is planned in Kazakhstan. Extraction of lead-zinc ores in the Altay and in southern Kazakhstan is being expanded.

Increased volume in nickel smelting will take place primarily due to increased production in the Urals and in the Kola Peninsula. Nickel will be produced in relatively small amounts in the Ukraine.

Expansion in production of rare elements will be effected primarily by complex utilization of different types of raw material, intermediate products, and waste production from non-ferrous metals. The shifts in distribution of non-ferrous metallurgical plants, as outlined in the Seven-Year Plan, must provide more complete utilization of existing productive forces, being industry closer to the sources of raw materials and fuel and energy, reduce considerably the inefficient long-distance shipping, contribute to the complex development of industry in economic rayons, and exploit rich, new raw material resources.

The new distribution of non-ferrous metallurgical plants must increase the economics and culture of the union and autonomous republics.

In the RSFSR, enormous new plants will be built, in which production of aluminum, magnesium, titanium, copper, lead, zinc, nickel, tin, and many other non-ferrous and rare metals will be carried out. During the Seven-Year Plan, the output of aluminum must increase by 3.2 times, copper by 1.6, magnesium by 3.7, nickel by 1.9, zinc by 1.3. Other non-ferrous and rare metals will be produced in large amounts.

Non-ferrous metallurgy will expand greatly in Kazakhstan, where crude copper production must increase more than 2 times, refined copper by 3.2, lead by 1.3, zinc by 1.7; great quantities of other non-ferrous and rare metals will also be produced.

Non-ferrous metallurgy will be further expanded in such republics as the Uzbek, Armenian and Azerbaidzhan SSRs. Uzbekistan will become a rayon producing considerable amounts of copper, lead, zinc, antimony and other metals. The Armenian SSR will increase the output of refined copper by 5 times, sulfuric acid by 7.3, copper sulfate by 2, superphosphate by 3, and molybdenum by 3.5. Non-ferrous metallurgy will be further developed in the Bashkirskaya ASSR, in the Ukraine, and in Georgia.

To insure the production growth of non-ferrous metals during the Seven-Year Plan, it is planned to put considerable capital outlays in the reconstruction of existing plants and the construction of new ones.

The volume of capital investment in non-ferrous metallurgy between 1959-1965 will increase 1.9 times as compared with the preceding Seven-Year Plan (1954-1958), and will comprise about 55 billion rubles.

Capital outlays only on industrial construction of non-ferrous metallurgical plants, not counting expenses for geological, exploring operations, will be several tens of billions of rubles.

Large appropriations to capital construction in non-ferrous metallurgy must be accompanied by their most effective use. The rate of growth in non-ferrous metal production depends both on the volume of capital outlays and on the degree to which they are efficiently utilized.

Concrete criteria for the economic effectiveness of capital investment usage are the resultant growth in production volume, maximum reduction of construction costs, amount of capital outlays per unit of volume, and per one ruble output of production goods.

In order to use capital outlays effectively during the Seven-Year Plan, great attention must be given above all to reducing construction costs and lowering proportional capital investment. It is very characteristic of capital investment in non-ferrous metallurgy that 60% are

spent on expanding and reconstructing existing plants. In particular, more than one third of the production volume of copper ore and of crude copper will be a result of reconstruction and expansion of existing plants.

This is the most expedient usage, since construction costs and proportional capital outlays on expanding and reconstructing existing plants is less than constructing new plants. Consequently, with decreased capital outlays it will be possible to more rapidly increase output of non-ferrous and rare metals in the coming years.

In resolutions of the 21st Congress of the CPSU, on the basis of a report by Comrade N. S. Krushchev, it was indicated:

"In order to use capital investment most efficiently, more effort must be expended on reconstruction, expansion, and technical equipping of existing plants and the modernization of equipment, which will make it possible to increase production output and increase labor productivity with less expense and more rapidly than with construction of new plants."¹

(¹ Materialy vneocherednogo XXI s'yezda CPSU [Materials from the Extraordinary 21st Congress of the CPSU], Gospolitizdat, 1959, p 149.)

The remaining 40% of the capital investment is expended on completing construction and on the construction of new plants. Under the plans for the construction of new plants, maximum concentration will be centered on a minimum amount of objects. Concentration on a small amount of constructions will make it possible to put the most important plants into operation rapidly and to reduce construction costs.

The most important constructions in non-ferrous metallurgy during the Seven-Year Plan will be aluminum plants in the Krasnoyarskiy kray and the Irkutskaya oblast', copper plants in Kazakhstan and the Urals, a nickel combine in the southern Urals, the Karagaylinskiy Combine in Karagandinskaya, oblast', a complex of plants in the Uzbek SSR, and several others.

Along with plants which must be finished and put into operation between 1959-1965, it is planned to construct plants over a longer period of time. However, the volume of incomplete construction will be low and will conform to the existing demands for construction.

The lowering of the volume of uncompleted production will eliminate the frequently seen freezing of funds and materials in the process of construction.

A reduction in construction costs, as planned under the Seven-Year Plan, will entail widespread rayon cooperation and combination between non-ferrous metallurgical plants, which will make it possible to reduce capital outlays on transportation, construction of auxiliary works, housing, as well as communal and cultural construction. In particular, figures have shown that as a result of combining aluminum and laminating plants in Krasnoyarsk, aluminum and cable plants in Irkutsk, copper and lead-zinc plants in the Uzbek SSR, copper and chemical production in Alaverd and Krasnoural'sk, expenses on construction and expansion of these plants have been considerably reduced.

The elimination of departmental barriers due to the reorganization

of the management of industry and construction will also lead to lowering of the net costs of construction since it creates the possibility of cooperation with the close-by enterprises in other branches of the national economy along the lines of the general domestic network of water supply and sewer systems, rail and auto transportation, and electric networks, cultural and domestic installations, the unification of construction depots, etc.

One characteristic of capital outlays during the Seven-Year Plan is almost complete utilization of the raw material. Considerably capital outlays will be directed towards complex utilization of the raw material being reprocessed by dressing plants and metallurgical plants. As a result, gases from all roasting and conversion works will be used, and some gases from electric smelting works will be used for sulfuric acid production.

Gas purification will be widely introduced in metallurgical plants, along with additional reprocessing to extract rare metals. Plans call for construction of several slag-sublimation installations in copper and lead plants to reprocess slag and extract metal from them. Complex utilization of the raw material makes it possible to decrease the need for capital outlays, to lower net production cost, and to increase the output of rare metals and other types of production.

Special attention will be given to the development of a raw material base and to an increase in the non-ferrous and rare metals which are most important for the national economy. In order to promote rapid development of production forces and to provide mineral-raw material reserves, it is planned to increase the total volume of geological exploring operations by 67% for industry as a whole, and by a much larger degree for the industry of non-ferrous and rare metals.

During the Seven-Year Plan, about two-thirds of all capital outlays will be expended on developing mining plants for non-ferrous metallurgy, which will facilitate development of its raw material base, and create normal working conditions for metallurgical plants. Widespread introduction of openpit mining in non-ferrous metallurgy will have a decisive effect on lowering construction cost.

In order to meet the growing needs of the national economy for aluminum, nickel, and copper, about 60% of all capital outlays will be expended on production of these metals.

The amount of capital outlays on the rare metal industry will triple during the Seven-Year Plan, as compared with the capital outlays between 1952-1958.

Another characteristic of capital investment during the Seven-Year Plan will be their distribution throughout the economic regions. The largest sum of capital outlays, amounting to 60%, will be spent on developing non-ferrous metallurgy in the Russian Federation (the Urals, Siberia, the Far East). More than 20% will be spent on non-ferrous metallurgy in Kazakhstan, and there will be an increase of capital outlays in the Ukraine, Armenia, Uzbekistan, Azerbaydzhan, Georgia, Tadzhikistan, and Kirghizia.

All of these measures are aimed at providing a more efficient use

of the sums allocated to non-ferrous metallurgy for capital construction.

Planning and construction organizations will play an important role in lowering net cost and accelerating construction time. Under the Gosplan (State Planning Commission) and sovnarkhozes for economic administrative rayons, there are several planning institutes for non-ferrous metallurgy handling industrial construction by means of plans and estimates.

The selection of a raw material base should be the basis of constructing one or another plant in a given rayon; determining production scope, selecting the construction site, technological process, and equipment; determining extent of capital outlays, and construction time - all of this has great effect on construction cost.

The Party and government have in their resolution repeatedly pointed out that for accelerating and reducing the cost of construction in designing one need not allow a surplus in the volume and area of buildings, have unnecessary reserves of equipment or an excess of architectural decoration or planning or designing decisions.

Planning must encompass progressive technological processes, the newest technology, automation and mechanization, high technical-economic indexes for production with reduced capital outlays per production unit, and also the necessary measures for improving working conditions.

The effect of progressive technology which has been planned on lowering net construction cost is enormous.

Thus, for example, the installation of modern electrolyte baths, with a much higher current than that in existing plants, at new aluminum and magnesium plants would make it possible to lower capital outlays in aluminum plants by 12-13%, and in magnesium plants by 25-26%.

More extensive use of open pit mining, with a changeover to enormous drilling and excavating aggregates would have a tremendous effect on reducing net construction cost in non-ferrous metallurgical mines. In underground ore extraction, net construction cost can be lowered by using more efficient methods of discovering and preparing deposits for exploitation. A plan has been worked out for Dzheskazban under which ore will be extracted in only 2 shifts, not in 9 as planned before. By this method, capital outlays per ton of extracted ore will be lowered by 12%.

Improvement in the operation of construction organizations handling plant construction in non-ferrous metallurgy will have great importance for the national economy. Only in this way is it possible to carry out the enormous construction program, as planned for in the control figures for the development of the national economy between 1959-1965.

According to directives of the 21st Congress of the CPSU, labor productivity must increase by 60-65%, net industrial construction cost must be lowered by not less than 6%, and housing construction must be reduced by 14%, as compared to 1958.

The main ways to accelerate and to reduce the cost of construction are as follows: complex mechanization of construction processes, widespread use of prefabricated, reinforced concrete units, changeover to industrial methods, expansion of advanced operational methods, and the use of an economic plan.

All of the proposals set forth above have an effect on reducing

constructing time and lowering capital expenses.

Improvement in the technology of extracting and processing ore, increase in the complex utilization of the raw material, widespread introduction of openpit operations; conversion to highly-productive equipment, expansion and reconstruction of existing plants, concentration of construction, further development of cooperation, specialization and combination -- all of these measures will increase the efficient utilization of capital outlays in comparison with the preceding Seven-Year Plan. Thus, according to data of planning organizations in the aluminum, copper, and lead-zinc industries, in comparison with the preceding Seven-Year Plan, capital outlays on increasing yearly output must be lowered by 20%, and by 30% for nickel.

6. INCREASE IN LABOR PRODUCTIVITY - A DECISIVE CONDITION FOR PRODUCTION GROWTH OF NON-FERROUS METALS

The problem of labor productivity has enormous economic and political importance for our country.

Labor productivity is the main source of expanded socialist reproduction. It is a basis for increasing the prosperity of the people, for reducing the length of the working day and increasing workers' relaxation time so as to develop their capabilities and satisfy their cultural needs.

In order to provide for a rapid growth in non-ferrous metal production and to carry out the construction program set forth by the Seven-Year Plan, growth in labor productivity will be of great importance.

During the Seven-Year Plan, labor productivity in industry must increase by 45-50% per single worker, while the output of industrial production must increase by about 80%. In construction work, labor productivity will increase by 60-65%, with a growth in construction volume of 80%.

Growth of labor productivity in different branches of industry varies; in particular, in non-ferrous metallurgy it is planned to increase labor productivity by 80%. By 1965, 3/4 of the growth in industrial production will have been attained as a result of increased labor productivity.

Over-fulfillment of the plan for labor productivity by 1% by 1965 will effect a production growth of more than 19 billion rubles. Each percent of growth in labor productivity in Soviet industry will decrease the number of men required for the work force by 200,000 men.

In his work Velikiy Pochin [The Great Beginning], V. I. Lenin wrote: "Labor productivity is, in the last analysis, very important, very essential for the victory of a new social system. Capitalism has created labor productivity of unprecedented strength. Capitalism can be finally conquered, and will finally be conquered, by the fact that socialism creates a new, immensely greater labor productivity."¹

(¹ V. I. Lenin, Works, Vol 29, p 394.)

In the report of Comrade N. S. Khrushchev to the 21st Congress of the CPSU, and in the reports of the congress delegates, it was pointed out that growth in labor productivity is a necessary prerequisite for solving the main economic tasks of the USSR which are providing an abundance of consumer goods, and changing over to the communist principle of distribution according to needs.

Communism, it is stated in a resolution of the 21st Congress, can exist if we surpass the production level of the capitalist countries, and if we provide a greater labor productivity than that which exists under capitalism. According to its growth rate, the Soviet Union has indexes which are much higher than those of the capitalist countries. Under Soviet rule, labor productivity in our industry has increased ten times, while in the capitalist countries it has increased only 2-3 times during the same period of time.

In non-ferrous metallurgy, and in other branches of industry, due to the introduction of advanced technology, of increased qualifications in the workers, of improved labor organization and production, the level of labor productivity has constantly risen. In recent years, the average yearly growth rate of labor productivity in non-ferrous metallurgy is greater than in the entire industry as a whole.

Due to the high growth rate of labor productivity, the USSR has outstripped the most highly developed capitalist countries of Europe, and has greatly diminished the difference in level of labor productivity in the USSR and the USA. In 1913 labor productivity in our country was 9 times less than in the USA, while at the present time it is only 2-2.5 times less.

During the Seven-Year Plan, labor productivity in our industry will increase by 5.5-6% per one worker yearly, and in non-ferrous metallurgy by 8.8%. The overall rise in labor productivity in non-ferrous per one worker during the Seven-Year Plan will be about 80%, which will greatly diminish the difference in level of labor productivity between the USSR and the USA.

The level of labor productivity is determined by many factors, depending both on the plants themselves and on the more general economic factors. The main factors are: the level of technology and its use, the degree of efficient cooperation, specialization, combination, production scope, natural conditions, quality of the original raw material, qualifications of the workers, and general production organization.

All of these factors, which have an effect on the level of labor productivity, have a specific relationship to each other. In different, even monotypic, non-ferrous metallurgical plants, the effect of these factors is different, and therefore there are great fluctuations in the level of labor productivity. Thus, in copper works of different factories, labor productivity, calculated for the main metal, can fluctuate from 57 to 210 tons of crude copper per year per worker. In dressing plants in the copper industry, fluctuations of labor productivity are even larger, ranging from 1000 to 20,000 tons of processed ore per worker per year. There are great fluctuations in the level of labor productivity in mines, in particular, between ore extracted by the

open pit method and underground operations.

These sharp fluctuations in labor productivity are connected with production organization to a great extent, i.e., with inter-production reserves.

Under the conditions of socialist production, continuous growth of labor productivity takes place under a planned system. The Seven-Year Plan sets forth measures leading to further planned growth in labor productivity. The main trends in increased labor productivity in socialist, non-ferrous metallurgical plants are:

1. An increase in the productive force of labor, due to the fact that with the same input of work there is greater production, resulting from an intensification of the productive processes, complex and better utilization of the original raw material, the use of new, more effective types of raw material, an increase in the skills of the workers, the introduction of advanced experience, and improvement in production organization.

2. More efficient use of labor resources existing at the plants: regulated working time, arrangement of the working force, and the creation of favorable conditions for development of the workers' creative activity, and increasing material incentives of the workers as a result of his labor.

3. An increase in the general level of production organization in order to make better use of the productive forces, and also improvement of the social forms of production organization (concentration, specialization, combination, efficient cooperation, and improvement of plant location).

As a result of putting these measures into operation, there will be an increase in labor productivity both due to an increase in the amount of production per unit of time and to a reduction in working time per unit of production.

Mechanization and automation of the productive processes can raise labor productivity considerably. Mechanization and automation also have an enormous social value. In a socialist society, complex mechanization and automation of the productive processes meets the daily needs of the workers, lightens labor for millions of people, and creates the conditions for reducing the length of the working day and for removing existing differences between mental and physical labor.

Non-ferrous metallurgical plants in the USSR have had considerable success in mechanizing production, especially the main processes and operations. Thus, in non-ferrous metallurgical mines at the present time, drilling has been completely mechanized, ore extraction has been 80-85% mechanized, removal and transporting of the ore has been 65-75% mechanized, underground haulage 95%, and loading of the ore into railway cars has been almost completely mechanized. In dressing plants and in metallurgical works, all of the main processes are also mechanized. However, the level of mechanization is still far from sufficient, and complex mechanization is lacking.

Automation is still in its beginning still in its beginning stages in non-ferrous metallurgical plants.

Almost 40% of the workers in the main plants are still occupied

with manual labor. Even in the dressing plants, a great deal of manual labor is used on auxiliary operations. In particular, the level of mechanization for production control is still unsatisfactory. In all the dressing plants, a large number of workers are occupied in auxiliary operations. Due to the lack of automation, many workers are occupied with starting and stopping of engines, with lubricating the engines, etc.

The 21st Congress of the CPSU has set forth the task of the complex mechanization of the productive processes in USSR industry, and in this way eliminate heavy, manual labor. Along with this, it is planned to introduce extensive automation, to change from automation of individual aggregates to complex automation, to creating fully automated plants and factories.

Between 1959-1965 in non-ferrous metallurgy it is planned to carry out further complex mechanization and automation of productive processes in mines, dressing factories, in metallurgical plants, and in plant transportation and loading-unloading operations. Along with an absolute increase in the level of mechanization and automation, it is planned to make qualitative changes in the means of mechanization by introducing new, highly-productive equipment, and by modernizing present equipment.

An important factor in increasing labor productivity in non-ferrous metallurgy is that of increasing the content of useful components in the original raw material (ore, concentrates, intermediate products). The richer in metal is the original raw material, the greater is the amount of finished production, the greater is labor productivity.

When high-quality raw material is being processed, labor productivity increases due not only to a large metal content but also to better metal extraction.

Therefore, the quality of the ore used in the dressing plants, the quality of the concentrates being reprocessed in the metallurgical plants, and finally, the quality of the intermediate products, being sent from one section of the plant to another for further reduction, are very important. Concrete measures are planned to raise the quality of the original raw material during the Seven-Year Plan.

It is well known that metal content in ore varies not only in different deposits but also for the same deposit, during different operational periods in the mine. Therefore, one of the important tasks of the Seven-Year Plan is to provide a definite metal content in all extracted ore. The average metal content periodically changes due to changes in extraction of rich and lean ores.

In order to secure a relatively stable metal content in ore, it is planned to exploit new deposits with rich metal content and favorable natural conditions.

Many steps are planned, among which is that of additional operations which will increase the quality of concentrates in dressing plants. If new dressing processes are introduced, there will be an increase in the main metal content in the concentrates and a better selection, as well as an increase in metal extraction.

If rich concentrates are being processed, productivity of the

metallurgical aggregates rises considerably. Concentrates rich in metal produce less waste and provide a higher metal extraction in metallurgical plants.

One important factor influencing the level of labor productivity is the extent to which the raw material is used completely. It is necessary that all extracted ore be reprocessed in dressing plants and in metallurgical plants with maximum efficiency.

For the majority of non-ferrous metals, expenses on the raw material amount to 60-70% and more of the total expenses per one ton of finished product. As a result, an increase in the percent of metal extraction has an enormous effect on all the main economic indexes of a non-ferrous metallurgical plant, among which is an increase in labor productivity.

At the present time, the total loss of the main non-ferrous metals during dressing and during metallurgical production amounts to 20-30% and more. Losses reach several hundreds of millions of rubles yearly.

The main types of loss are mechanical losses incurred during transportation of the raw material and intermediate products from one plant to another or within the plant, and also technological losses - production waste.

The amount of technological losses serves as an important index of how the productive process is organized, how efficient and economical is the technological and productive process, and to what extent the technological process has been mastered.

When a polymetallic ore is being processed, the metals are distributed throughout similar concentrates, diverse concentrates, and in waste tails.

Metals distributed throughout diverse concentrates have been completely, or almost completely, lost without recovery.

In metallurgical production, technological losses are connected with waste slags and waste gases.

During the Seven-Year Plan, measures are planned to decrease mechanical and technological losses.

It is planned to improve the preparation of charges, increase the quality of the original raw material being processed, to introduce more modern technology in dressing plants and factories in non-ferrous metallurgy, to introduce new reagents for flotation, organization of transporting raw materials and intermediate products, the elimination of long-distance hauling, etc.

This will raise the percent of utilization of raw material components; in particular, during the Seven-Year Plan, there will be an increase in copper, lead, zinc, and nickel extraction by 3.5-5%, and also an increase in the extraction of other metals due to the modernization of technological dressing and metallurgical processes.

As a result of these measures, the USSR national economy will be able to produce additional large amounts of non-ferrous and rare metals every year, and to raise the level of labor productivity.

Intensification of productive processes is of great importance in raising the level of labor productivity. This problem can be solved

by introducing highly-productive ore extraction by the open pit method and by changing over to efficient methods of underground mining.

There will be widespread use of such progressive processes as processing of materials in a boiling layer, utilization of oxygen for the intensification of technological processes, further development of electrothermic processes in production of non-ferrous and rare metals, intensification of electrolysis for aluminum, magnesium, zinc, and copper, zonal smelting, technological processes using high pressure and a low vacuum, and conversion to continuous processes. Introduction of these methods must increase labor productivity in metallurgical production.

As is well known, one of the main conditions for increasing labor productivity is the changeover to more powerful and highly-productive equipment. A material basis for increasing labor productivity will be effected by the introduction of more powerful, excavators, scraper hoists, loading machines, crushing equipment, flotation machines, electrolyzers, enlargement of metallurgical ovens, and modernization and replacement of old equipment. Further development and concentration of production will also contribute to this.

It should be kept in mind that, in contrast to plants in many other branches of industry, in dressing and metallurgical plants the number of workers in many sections does not depend on the production volume, due to the nature of the production process. As a rule, the greater the output of these plants, the greater the labor productivity. This is one of the main reasons for sharp fluctuations in indexes of labor productivity in monotypic, but varying in terms of size, plants.

The factors cited above, which have an effect on increasing labor productivity, represent different sides of a technological process. They comprise a basis for the growth in labor productivity throughout all branches of non-ferrous metallurgy. According to calculations of planning organizations Giproaluminii, Giprotsvetmet, and Gipronikel, the widespread use of new technology during the Seven-Year Plan will make it possible to raise labor productivity per one worker in the aluminum industry by 64%, by 70% in nickel, and double in the lead-zinc industry.

An increase in the level of public production organization - concentration, cooperation, combination, specialization, and distribution of production - has an important effect on the growth of labor productivity.

During the Seven-Year Plan, great attention will be given to eliminating defects in the distribution of production in non-ferrous metallurgical plants. An increase in the level of production organization will be seen in the rhythmical plant operation, in improved utilization of equipment in terms of time and capacity, and in complete utilization of the productive capacity of sections, works, and plants as a whole. One of the important tasks in bringing plants which are lagging up to the level of the leading ones. As a rule, leading industrial plants have 20-30% greater equipment productivity and higher qualitative operational indexes, with the same equipment. An increase in the number of workers handling main operations due to a reduction in number of workers occupied with auxiliary operations, better utilization of workers in accordance with their qualifications, a changeover to more modern forms of labor

organization, improved use of working time, correct handling of technological processes, and improvement in operators' position are of great importance.

Remuneration for labor depending on the amount and quality of labor expended correctly meets the interests of society, of developing social production, and the interests of the individual worker. Therefore, a personal, material incentive on the part of the workers in the results of their work is of great importance in raising labor productivity.

The 21st Congress of the Party placed great attention on the problem of the most efficient use of the principle of material incentives for the workers in developing social production and raising labor productivity. During the Seven-Year Plan, it is planned to improve further the forms of materials stimulation for the workers in order to increase their activity and to remove defects presently existing in non-ferrous metallurgical plants. Therefore, great attention is given to the question of correct organization of salaries and of increased level of technical standardization.

The forms and systems of salaries during the Seven-Year Plan will change in terms of an increased role of salary for fulfilling and over-fulfilling the plan, improving production organization (an increase in the use of equipment and metal extraction, decrease in consumption of fuel and electric energy, improvement in other basic, technical-economic indexes), and increasing labor productivity. In non-ferrous metallurgical plants, salaries will be regulated, along with a changeover to a shorter working day.

The role of socialist competition is enormous in the struggle for increased labor productivity. Along with the increased role of personal, material incentive in the growth of labor productivity, social, moral stimuli are of growing importance. One of the most important factors in raising labor productivity will be a constantly growing, communist awareness in the workers.

Widespread development of socialist competition for new productive successes has as its basis great awareness of the social good and a striving to increase the well-being of all the people. A planned program for the development of the national economy will cause a new wave of creative progress under socialist competition, which will be expressed in the fulfilling of the Seven-Year Plan, improving production technology and increasing further labor productivity.

The creative initiative of the masses brings about new forms of competition, among which the movement among brigades for the right to be called brigades of communist labor, where striving for high labor productivity occupies an important place.

In the brigades of communist labor, the workers have glimpsed a new, higher form of competition, which corresponds to the modern period of development in our country. Workers in the Moskva-Sortirovochnaya Moskovsko-Ryazanskiy Railway were pioneers in this movement. Following their example, thousands of brigades competing for the title "brigade of communist labor" were created in non-ferrous metallurgical plants, and in various industrial centers. Thus, in the Sverdlovskiy Economic Rayon

alone there are now hundreds of brigades striving to work in the communist way and to direct all their energies toward raising labor productivity. Members of a brigade of communist labor pledge themselves to study and to master modern technology, to fight vestiges of the past, and to subordinate their interests to the interests of society.

During the course of communist competition, other creative undertakings of the workers are born. The initiative of Valentina Gaganova is known throughout the country and is widely circulated.

An important factor in increasing labor productivity is the growth of the cultural-technical level of the workers: general and professional education and cultural development.

The use of more complex technology in non-ferrous metallurgical plants and widespread introduction of new technological processes require the constant enlargement of their technical knowledge and a rise in their production qualifications from workers and from engineers and technicians. During the Seven-Year Plan, special education of the workers is planned to increase their knowledge of modern equipment, methods of complex mechanization and automation, and also new technological processes.

A constant rise in the cultural-technical level of the working class is very important as a necessary condition for our country's changing from socialism to communism, under which the existing difference between physical and mental labor disappears.

Factors contributing to the growth of labor productivity are: rhythmical operation, complete use of productive capacity and working time, correct organization of labor, arrangement of working power, organization of standardization and salaries, strengthening working discipline, developing socialist competition, and introducing new work methods. Due to improved organization of production in non-ferrous metallurgy, during the Seven-Year Plan there will be a considerable increase in labor productivity and approximately 20% of the entire production growth will be achieved, among which the growth of nickel and zinc will be not less than 20%, copper will be 23%, and aluminum will be 8%.

7. THE STRUGGLE FOR THE STRICTEST SAVINGS IN THE PRODUCTION OF NON-FERROUS METALS

The 21st Congress of the CPSU has outlined a grandiose program for the further development of the national economy, for a new rise in the economy, culture, and material welfare of the workers between 1959-1965.

This program has no equal in history in its scope. It is sufficient to note that the general volume of state capital investment during the Seven-Year Plan will be approximately equal to the volume of capital investment throughout the entire period of Soviet rule.

In the light of the new tasks, the demands on the level of economic work are limitless. The struggle for increased savings and for lowering the production expenses, at the present time are particularly important.

The importance of the struggle for the most rigid economies, and for lowering costs was stressed in the resolutions of the 21st Congress of the CPSU.

Cost is one of the main indexes which characterizes the success of the productive and economic activity of a plant.

Under the Seven-Year Plan, it is planned to lower production cost in industry by about 11.5%.

In 1959, each percent that cost was lowered saved the USSR more than 12 million rubles. By the end of the Seven-Year Plan, a 1% reduction in cost will provide a savings of up to 21 billion rubles per year.

There are great possibilities of lowering net production cost between 1959-1965. This is due to the advantage of the socialist production method, to the introduction of new technology, to further development of concentration, specialization, cooperation, and combination, to the improved distribution of industry, to the possibilities of complete utilization of productive capacities, to socialist forms of labor, and to the active, creative participation of workers in the struggle to improve plant operations.

Although there are many varied ways to lower net production cost, they are general for all branches of industry.

The intra-production factors in lowering cost are: increase in labor productivity, economic consumption of raw materials, materials, fuel, and other types of energy, complete utilization of productive capacities, efficient control of production and reduction of administrative expenses, elimination of all types of loss and nonproductive waste.

Each of these factors has a varying effect on forming net production cost and depends on the nature of the technological process.

There are labor intensive types of production in non-ferrous metallurgy (mines), where expenses for labor, material production (dressing plants, metallurgical factories) take up the largest amount of production expenses, where expenses for past labor predominate (raw material, materials), and energy-consuming production (for example, aluminum and magnesium factories), where the expense for energy is very great.

As a whole, non-ferrous metallurgical production is characterized by high production costs, and plant construction requires large capital outlays.

Net production cost in monotypic plants in non-ferrous metallurgy varies, depending on the level of technology, geographic location of the plant, cost and quality of raw material which is needed, fuel, energy, and level of production organization. In every plant there are more or less unused reserves for lowering net production cost.

By analysis and study of the operations in each plant, the hidden reserves must be detected, and measures taken to lower net cost, taking into account the nature of the technological process.

An increase in labor productivity is the main factor which can reduce net cost in mining plants. The main conditions for growth of labor productivity in these plants are: mechanization and automation of ore extraction processes, introduction of progressive technology and

advanced methods for labor and production organization.

As has already been pointed out, during the Seven-Year Plan there will be widespread use of open pit operations and highly-productive systems for underground ore extraction. Operational technology will be improved by the use of highly-productive equipment. A change to highly-productive operational methods must be accompanied by an improvement in labor and production organization. The organization of brigades, in which each member has mastered several skills, is of great importance. All of these measures will make it possible to raise labor productivity of mining workers, to eliminate a great amount of idle time, to provide conditions for rhythmical operation of technological processes, and to lower the net cost of ore. Mine face workers in non-ferrous metallurgical mines comprise 20-30% of the total number of workers. Work practices of the miners have shown that a growth in productivity of the mine face workers does not solve the cardinal problem of raising mine productivity where a large number of workers are occupied with auxiliary operations. In underground ore extraction, 40-50% of the workers are occupied with auxiliary operations (servicing transportation vehicles, ventilation, material delivery, repair of equipment). Due to this, labor productivity per one underground worker is 2-2.5 times lower than that for face workers taken alone.

One basic way to increase labor productivity among underground mine workers is widespread introduction of complex mechanization, and remote control by automatic processes. This would make it possible to reduce sharply the number of couplers, signal men, workers repairing and servicing ventilation apparatus, pump mechanics, and workers in other specializations. If mine face workers mastered several specialized types of work, this would free a large number of mechanics and blasters.

A large number of workers service operations at the surface of the mine, and in many instances these workers comprise 20-30% of the total number of workers. As a result, the general productivity index per one mine worker is 3-5 times lower than that for the mine face workers. The automation of elevator, ventilation, compressor, and heating equipment, the mechanization in servicing the boiler equipment, the preparation of shoring, transportation and loading-unloading work on the mines' surface, and also the transition to a centralized supply of spare parts and steel fittings will bring about a sharp decrease in the number of auxiliary workers at the surface. This will also increase labor productivity per worker. There are great possibilities in arranging self-servicing for the ventilation and lighting arrangements.

If all the measures mentioned above were put into practice, it would decrease the amount of labor intensive work and the net cost of ore which is very important for non-ferrous metallurgy. Another way to lower net cost of ore is to use barren rock as gravel for building.

There can be considerable reduction of net production cost in dressing plants if material outlay on raw material, auxiliary materials, and electric energy is reduced.

Some basic ways to lower the net cost of processing ore and of producing a large metal output in metallurgical production are to increase

metal extraction and complex use of all raw material components, and to improve the quality of concentrates.

The correct selection of a dressing process, observance of an established policy for the technological process, use of advanced operational methods and industrial use of waste from the dressing process all provide for complete use of the raw material in the dressing stage.

In order to increase labor productivity in dressing plants, enlargement of crushing-grinding and other types of equipment, and a change to more productive classifying and flotation machines are of great importance. Remote control, automation of control and regulation of the technological processes, a radical change in the organization of equipment repair, and an increase in the durability of component parts of the equipment are of great significance.

The introduction of progressive norms for the consumption of reagents and electric energy has a great effect on lowering net cost of processing ore.

In the metallurgical industry, lowering of net cost must first of all be achieved by reducing raw material, fuel, and electric energy expense. Expenses for raw materials and materials comprise 30-50%, and often reach 70-80% and more; expenses for fuel and electric energy also comprise 18-30% and over, as compared to the total net cost per ton of production. Production of nickel and alumina belongs to the group consuming the greatest amount of fuel. The greatest electric energy consumption is required for aluminum, magnesium, and particularly titanium production. An increase in metal extraction, complex utilization of the raw material and production wastes (slag, dust, and gases) are fundamental problems on which reduction of net production cost rests.

These problems can be solved if qualitative preparation of the raw material for processing, its neutralization, introduction of a new technology, and an optimum regime for technological processes are all carried out.

An economy can be effected in fuel, and often intensification of the technological processes, as the experience of several copper plants has shown, if secondary energy resources are utilized. Thus, for example, in the Kirovgradskiy Copper Combine, a tubular air preheater and a boiler-utilizer were set up for the reverberatory oven. The waste gases of the reverberatory oven fell first in the boiler-utilizer, which made steam for manufacturing electric energy, and then passed into the air preheater for heating the secondary air which entered the reverberatory oven. The boiler-utilizer and the recuperator used $\frac{2}{3}$ of the heat from the waste gases, as a result of which the plant saved about 19,000 tons of conventional fuel per year. In addition, the heated air entered the reverberatory oven and increased fusion of the charge by 18-20% while reducing the fuel consumption by 8-12%.

The Pyshminskiy Copper Electrolyte Plant uses heat from waste gases from anode and wire bar ovens, which produces a savings of about 25,000 tons of conventional fuel.

In the Krasnoural'skiy Copper Combine, heat from the slag from the reverberatory ovens is used to heat the building.

However, such examples are still isolated in non-ferrous metallurgical plants. In the majority of plants, insufficient attention is paid to the possibilities of using internal secondary energy sources.

Our country spends billions of rubles yearly on expanding the output of different types of fuel, which in many cases is burned up with a low utilization coefficient, on the order of 15-20%. Plant operations have shown that utilization of waste slag is an important way to lower net cost. Waste slag which does not contain non-ferrous metals can be widely used as a construction material.

The large expenses on equipment repair in non-ferrous metallurgical plants can be lowered by increasing durability of the component parts, using highly-resistant materials, organizing rapid repair work, centralizing production of spare parts, and increasing the durability of tools. These measures would make it possible to increase the lifespan of equipment, to reduce expenses for spare parts and tools, to reduce considerably the amount of repair work and the need for repair workers, which presently comprise 25-30% the total amount of plant workers. As a result, labor productivity can be raised, an additional amount of production can be turned out, and its net cost lowered.

Another way to lower net production cost is the complete use of the operational time of equipment and its capacities, along with the productive capacities of the section, works, and plant as a whole. In many non-ferrous metallurgical plants, there are great reserves in this field, primarily in plants where equipment is poorly utilized in terms of time (only 40-60%) and of capacity.

There are great differences in the scope of these indexes between the advanced concentrating factories and metallurgical plants and the average indexes for the field as a whole.

It is necessary to raise the level of production organization higher. An increase in the level of planning, both branch planning and intra-plant planning, is very important. Defects in this area cause inefficient transportation of the raw material, as a result of unsatisfactory planning, and also due to discrepancy between development of a raw material base and the productive capacities of dressing plants and metallurgical factories in individual rayons.

The Seven-Year Plan provides for the elimination of these defects by the improved distribution of non-ferrous metallurgical plants and the efficient development of cooperation. An improvement in utilization of productive capacity makes it possible to increase production volume and to lower net cost.

Further development of innovation and inventiveness is of enormous importance in the struggle for material and labor savings. Throughout industry as a whole, by 1958 there were more than 1.5 million innovators and inventors in the USSR. They introduced 2,700 ideas, from which many were used in production and saved the country more than 8.5 billion rubles yearly. There are thousands of innovators and inventors in non-ferrous metallurgical plants. With their active participation in plants, mines, dressing plants, many technological improvements have been made, and millions of rubles have been saved. Each year

the number of innovators and inventors increases, and the amount of ideas grows which are put into practice. Thus, for example, in the Ural'skiy Aluminum Plant, the number of innovators doubled by 1958, and the number of ideas which were introduced tripled; each fifth worker became an innovator. In the Ural'skiy Aluminum Plant, the yearly saving from these ideas amounted to 8.5 million rubles. This example is typical for many non-ferrous metallurgical plants. Defects in organizing innovating work must be removed; in particular, delays in considering innovating ideas must be removed, descriptive agitation must be improved along with propaganda activity of the innovators, and brigades must be created for innovating and inventing activity.

The struggle to save material resources demands that non-financing by the State be increased. As a general index, net cost is an instrument in cost accounting and of control over the spending of government capital.

Cost accounting promotes the introduction of an economical policy in handling production, creates a material incentive for improving the end product of labor and for economizing on capital expenses.

In many non-ferrous metallurgical plants, cost accounting is still very slight. Brigades have not changed over to cost accounting to a sufficient extent. In spite of the difficulties, there are individual plants which have been able to organize interworks, works, section, and brigade cost accounting. By way of an example, the experience of the northern Urals bauxite mines can be cited. The workers were given an incentive to bring about savings in material resources above those called for by the plan. Plans were formed and carried out in the northern Ural bauxite mines for changing over the brigades to cost accounting along with a system of awards for saving materials. According to this system, a brigade which had fulfilled or over-fulfilled its assignment of ore extraction received up to 30% of the cost of the materials saved, depending on the type of material saved, if there had been high-quality work, or no violation of labor discipline or technical safety.

Use of the personal incentive principle made it possible for this plant to change many brigades over to cost accounting and to effect a considerable economy. This valuable experience should be carefully studied and widely disseminated.

In order to introduce cost accounting successfully, qualitative norms for the consumption of material resources are very important. At the present time, not all of the norms for material, energy, fuel, and other types of consumption are progressive. Usually, statistical norms derived from experience for the consumption of materials, energy, and fuel, predominate and are corrected from year to year. The important task of changing from statistical norms based on experience to norms based on technology stands before these plants. In order to effect cost accounting, it is necessary to study their economic activity during a year, to make an analysis of the course of the plan's fulfillment in a division and in the plant as a whole, to discover the reasons for deviations from the plan, and to discover the internal resources not being used, and to use them.

Great attention must be given to the technical-economic basis of technological processes during the Seven-Year Plan. An increase in economic efficiency of the new technology will have enormous significance for the national economy.

Unsound economic indexes, or incomplete or inflated figures are used in many plants and in planning and research organizations making plans for new technological processes, for new equipment, or for selecting a method of mechanization or automation. This points to the necessity of increasing the attention given by plant directors to the indexes for economic efficiency of a new technological process and of analyzing them. It is essential that plans for introducing a new technological process be in content and form technically and economically sound. Great attention must also be given to increasing the role and responsibility of workers in economic divisions of plants and institutes for introducing highly-effective, progressive technological processes, and for discovering internal production reserves and using them.

The main trends which have been considered above in lowering net cost show that in non-ferrous metallurgy there are great possibilities for doing this and that their realization depends on us. According to the calculations of the Giprotsvetmet, the Giproalyuminii, Gipronikel, during the Seven-Year Plan reduction in net cost of the main non-ferrous metal will be 20% for aluminum, 25% for copper, 15% for lead and zinc, and 21% for nickel.

The 21st Congress of the Party has demanded that all economic and Party organizations greatly improve economic operations in all fields of economic and productive activity.

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The Soviet people are setting out to fulfill the Seven-Year Plan with enormous enthusiasm. Industrial workers, inspired by the historic resolutions of the 21st Congress of the CPSU and the June Plenum of the CPSU Central Committee (1959) are developing a national, socialist competition to fulfill the Seven-Year Plan with the least labor, material, or monetary expense. Successes in fulfilling the national economic plan before 1959 show that in the first year the plan will be fulfilled ahead of time, and will be considerably over-fulfilled. The collectives of many non-ferrous metallurgical plants have joined the ranks of those competing for fulfillment ahead of time of the Seven-Year Plan.

The collective of the Ural'skiy Order of Lenin Aluminum Plant has decided to complete the Seven-Year Plan one year early, to increase by 19% the aluminum output, and to save not less than 60 million rubles by innovation and invention.

Metallurgists of an enormous lead-zinc combine, in considering their possibilities, decided to complete their yearly plan ahead to time, to turn out 55 million rubles worth of additional production, to lower net production cost and to overfulfill their inventory assignment by not less than 10 million rubles, by increased complex utilization of the raw material and by extracting more metal than called for by the plan, to turn

out additional production worth 9.5 million rubles, and to put into practice not less than 600 innovating ideas, with a resultant yearly savings of 6 million rubles.

Miners in the Degtyarskiy Mine have taken on the responsibility of fulfilling the Seven-Year Plan one year early, and to lower net cost and increase labor productivity beyond that called for by the plan.

In 1959, non-ferrous metallurgical plants pledged themselves to produce more than 600 million rubles worth of production beyond that called for, to lower net production cost, resulting in more than 125 million rubles savings, and also to introduce about 40,000 innovating ideas, with a yearly savings of about 300 million rubles.

Carrying on the struggle to fulfill the Seven-Year Plan, the workers in non-ferrous metallurgy, as well as workers throughout the country, have achieved enormous successes in fulfilling the plan for the first year.

The State Plan for the first half of 1959 was overfulfilled for production of the most important metals, among which were the production of refined copper, lead, zinc, aluminum, tin, magnesium, molybdenum, nickel, cobalt, and titanium. In comparison with the preceding first half of 1958, labor productivity rose by 9%.

In 1959, a number of new non-ferrous metallurgical plants went into operation, among them the Stalingradskiy Aluminum Plant.

But the Soviet people cannot and must not rest on their achievements.

The June Plenum of the CPSU Central Committee (1959) called on the Soviet people to develop competition even more widely for the fulfillment ahead of time of the Seven-Year Plan for technical progress. It is necessary to discover further internal productive reserves, to struggle for improved utilization of productive capacity, for high labor productivity, for complex mechanization and automation of production, for improvement and introduction of new technological processes, for an increase in metal extraction, and for a reduction in net production cost.

The experience of those in the vanguard and the innovations of innovators and inventors must be widely disseminated, and the union between workers in science and industry must be solidified.

The experience of the advances enterprises shows that non-ferrous metallurgy possesses enormous possibilities for fulfilling the Seven-Year Plan ahead of time.

Workers in non-ferrous metallurgy, inspired by the program of communist construction, are expending all their energies in fulfilling and overfulfilling the plans, in the name of further strengthening the power of the socialist Motherland, in the name of improving the life of the people, and in increasing their material and spiritual welfare.

Fulfillment of the Seven-Year Plan for developing the national economy between 1959-1965 is the most important stage in the world economic competition between two systems - the socialist and the capitalist systems.

With the fulfillment of the Seven-Year Plan, the Soviet Union

will occupy the leading position in Europe in terms of industrial per capita production.

The superiority of the USSR in rate of production growth will create a real basis for catching up with and surpassing the per capita production level in the USA by 1970, and to occupy first place in the world in terms of the absolute production level as well as per capita production.

The role of the Soviet Union and the entire socialist system is constantly growing in world industrial production. In 1958, the USSR percentage in world production was almost 20%, but more than half of world industrial production will belong to the USSR with the fulfillment of the Seven-Year Plan and the rapid economic growth in all countries of the socialist camp. This will be a victory for socialism in the world competition with capitalism.

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