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SOVIET NONFERROUS METALLURGY

NO. 11

SELECTED TRANSLATIONS

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Introduction

This is a serial publication containing selected translations on nonferrous metallurgy in the Soviet Union. This report contains translations on subjects listed in the table of contents below.

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a. The Work of Scientists in the Field of Mechanization  
and Automation in Nonferrous Metallurgy

Following is a translation of an article by Sh. Chokin in Narodnoye Khozyaystvo Kazakhstana (National Economy of Kazakhstan), No. 11, November 1959, pages 14-21.

During the period of the advanced building of Communism the problems of technological progress, over-all mechanization and automation of production processes, and specialization and cooperation in all branches of the national economy acquire a particularly great importance. Technological progress is inseparably tied to the advancement of science. Thanks to the efforts of Soviet scientists, our country is among the world's leading countries in the level of technological progress in the principal branches of national economy; the Soviet Union leads the world in a number of the principal fields of knowledge.

A definite contribution to technological progress is being made by the Academy of Sciences Kazakh SSR. In the last few years alone our scientists have executed a number of extremely important projects relating to the creation of new techniques and progressive technology for the leading branches of the national economy of the Kazakh Republic, particularly for nonferrous metallurgy and ore-mining industry.

The Academy of Sciences has developed the so-called cyclone method of smelting copper ores and concentrates. The productivity of the furnace smelting space at this method is 30 times as high as at the regular reverberatory-smelting method. The then obtained mattes contain one and one-half to two times as much copper as do the mattes of reverberatory furnaces. This in turn greatly accelerates the subsequent operation -- converting. Further, the consumption of fuel on smelting is nearly halved.

At present, the Academy's scientists are, in collaboration with the workers of the Balkhash Mining and Metallurgical Combine, successfully completing their tests of the smelting of copper concentrates in a high-productivity semi-industrial cyclone installation. The conversion of the metallurgical shop of the Balkhash Combine to cyclone smelting will make it possible -- within the same production space -- nearly to double the smelting-out of copper, improve the working conditions, cut drastically fuel consumption, and obtain thousands of tons of sulfuric acid annually.

The cyclone method of smelting is extremely effective

also for retreating a number of materials, e.g., the old slag heaps of lead plants, zinc cakes, intermediate products of concentrator plants. At the Ust'-Kamenogorsk Lead-Zinc Combine zinc cakes (slimes of the hydrometallurgical processing of zinc) are retreated in tubular furnaces. The daily retreatment rate of such furnaces is by no means very high. This involves a process evolving at low temperatures, and therefore copper and precious metals remain in the wastes -- clinker -- whose subsequent retreatment is extraordinarily difficult. A cyclone furnace is economically more convenient and has a high productivity, and moreover it serves to recover completely copper, lead, zinc, and precious and rare metals, so that only slags remain in the wastes. The Irtysh and Leninogorsk Combines have accumulated millions of tons of slags containing as much as 10 percent zinc and 30 percent lead. Such slags are at present retreated in fuming furnaces. However, fuming furnaces are designed for retreating only pre-melted slags, a circumstance which causes additional consumption of fuel. A cyclone furnace, on the other hand, in the course of the smelting of slags, recovers lead, zinc and rare metals without requiring any special preliminary preparation of the slags. Thus, the process will make it possible to include into the national-economic turnover the old slag heaps accumulated in enormous quantities on the plants.

A considerable effect is to be expected also from the introduction of the cyclone method in ferrous metallurgy. Preliminary estimates show that this will make it possible to obtain steel directly from ore (by-passing the pig iron stage), and thus to dispense with expensive coke and giant blast furnaces. It may be assumed also that this method will find broad application in chemical technology, petroleum cracking processes, etc.

Complex tasks are posed to scientists by the problem of an efficient retreatment of the ores of Dzhezkazgan. The largest copper deposit in the USSR, Dzhezkazgan is actually a poly-metal deposit containing lead, zinc, silver, a number of valuable secondary components and dispersed rare metals. In terms of value, copper accounts for 42 percent, and the share of the dispersed elements totals another 42 percent, while lead, zinc, iron and sulfur account for the remainder. However, the present technology of the beneficiation and metallurgical processing of Dzhezkazgan ores makes it possible satisfactorily to recover into marketable production only copper and silver out of the 18 valuable elements contained in these ores. The percentage of the recovery of lead is low, and selenium and tellurium are recovered to a very limited extent, while zinc, iron, sulfur, cadmium, gall-

ium, molybdenum, tin, and antimony are completely forfeited. The value of the released commercial production is no higher than 40 percent of the value of the valuable elements contained in the raw ore.

The principal reason for such an unsatisfactory utilization of the ultra-rich ore raw material of Dzherzkazgan lies in the inappropriateness of the pyrometallurgical processes applied there -- processes oriented toward the recovery of copper alone. At a time when the demand of the Socialist industry for nonferrous and rare metals is growing, any further such unilateral utilization of a most valuable raw material becomes intolerable. Scientists are persistently exploring the ways and means of expanding drastically the comprehensiveness of the utilization of Dzhezkazgan's sulfidic raw material.

The spirit of inquiry is oriented toward developing methods of beneficiation that would make it possible to concentrate the maximal amount of valuable elements in bulk concentrates and to isolate low-value dump tailings that could be utilized for construction and other purposes. Subsequently, these concentrates should be directly retreated by novel metallurgical procedures without any prior selective flotation. The development of these procedures is advancing in two directions. The first direction consists in the direct hydrometallurgical retreatment of bulk concentrates on the basis of the methods of fine chemical technology. This assures the recovery of not only nonferrous, rare and precious metals but also iron and sulfur in elementary state. The other direction is oriented toward the prior pyrometallurgical smelting of concentrates in cyclones or electric furnaces or in suspended state. Then the nonmetallic mineral components are extracted from the ore in the form of a non-ferriferous slag, while the valuable components are concentrated in mattes and fumes which are further retreated hydrometallurgically.

The results of the conducted laboratory experiments and technical-economic calculations have shown that, at present, bulk flotation with direct hydrometallurgical retreatment of concentrates is the most promising method of retreating all the varieties of the sulfidic ores of Dzhezkazgan. Such a scheme will yield, in addition to copper, lead, zinc, iron, sulfur, selenium, tellurium, rhenium, indium, and other dispersed elements. In the immediate future, this method, offered by Academician of the Academy of Sciences Kazakh SSR A. L. Tseft, should be tested industrially in the enterprises of Dzhezkazgan and Balkhash.

A great deal of work has been done in the Academy of Sciences with regard to obtaining pure metals from the dusts

of metallurgical production. In particular, the amalgam method of obtaining pure thallium from such dusts has been introduced at the Chimkent Lead Plant. Now thallium is one of the most valuable rare metals, widely used in the production of high-quality steels, in the manufacture of photocells and optical glass, and in radio engineering, telemechanics, pyrotechny, etc. The raw material for obtaining thallium is constituted by the semifinished products and wastes of the processing of sulfidic ores. In particular, in the lead plants, a considerable percentage of thallium is contained in the metallurgical dusts forming during the sintering of agglomerate, because the content of thallium in these dusts is incomparably higher than in the starting product -- lead concentrates.

The existing technology of the production of thallium is, considering the small content of that element in the re-treated material, complex and cumbersome. It involves a number of labor-consuming processes, and it entails the consumption of a great deal of various materials and the loss of a part of the basic metal -- thallium. The considerable expenditures on the production of thallium and the negligible recovery of that metal cause it to be a highly expensive one and this, of course, cannot but impede a broad use of thallium in the national economy.

The fundamentally new technological scheme of obtaining thallium from metallurgical dusts, as offered by the Academy of Sciences of the republic and by Kazakh State University, is based on the amalgam method. This method of recovering thallium currently appears to be the simplest one, and one not requiring high expenditures of reagents and materials, not to mention the fact that it serves to obtain a metal with a high degree of purity, on recovering thallium from dust into metal to the extent of 40-42 percent. This new technological scheme was materialized on an enlarged installation at the Chimkent Lead Plant. That plant has built an experimental industrial installation producing planned marketable thallium metal.

Throughout a number of years the Academy's scientists have been working on the problem of intensifying the extraction of crude in the Emba Region. In particular, they have been exploring the ways and means of utilizing the energy of the side-recovery gas from the gushing oil wells. The existing technological scheme in operation at many crude extraction establishments in that Region does not ensure the separation of gas from crude and its high-pressure uptake. As for the construction of compressor installations, it is extremely costly and it requires scarce equipment and a detailed exploration of gas reserves. All this virtually ex-

cludes the possibility of an industrial utilization of the excess gas which has heretofore been uselessly burned in torches in situ. The scientists of the Academy of Sciences have succeeded in developing a new technological scheme ensuring the utilization of such petroleum side-recovery gas for increasing the extraction of oil from deposits. At the Kulsary Oil Deposit a project drafted by these scientists has served as the basis for constructing an installation for the high-pressure separation of side-recovery gas from the gushing oil wells, and a scheme for the compressorless pumping of that gas into the depleted oil horizons for the purpose of creating water-and-gas re-pressure in these horizons, and for the accumulation of gas in other horizons as well. The new scheme has successfully passed prolonged industrial tests.

The Academy of Sciences has worked out methods of obtaining new high-active, stable and inexpensive petroleum-cracking catalysts from "monrakskaya" bentonite, and it has investigated their characteristics circumstantially. This year these catalysts have passed successfully their industrial tests on a pilot installation at the Gur'yev Oil Refinery.

The scientists of the Academy of Sciences are successfully conducting research in the over-all mechanization and partial automation of processes of ore extraction by the underground method, in particular processes of the gouging out of ore and its conveyance to the mine shaft, which account for 80-90 percent of the labor input required by the complete cycle of extraction.

They have developed a progressive method for the mechanization of mining operation on the basis of large-capacity trackless self-propelled drilling, loading and transporting machines making it possible to increase 2.5-3 times the labor productivity of underground miners and to cut drastically the ore extraction costs. For this purpose, the scientists have suggested a number of new high-productive machines: self-propelled drill carriages for stoping and entry work, a telescoping shovel for stopes, an electric automatic dumper, a lifting bulldozer, etc. To test these and other new self-propelled machines, the Dzhezkazgan Ore Administration has established in its Mine No. 45 an experimental sector where, for the very first time in the Soviet Union, trackless equipment has operated with very great success during the past year. If the conversion of the Dzhezkazgan Ore Mine Complex to the new technology is materialized within the next few years, then the planned increment in the ore output there could be achieved without expanding the labor force currently available at the enterprise. That technology should also be success-

fully introduced in many other ore-mining enterprises as well.

The Academy of Sciences is also conducting major researches in the field of the automation of the technological processes of ferrous metallurgy. Its scientists-chemists have developed methods of electrolytic production of zinc at high current densities. This process makes it possible to mechanize the peeling-off of cathode metal and to conduct it on a continuous basis and, by the same token, to eliminate the arduous physical labor involved in the removal of zinc sediments from electrodes and to improve the salubriousness of the shop atmosphere. At present this method is being tested on a larger scale. At the Ust--Kamenogorsk Lead-Zinc Combine finishing touches are now being put on the assembling of an experimental electrolyzer installation which will be set in operation in the immediate future for testing purposes.

The Academy's scientists have also developed a large number of automation instruments for nonferrous metallurgy. They have devised an electromicrometer -- a device for measuring the thickness of the moving strips of nonferrous metals and their alloys. That device has been successfully introduced at the Balkhash Nonferrous Rolled Stock Plant. Other instruments to be developed and industrially tested were: a universal electronic polarograph, a photo-electronic colorimeter, an automatic universal titrator, all of which can be utilized in the capacity of sensors for automatic chemical control in nonferrous metallurgy. Also developed was the scheme of a device for the automatic [assessment of the] content of copper and other nonferrous metals in the tailings of concentrator plants. The drawing mills will eventually be provided with a photo-electronic device for measuring wire diameter, drawing speed and wire stretching; in addition, an electronic model of a uniflow drawing mill is being worked out. Of great importance are the researches being conducted in the application of the photoelectronic spectograph to the automation of the analysis of industrial gases in nonferrous metallurgy.

In accordance with the decisions of the 21st CPSU Congress the Academy of Sciences Kazakh SSR has drafted a seven-year plan of its scientific research. In that plan considerable attention is paid to topics concerning a further rise in the level of technological progress. The Academy of Science has reserved about a half of its scientific staff and funds for developing the research problems of such leading branches of the republic's national economy as ore-mining, coal, and chemical industries, ferrous and nonferrous metallurgy, and power industry.



lurgy, and power industry.

In the field of mining, the Academy's scientists will explore new progressive methods of underground and open-pit development of deposits, design highly productive models of mining equipment, perfect the technology of blasting operations, and solve the problems of improving the working conditions of miners. Plans exist for developing and introducing in the mines of Dzhezkazgan and Achisay a new highly productive method of extraction based on self-propelled equipment, which raises labor productivity steeply.

The researches in the intensification of the development of deposits by the open-pit method will encompass the problems of the organization of pit operation on "continuous-flow" basis and the introduction of new types of drilling equipment based on the principle of thermal and electrohydraulic effects.

Plans exist for continuing the work on the devising of new physical methods of the disintegration of rocks. The topics concerning a healthier atmosphere in the mines have been expanded. An extensive program of research has been adopted with regard to the intensification of the extraction of petroleum specifically in the Emba Region. Plans exist for developing improved methods of the drilling of wells and exploitation of deposits -- water-and-gas re-pressure, thermo-hydraulic flooding, application of high-frequency currents.

In the field of metallurgy the principal aim of scientific research for the present seven-year period is the development of methods of a comprehensive recovery of all valuable components from the polymetal and iron ores of Kazakhstan. Plans exist for elaborating the procedures for improving the technology of the beneficiation of the polymetal ores of the Tekeliy Deposit and of the copper ores of the -- country's largest -- Dzhezkazgan Deposit, and for perfecting the metallurgical processes of nonferrous and ferrous metals and rare and dispersed elements. In particular, research in the afore-described cyclone method will be conducted on a broad front. This method is expected to be industrially tested on a large scale with regard to its applicability to not only the concentrates of Dzhezkazgan, Nikolayevskiy and other deposits of polymetal copper ores but also iron ores.

The research program of the Academy of Sciences in ferrous metallurgy has been greatly expanded, especially regarding the development of new technological processes for a comprehensive retreatment of the ores of ferrous metals. Plans exist for the development of efficient methods of processing the rare-metal ores of the Batystau and Verkhnyye

Kayrakti deposits. The physicochemical and other properties of rare and dispersed metals will be omnilaterally investigated and the technological schemes of their recovery will be perfected. The object of this research will be the rare-metal ores of the Karazhal, Verkhnyye Kayrakti and other deposits. One aim is to develop processing schemes that would yield the maximal possible recovery of valuable components.

A considerable potential for increasing the production of nonferrous metals is latent in the retreatment of metallurgical wastes. The research plan stipulates the development of fundamentally new technological schemes for the recovery of the most valuable metals from the wastes of metallurgical production on the basis of the newest achievements of electrochemistry, and the provision of theoretical and experimental foundations for obtaining highly pure zinc and its companion metals.

Plans exist for the elaboration of a number of the principal problems of the metallurgy of light metals as well, inclusive of the comprehensive processing of alumina-containing raw materials, and for research in simplified methods of recovering alumina from andalusites, bauxites and sericites for the purpose of providing the aluminum industry with a raw material base. Also, new types of fire- and acid-resistant refractories and silicate coatings will be developed for metallurgical plants.

With regard to chemistry, the plan of scientific research work of the Academy of Sciences is oriented toward solving the problems specified in the well-known decisions of the Party and State concerning the development of chemistry and chemical industry in our country. Large-scale research is planned in the field of organic chemistry, and particularly monomers and polymers. In particular, plans exist for an omnilateral investigation of certain products of the refining of Emba petroleum for the purpose of obtaining certain types of polymers and, on their basis, plastics. Of great national-economic importance will be the labors of our scientists on the development of methods of obtaining new types of mineral fertilizers and exploration of additional sources of sodium sulfate, which is in increasingly greater demand. In this connection, the phosphorites and natural salts of Kazakhstan are being subjected to physicochemical and technological studies....

b. We Are Adopting the New and Advanced in Production  
(at Nonferrous Metallurgical Enterprises)

Following is a translation of an article by  
K. Simakov in Narodnoye Khozyaystvo Kazakhstana  
(National Economy of Kazakhstan), No. 11, November  
1959, pages 25-29.

The decision of the June Plenum of the CC CPSU have inspired the workers of the enterprises of the East Kazakhstan Sovnarkhoz with the desire to struggle for a pre-term fulfillment of the Seven-Year Plan, and they have broadened the prospects for the manifestation of creativity in work. The plants, ore mines, pits, have become the sites of a drive for raising the technical level of production, for developing more fully the potential of the East Kazakhstan economic rayon and for utilizing its natural resources from the standpoint of gaining time. During the seven-year period the gross industrial product of the local Sovnarkhoz will increase 2.3 times, and the extent of its income will increase sevenfold. Such qualitative features of the economic development of the rayon are becoming feasible thanks to the steep rise in labor productivity, which assures nearly 70 percent of the increment in gross industrial product.

The rise in labor productivity is occurring mainly on the basis of the introduction of new equipment, mechanization of labor-consuming operations and automation of technological processes, and comprehensive utilization of raw materials as well.

The June Plenum of the CC CPSU has appealed to the workers of the mining and extracting industry for a broader employment of the roller method of deep borehole drilling, for the extraction of ore by the method of forced mass block caving, and for a more widespread mechanization of labor-consuming processes and automation of mining equipment. To fulfill these requirements, quite a great deal of work has been done in the ore mines of our economic rayon in the recent past. The mechanization of the conveyance of ore has been increased to 98.3 percent, and of the conveyance of bulk rock, to 94 percent, thanks to the introduction of heavy-duty scraper winches, large-capacity scrapers, etc. As a result, savings totaling 1,100,000 rubles have been achieved this year through a reduction in the costs of ore extraction. Thanks to the employment of the progressive method of drilling deep boreholes by indigenously produced rollers and

and pneumatic percutors, and thanks to the mastering of the production of new BA-100 drilling machines, the savings in production expenditures for the last six months alone had totaled three million rubles.

The recently established Special Design Bureau of Mining Equipment at the Leninogorsk Polymetal Combine has devised drilling rigs -- the LPS-3 machine and the P-150 pneumatic percutor -- which ensure a 20-percent rise in the labor productivity of drillers. The mass use of these rigs will yield a saving of not less than 2,500,000 rubles annually. The roller bit has passed its test excellently, ensuring a 75-percent rise in the productivity of drilling machines. The same Special Design Bureau has also developed, constructed and transmitted for serial production a pneumatic explosive charger, a gutter cleaner, a rubble breaker, and a number of other attachments for mining operations.

In the large ore mines of Leninogorsk and Zyryanovsk complete automation has been introduced in the lifting of ore by skip hoists, in most of the pumping installations for transferring mine water, and in the performance of the motor-generators for powering the haulage of ore by electric locomotives, and the underground transport of ores has been modernized by the introduction of an automatic signaling and block traffic system. This year over 1,000 running meters of reinforced-concrete props and 3,400 running meters of rod props have been introduced, and 2,500 running meters of props have been installed by the spray-on method. All these measures have made it possible considerably to raise labor productivity and to increase the extent and reduce the costs of ore extraction.

The technological processes of the beneficiation of the ores of nonferrous metals are being perfected, and its qualitative indexes are improving. At the Zyryanovsk Concentrator Plant, e.g., concentration by two-stage grinding and flotation has been commenced as of this year for the purpose of increasing the recovery of metals, and the Belousovka Concentrator Plant is, following the experiments at the VNIITsvetmet All-Union Scientific Research Institute for Design and Planning of Nonferrous Metals Industry. For the same purpose, making preparations for conversion to bulk-selective flotation. This year the use of rubber for lining the parts of flotation machines and pumps, which increases their longevity several times, is being widely applied. All this has made it possible to increase the recovery of metals in concentrator plants. The next stage will be the transition from the automation of individual units of the equipment and mechanisms of concentrator plants to the over-all automation of all large plants of this type.

Emulating the example of the Leninogorsk concentrators, the Zyryanovsk Concentrator Plant has mastered and commenced the fabrication of a new product -- pyrite concentrate, which is a raw material for the production of sulfuric acid. The pyrite concentrates of the Altay concentrator plants contain large amounts of gold and silver and in addition some copper, lead, zinc, cadmium, and rare metals, which had previously used to be dumped together with the concentration tailings. Now pyrite concentrate will be transmitted to the Dzhabul Superphosphate Plant for the production of sulfuric acid, whereupon the residue of that concentrate (pyrite calcine) will be returned to the metallurgical plants of our Sovnarkhoz. On replacing iron ore by pyrite calcine in the charge of lead metallurgy, it will be possible to recover the nonferrous and precious metals contained in that calcine. In the immediate future this will dispense with the need for importing tens of thousands of tons of iron ore from the Urals.

The difficulties that have arisen in the retreatment of pyrite calcine because of its tendency to form dust and to compact the charge are being skillfully resolved by the workers of the Ust'-Kamenogorsk Lead-Zinc Combine who have, in collaboration with specialists from the VNIITsvetmet, mastered the method of combining pyritic calcine with the moist lead-containing cakes of zinc production. The related experiments have yielded good results.

However, in the future the Dzhabul Superphosphate Plant will not be able to retreat all of our East Kazakhstan Sovnarkhoz pyrite concentrates. Therefore, the problem of retreating them by other methods as well has become actual. One such method has been developed by the workers of the Leninogorsk Polymetal Combine. Experiments in the retreatment of concentrates are also being conducted at the Ust'-Kamenogorsk Lead-Zinc Combine, where the pyrite concentrate, containing nonferrous and precious metals, will supplant completely the imported pyrite ore containing no other valuable elements except sulfur.

The Ust'-Kamenogorsk Zinc Plant annually accumulates a large quantity of zinc cakes containing much zinc and lead. To recover these metals, the construction of a special shop with facilities for retreating the cakes has been completed. In 1960 more facilities of this type will be installed in the shop. This will make it possible to retreat the previously accumulated and the new incoming zinc cakes.

The experience of the Ust'-Kamenogorsk Lead Combine in the retreatment of the slags of lead production was used as the basis for drafting the projects of three future shops for retreating all the current slags of lead and copper

smelting plants, and their accumulated old slags as well, so as to produce annually a large additional amount of lead, zinc and precious metals. Inasmuch as these slags contain more nonferrous and precious metals than the raw ore extracted here, therefore the profitableness of their retreatment is very high, and the capital expenditures this will incur are low compared with the expenditures on the construction of a new ore mine and concentrator plant. The construction of three slag-retreating shops will be carried out within two years, with its costs to be recouped within 17 months thereafter, whereas the construction of a new ore mine and concentrator plant would take about five years and its recoupability period would be 30 years.

The improvement in the quality of the concentrates of nonferrous metals is one of the most important measures for increasing the operating efficiency of metallurgical plants. The point is that because of the unsatisfactory selectiveness of concentration, out of the total amount of recovered lead from ore nine percent is recovered into zinc and copper concentrates, 13 percent of the zinc is recovered into lead and copper concentrates, and 22 percent of the copper is recovered into zinc and lead concentrates. During the processing of these concentrates into basic metals the other metals are either completely lost or recovered partially, in a complicated manner involving considerable expenditures of labor and funds. Moreover, this is detrimental to the basic production, by complicating the technological process.

If pure monometal concentrates could be obtained, the capacity of the metallurgical plants would increase 25-30 percent without any additional capital expenditures, and labor productivity would increase correspondingly, while production costs would decrease by 10-15 percent. This is confirmed by the fact that certain small less modernly equipped lead-zinc plants in our country, whose output capacity is three to five times as low as the output capacity of the plants of our Sovnarkhoz, attain a higher labor productivity and lower production costs, solely because they operate with more metal-rich concentrates. Such an improvement in concentrates could also be achieved by the concentrator plants of our Sovnarkhoz, but this would inevitably involve either an increase in the losses of nonferrous metals in the tailings or the obtainment of additional bulk concentrate.

Now, no reliable and simple method of processing bulk concentrate exists as yet. To solve this problem, the Gintsvetmet State Institute of Nonferrous Metals is engaged in a major experimental project concerning an electrothermal process.

The managers of the Ust'-Kamenogorsk Lead and Zinc Combine and the leading workers of the zinc plant have taken many creative measures to attain an old goal of metallurgists -- thorough cleaning of zinc solutions subject to the last zinc-converting operations -- electrolysis, so as to ensure a rise in current density which determines, as is known, the productivity of the electrolytic baths. They have, e.g., introduced the "fluidized-bed" roasting of concentrate and have replaced 16 filter presses of obsolete design by two totally mechanized condensing filters which automatically ensure a set degree of purity of solution. Other original methods of removing harmful admixtures from the solution have been also introduced. An installation for the production of a coagulant -- polyacrylamide -- whose introduction will accelerate the process of clarification of the solution, has been designed and constructed. A new method of removing cobalt from the solution by zinc dust instead of xanthogenate has been introduced.

All these complex and rational measures will make it possible to increase the productivity of the electrolytic baths by 15-20 percent in terms of their zinc output through an increase in current density without a decrease in the quality of the metal. In addition, these measures will drastically raise labor productivity and cut the costs of zinc production.

The metallurgists of the Combine are at present concerned with introducing the continuous refining of lead, mechanizing the removal of cathode zinc, and totally mechanizing the pouring of spelter. Next to come is the total automation of the performance of the "fluidized-bed" furnaces, and the mastering of the isolation of new metals from the processed raw material -- metals which in the past used to be irreversibly lost.

The metallurgists of the Irtysh Copper Smelting Plant have completed the construction of a large-capacity oxygen shop which will serve to intensify their smelting of copper. That plant also has installed machines for mechanizing the pouring of converter slag and blister copper and perfecting their conveyance. The conveyance of dusts has been mechanized by means of compressed air. The workers of the Leninogorsk Lead Plant have automated certain shaft-furnace parts, introduced self-cleaning grates for sintering machines, and converted the refining vats to electric instead of manual heating.

The problems of over-all mechanization and automation of production are also being solved in enterprises of the light and food industries and in the field of power development and capital construction. However, all this is

only the beginning of a great and intricate task which will have to be executed in order to realize the decisions of the June Plenum of the CC CPSU. We have still many unmechanized labor-consuming operations; a great number of people are still occupied with auxiliary and secondary operations; labor productivity, especially in underground ore-mine operations and in plant transport shops, is still low; considerable losses of nonferrous metals are sustained; and an excessive consumption of metal, fuel, electrical energy, and other resources, is still taking place. Likewise the situation is unsatisfactory with regard to the utilization of technology, instruments, machinery and equipment; damages, breakdowns, stoppages, etc., take place. All this incontestably interferes with normal operations and curtails the opportunities for a pre-term fulfillment of the Seven-Year Plan in our enterprises.

The principal task of all workers of the Sovnarkhoz and enterprises is to eliminate as rapidly as possible the shortcomings in operations on the basis of the methods and procedures indicated so clearly and concretely by the June Plenum of the CC CPSU. The Sovnarkhoz is taking measures for eliminating these shortcomings, for an improved utilization of the potentials and possibilities of its enterprises, for raising the technological level of its enterprises in accordance with the directives of the Party and State. A decision was adopted for reinforcing the existing design bureaus in enterprises and for establishing new such bureaus. Thus, with the Leninogorsk Special Design Bureau as an example, a special design bureau of electrical engineering industry has been established at a capacitor plant, etc. Branch-of-industry experimental shops are being established in appropriate enterprises for conducting operations on a broader scale and resolving complex problems. An experimental concentrator plant has been established with regard to the beneficiation of heavy nonferrous metals, and another such plant, to be opened in 1960, is being established for the beneficiation of the ores of light metals. In the field of the metallurgy of heavy nonferrous metals, an experimental shop has been built at the Ust'-Kamenogorsk Lead-Zinc Combine, and another such shop, to be concerned with metals of the lighter group, will be built by the end of 1959. Later on, yet another experimental shop will be built in a future machine building plant, and yet another such shop is being organized for the construction organizations as well.

All these experimental shops, and the design bureaus, research departments, and special design bureaus, will, in addition to their principal activities, have the duty of providing consultation and assistance to work innovators and



testing and developing both the accepted and the newly incoming labor-saving suggestions. In this connection, the branch-of-industry special design bureaus and experimental shops in enterprises are concerned with perfecting equipment and technological processes and promoting the development of labor-saving ideas as well.

The experimental shops (bases) should each consist of a testing department, department for repair, installation and adjustment of control and measuring instruments, a design bureau, machine shops, and a chemical laboratory. We will staff them with technicians and engineers who will be procured by freeing a part of the specialists occupied directly in the production shops, sections, and departments.

In all enterprises more support has been provided to research departments, or such departments have been established wherever they did not exist. These departments provide consultations and assist work innovators in conducting technological experiments in laboratories on experimental installations or directly under industrial conditions. If necessary, the research departments themselves develop or test the incoming labor-saving suggestions.

The activities of design bureaus, experimental bases and norming-and-research stations in our Sovnarkhoz are rigorously coordinated. Here a major role is played by the continually held production conferences in enterprises, which periodically examine the activities of the design bureaus, experimental bases, norming-and-research stations, and research departments. Technical and economic evaluations of the most important of the developed and introduced measures are provided by sections of the Technical and Economic Council, which provide considerable assistance to the Sovnarkhoz.

In the next few years, on the basis of the emphasis on the growth of the heavy industry, new qualitative changes should take place in all branches of industry. A decisive factor in these changes is the raising of the technological level of enterprises, widespread introduction of over-all mechanization and automation, and perfection of the organization of production. The omnilateral introduction of all that is most up-to-date, most advanced and efficient, all that promotes a pre-term fulfillment of the Seven-Year Plan, is a primary goal. This is precisely the goal toward which all activities of the engineers, technicians and workers of East Kazakhstan are oriented.

c. Comprehensive Utilization of the Ores of the  
Gay Deposit

Following is a translation of an article by F. I. Nagirnyak and V. N. Popova in Byulleten' Tsvetnoy Metallurgii, Tsentral'nyy Institut Informatsii (Bulletin of Nonferrous Metallurgy, Central Institute of Information), No. 10, May 1958, pages 10-13.<sup>7</sup>

The Gay Copper-Pyrite Deposit is located in the Southern Urals, and it is a large raw material base of non-ferrous metallurgy.\*

Bodies of sulfur-pyrite, rib-sulfidic, copper, and veined-disseminated sulfidic copper rib ores have been explored in that Deposit. Individual ore sectors are copper-nickel and contain as much as seven percent barite.

The ores of the Gay Deposit display numerous common traits characteristic of the ores of the Southern Urals (Sibay, Uchaly): massive or banded fine-grained structure, occasional predominance of pyrite over other minerals, sharp variations in the chalcopyrite/sphalerite ratio, and a small content of galenite. The metamorphism of the ores and their gangue manifests itself insignificantly, a fact which is typical of all pyrite deposits of the Southern Urals.

The qualitative mineralogical composition of all these ore types is analogous: pyrite is the predominant metallic mineral; the cupriferous minerals are represented by chalcopyrite, bornite, gray copper ore, and, to a very limited extent, by chalcocine. The ores of the cementation zone contain, in addition to the above-mentioned minerals, considerable amounts of covellite and chalcantite.

The other metallic minerals present include sphalerite, galenite and gold nuggets.

The gangue present in the ore bodies consists of quartzized quartz albitophyres, which are present in considerable amounts in the disseminated ores.

Both in the rib ores and in the disseminated ores the sulfides are interspersed with inclusions of quartz and, less often, sericite, carbonates, feldspars and gypsum.

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\* Cf. Tsvetnyye Metally, No. 10, 1957, page 12

The size of the concretions of metallic minerals varies broadly, from two or three microns to several centimeters, with most concretions lying in the 0.074-0.15 mm size range.

The composition of the ores of the Gay Deposit is very heterogeneous with regard to its content of secondary copper minerals and sulfate copper. The content of the secondary sulfides of copper varies from 14 to 70 percent, and that of sulfate copper -- from 0.5 to 13.2 percent, of the total content of copper in the ore. As for the ore's zinc, it is represented 94.0-98.0 percent by sphalerite.

Investigations by the Uralmekhanobr /Urals Scientific Research Institute for the Mechanical Concentration of Minerals/ established that the rib copper ores can be concentrated according to a simple scheme (Fig. 1), so as to yield copper concentrates and pyrite-containing tailings.

The flotation of this kind of ores is carried out upon grinding ore to the extent of 93.0-96.0 percent in the -74 microns size in an alkali lime medium and upon adding 650 grams of free calcium oxide per  $m^3$  of the pulp. The collecting agent used was butyl xanthate (80.0 grams/ton), and the frothing agent -- heavy pyridine (40.0 grams/ton). The flotation lasts 20 minutes. During the flotation of ores from the upper horizon it is necessary, in order to obtain satisfactory indexes of concentration, to use, in addition to lime, sodium sulfide (1.0 kg/ton) and cyanide (200 grams/ton).

Under such conditions, the ore yields a copper concentrate with a 16.0-percent content of copper and with a 94-percent extent of the recovery of copper from the raw ore.

The ores of Lode No. 5 (samples 1-2-3) have yielded copper concentrates with a 12.0-14.0 percent content of copper and with a 79.0-84.0 percent extent of the recovery of copper from raw ore.

The flotation of disseminated ores (according to the scheme illustrated in Fig. 2) with grinding to the extent of 85 percent in the -74 micron size, was conducted in an alkali lime medium upon adding 450-480 grams of free calcium oxide per  $m^3$  of the pulp and consuming 30 grams of butyl xanthate per ton and 20.0 grams of pine oil per ton. Flotation time -- 15 minutes. After the isolation of the copper concentrate the tailings of copper flotation were thickened to remove excess alkali. For the same purpose, the thickened tailings were doused with fresh water until the alkalinity of the pulp fell to less than 100 grams of free calcium oxide per  $m^3$  of the liquid pulp phase, and this was followed by the flotation of pyrite. This had yielded copper concen-

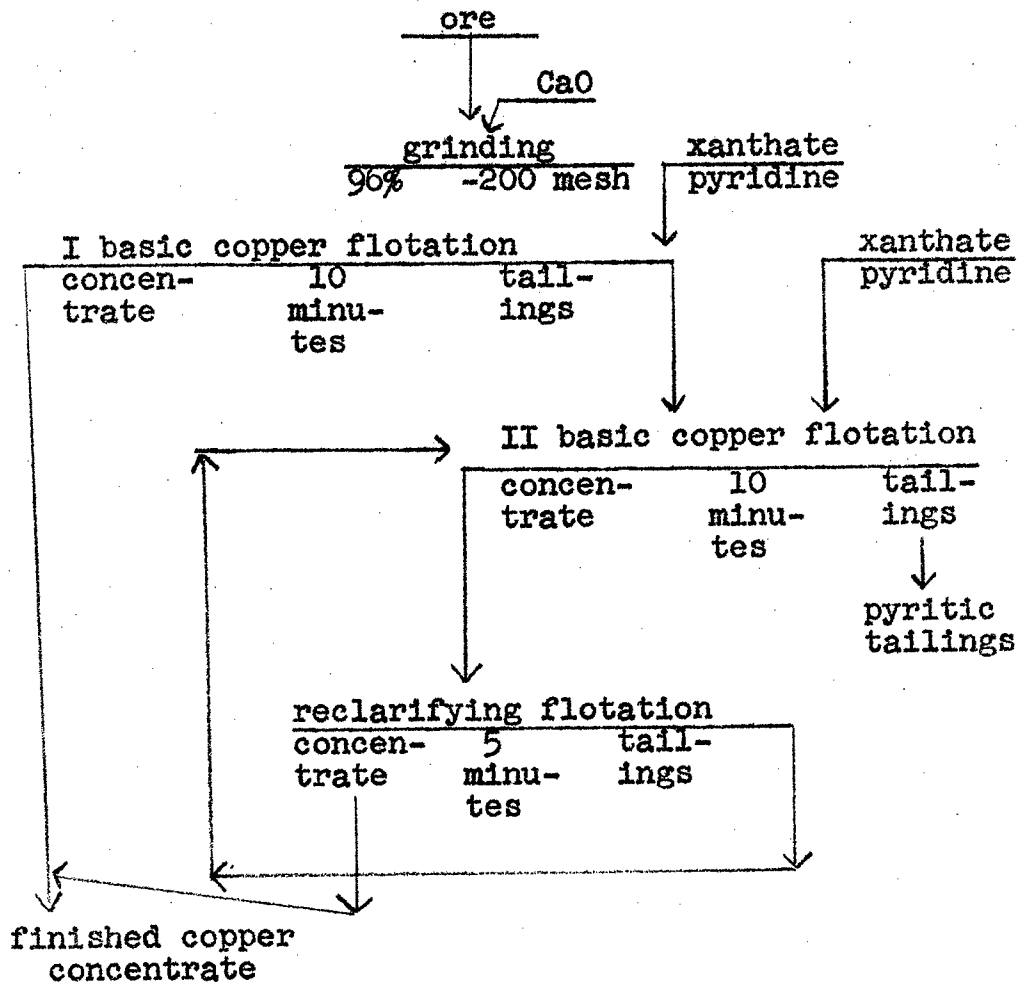


Fig. 1. Technological Scheme of the Concentration of Rib Copper Ores

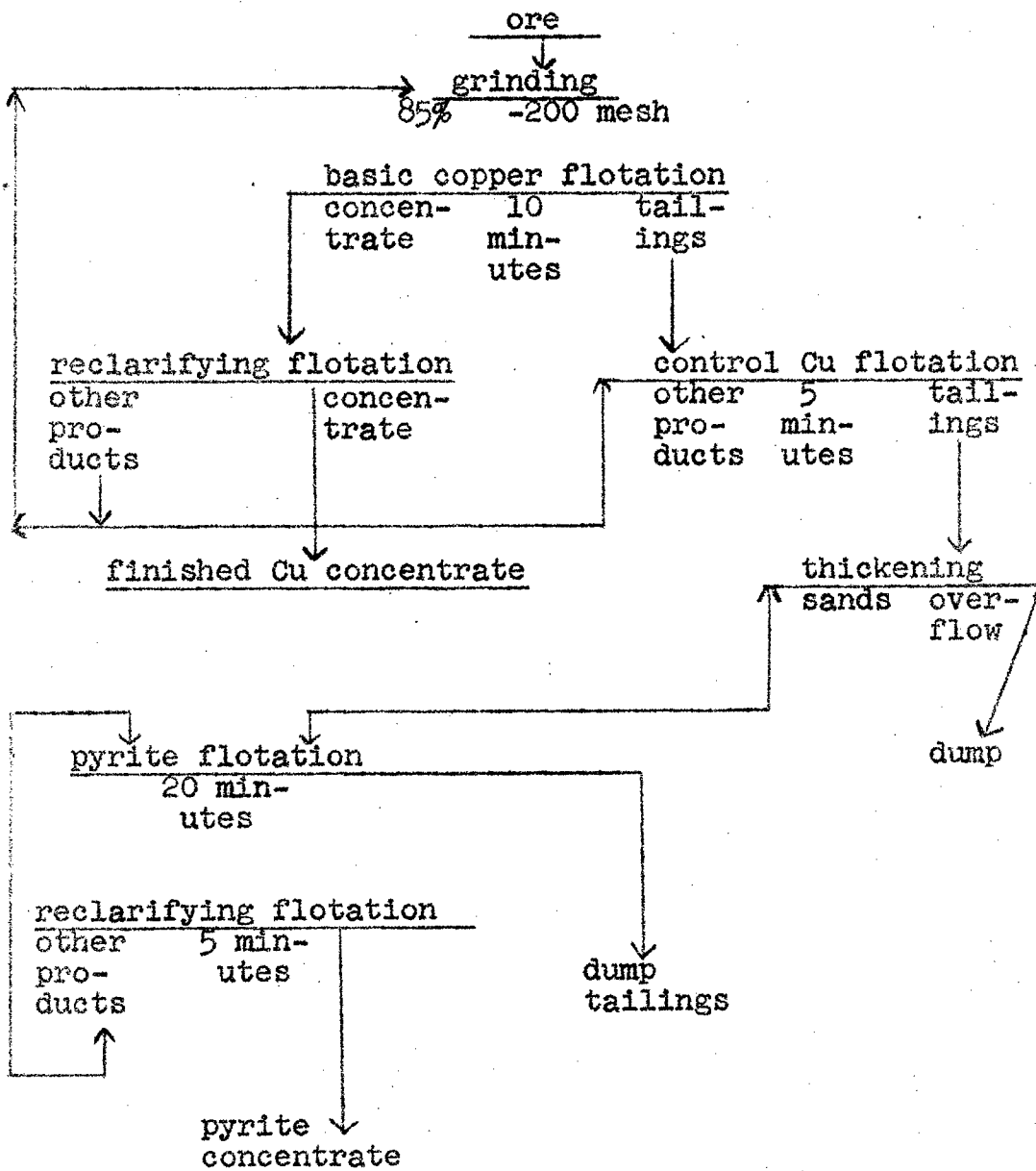


Fig. 2. Technological Scheme of the Concentration of Rib Sulfidic Ores With a High Pyrite Content

trates 13.0-20.0 percent Cu and pyrite concentrates containing 0.2-0.3 percent Cu and 44-40.0 percent S, with a 94.0-93.0 percent extent of the recovery of copper into the copper concentrate and 50.0-60.0 percent extent of the recovery of sulfur into the pyrite concentrate.

The rib sulfidic ores of one of the Deposit's lodes are characterized by a high content of copper and the presence of sphalerites. These ores yield, upon grinding to the extent of 93.0 percent in the -200 mesh size, according to the scheme in Fig. 2, a copper concentrate containing 13.8 percent Cu, 5.8 percent Zn, and a pyrite concentrate containing 51.4 percent S, 0.15 percent Zn, and 0.72 percent Cu, with a 98.5-percent extent of the recovery of copper into the copper concentrate and a 25.0-percent extent of the recovery of sulfur into the pyrite concentrate. Copper-zinc-barite ores are easily beneficiated and comprehensively utilized according to the scheme shown in Fig. 3 and according to the regime described in the Table below, so as to yield copper, zinc and barite concentrates.

The copper concentrate obtained from this kind of ores contains 19.0 percent Cu, and 4.35 percent Zn; the zinc concentrate -- 51.2 percent Zn and 2.0 percent Cu; and barite concentrate -- 87.0-90.0 percent barium sulfate and 2.0 percent sulfur.

The recovery of copper into zinc concentrate reaches 96.5 percent; zinc into zinc concentrate -- 50.0-55.0 percent; and barite into barite concentrate -- 60.0-65.0 percent. The other metals are recovered secondarily: lead and gold (80.0-89.0 percent) -- into copper concentrate; and cadmium (50.0 percent) -- into zinc concentrate.

A study of the technological features of the ores of the Gay Deposit demonstrates the real possibility of their comprehensive utilization by means of selective flotation upon the observance of the above-mentioned conditions.

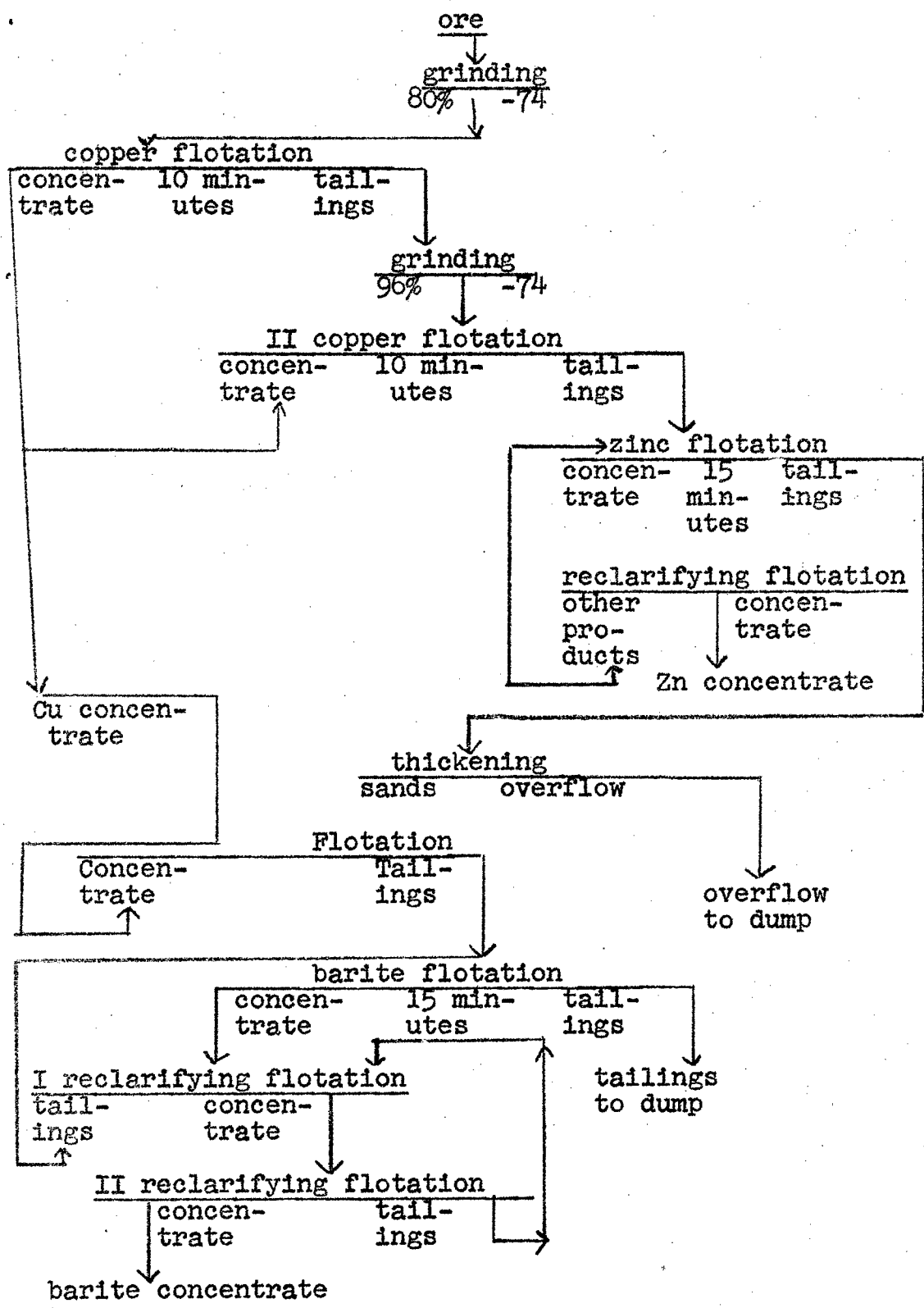


Fig. 3. Technological Scheme of the Concentration of Copper-Zinc-Barite Ores

Regime of Concentration of the Copper-Zinc Ores of the  
Gay Deposit (Lode No. 3)

Conditions of Grinding and Flotation, and Kind of Reagents and Purpose of Their Consumption	Consumption of Reagents, in grams/ton	
	First Stage	Second Stage
Grinding of Ore, percent in -200 mesh	80.0-82.0	96.0
Consumption of Reagents for Grinding:		
Sodium Sulfide	500.0	500.0
Zinc Sulfate	1000.0	1000.0
Cyanide	60.0	60.0
For Stirring Lime	2000.0	2000.0
	(CaO, 180 grams/m <sup>3</sup> )	(CaO, 300 grams/m <sup>3</sup> )
For the Copper Flotation Cycle:		
Butyl Xanthate	20.0	20.0
Butyl Aerofloat	10.0	20.0
Pyridine	40.0	40.0
Duration of Copper Flotation	10 minutes	10 minutes
Consumption, for the Zinc Flotation Cycle, of:		
Lime	4000/CaO	800 grams/m <sup>3</sup>
Copper Sulfate	500.0	--
Butyl Xanthate	50.0	--
Butyl Aerofloat	20.0	--
Pine Oil	30.0	--
Duration of Zinc Flotation	15 minutes	--
Consumption, for the Sulfide Flotation Cycle, of:		
Sodium Sulfide	200.0	--
Copper Sulfate	200.0	--
Butyl Xanthate	100.0	--
Pine Oil	60.0	--
Butyl Aerofloat	20.0	--

/Continued on next page/



[Continued from Page 22]

	First Stage	Second Stage
Duration of Sulfide Flotation	20 minutes	--
Consumption, for the Barite Flotation Cycle, of:		
Water Glass	500	--
Sodium Alkyl-Sulfate	400	--
Duration of Barite Flotation	15 minutes	--
Consumption of Lime for Reclarifying Zinc Concentrate	2000.0	(CaO 1200 grams/m <sup>3</sup> )
Consumption of Water Glass for Reclarifying Barite Concentrate	500.0	300.0

d. Copper Reduction During Fire Refining With Coaldust

Following is a translation of an article by Ye. V. Odegov in Byulleten' Tsvetnoy Metallurgii, Tsentral'nyy Institut Informatsii (Bulletin of Nonferrous Metallurgy, Central Institute of Information), No. 10, May 1958, pages 20-23.<sup>7</sup>

The blister copper obtained during the bessemerization of mattes contains sometimes more than 1.5 percent various impurities.

Below is cited the average chemical composition of the blister copper of the Noril'sk Copper Smelting Plant (in percent): 98.12 Cu; 0.59 Ni; 0.084 S; 0.0005 Sb; 0.094 Fe; 0.0003 Pb; 0.0007 Zn; and 0.0002 Bi.

This blister copper is subjected to fire refining in anode furnaces, whose normal performance graph at the above-named Plant is as follows:

	<u>hours</u>
Smelting	6
Oxidation of copper	2.5
Reduction ("poling")	3
Other operations:	
slag tapping, pouring,	
strengthening of banks,	
and charging of furnace	<u>11</u>
Total . . .	22.5 hours

The reduction of copper during fire refining at the Noril'sk Copper Smelting Plant was conducted by the method of poling with wooden staves. In this connection, the wood upon coming into contact with the molten metal becomes subject to dry distillation and the reduction takes place on account of gaseous reducing agents and solid carbon.

Recently, tests have been conducted for the purpose of supplanting the expensive -- in the conditions of Noril'sk -- wood by other reducing agents, particularly coaldust.

## Installation for Feeding Coaldust to the Anode-Furnace Bath

An experimental installation for reducing copper with coaldust was mounted in a 100-ton anode furnace. The coaldust was transported from a coaldust-preparing plant along a system of ducts and conveyed to the heating bins of the furnace. From the bins the coal dust proceeded by natural gravity flow, via a reducing pipe and a cone valve, into a chamber air pump and thence along hoses and 50-mm pipes it was blown through inlet ports into the furnace bath by means of ejector force pumps operating at 6-atmosphere pressure.

The experiments were conducted with pipes lined by a refractory paste consisting of 85 percent chrome iron ore (with a grinding fineness of minus 2 mm) and 15 percent refractory clay and water glass. The lined pipes hold up much better, but their higher cost is not recouped by the prolongation in their service life.

An installation for feeding coaldust to the molten bath through the furnace arch has been perfected. Fig. 1 shows a block diagram of that installation. Coaldust from heating bin 1 proceeds to chamber air pump 2 whence it is transferred by ejector pump 3 along hoses, tuyeres and three 76-mm pipes into the molten furnace bath. The three pipes, which are immersed in the furnace bath, are fastened to the tuyeres and manipulated by console-type mechanisms. Details of the design of the chamber air pump are provided in Fig. 2, and of the water-cooled tuyere -- in Fig. 3.

### Results of Experiments

The experiments were conducted with local-coal dust. The calorific value of the coaldust was approximately 6,200 kilocalories/kg, and its ash content was 23 percent; sulfur content -- 1.0-1.2 percent; content of volatile constituents -- about 23 percent; carbon (not counting the volatile carbon) -- 60.1 percent; and its fineness of grinding was 90-91 percent in the minus 0.074 mm size.

The blowing of the coaldust into the molten bath of oxidized copper results in the evaporation of moisture, dry distillation, formation of slag from ash, and reduction of cuprous oxide.

The experiments showed that it is impossible to attain the final reduction of copper without poling with wood. Therefore, primary reduction with coaldust was followed by final reduction with wood (first method). Another method was also tried: simultaneous blowing of coaldust through the bath and the poling of the bath with wood (second method).

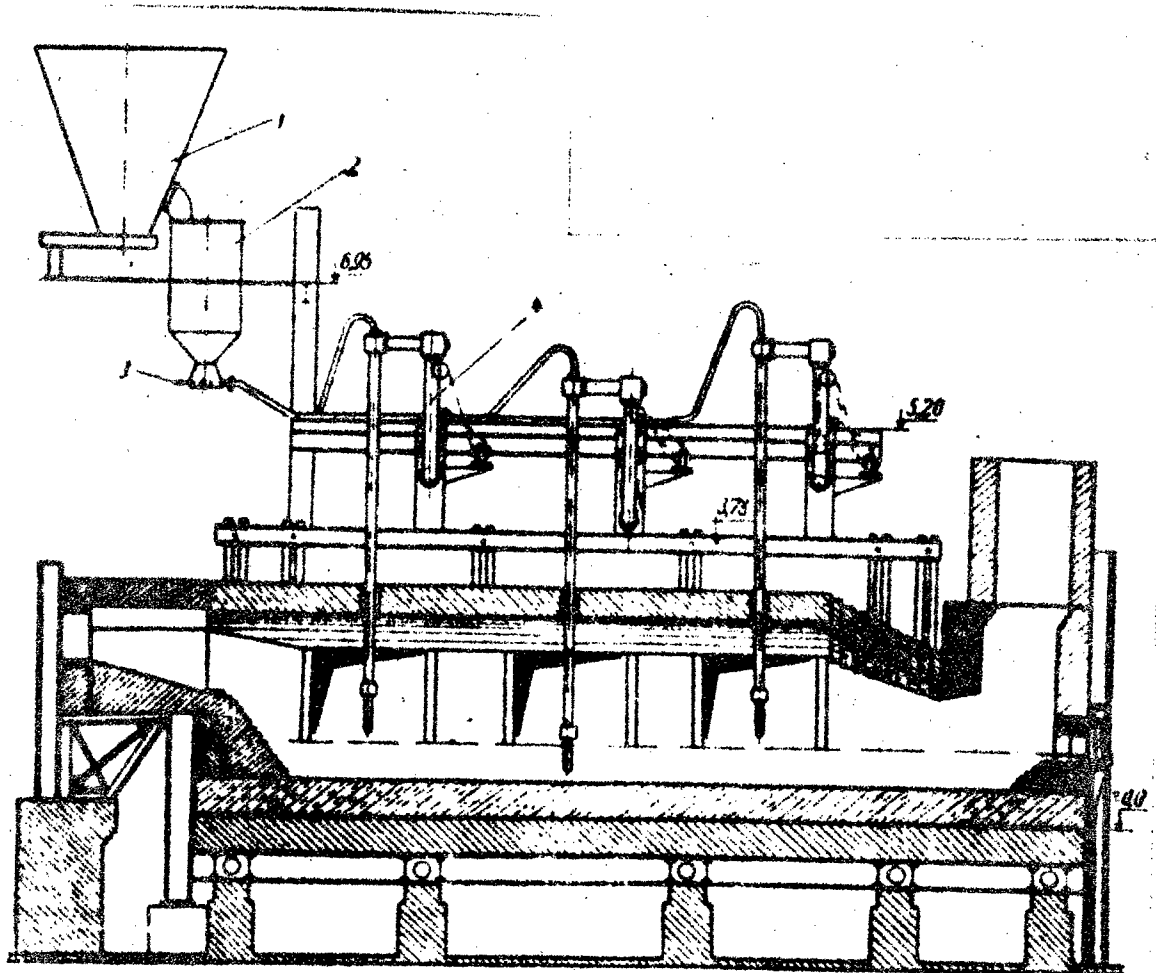


Fig. 1. Installation for Conveying Coaldust to Anode Furnace:

1. Bin; 2. Chamber air pump; 3. Ejector pump; 4. Telescoping rod.

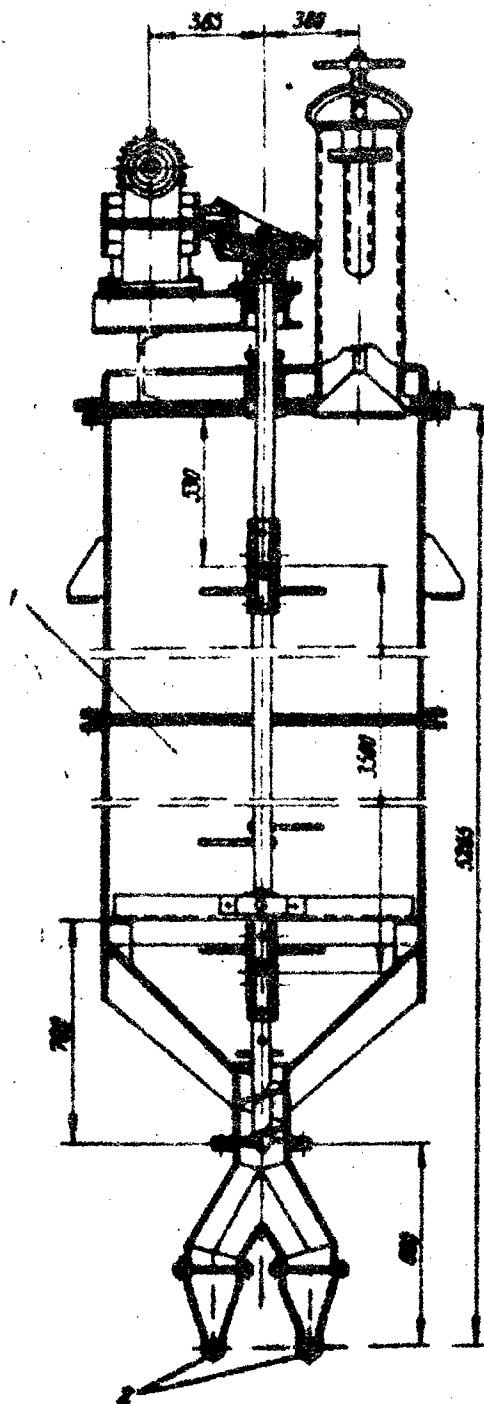


Fig. 2. Chamber Air Pump

1. Chamber of air pump; 2. Forcing ejectors

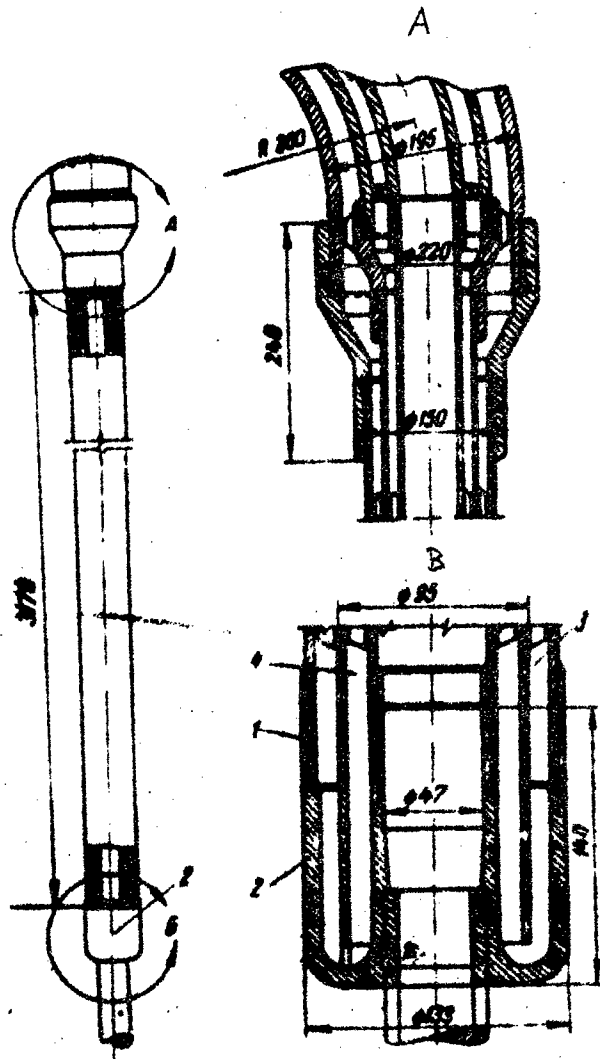


Fig. 3. Water-Cooled Tuyere  
 1, 3, 4 -- Pipes; 2. Tuyere head

The general duration of poling during the experimental smeltings with reduction of copper with coaldust and subsequent final reduction with food amounted to 80-90 minutes, in which reduction with coaldust took from 40 to 80 minutes. The introduced coaldust was incompletely assimilated: a part of it coated the bath with a 10-15 cm layer, forming a "cap." This had delayed the reduction process.

The experimental smeltings with the reduction of cuprous oxide by simultaneous blowing-in of coaldust and poling with wood had shown that then the duration of reduction is shorter than in the case of the first method, the consumption of wood is cut, and the consumption of coaldust increases somewhat. Then the coaldust is utilized completely and no "cap" forms on the surface of the bath.

Table 1 cites the mean comparative data for both methods of reducing anode copper.

Table 1

Consumption per ton of Anode Copper	First Method	Second Method
Wood, m <sup>3</sup>	0.016	0.014
Coaldust, kg	12.2	16.5
Air, m <sup>3</sup>	10.0	14.8
Iron pipes, running meters	0.019	0.019
Duration of reduction, in minutes	90	75

#### Quality of Anode Copper

The degree of the reduction of cuprous oxide during the blowing-in of coaldust was determined by the appearance of the samples collected into horizontal chill pans. If a sample has a level, finely rippled surface, this means that the copper was reduced. Usually, the samples collected after 30-40 minutes of reduction lose their structure of an oxide-saturated copper, and those collected after 50 minutes are sufficiently ductile, with a fibrous structure and with a silky-lustrous surface of fracture.

The content of oxygen in the collected copper samples was determined under a microscope (at 80-fold magnification) according to the amount of the copper-cuprous oxide eutectic. The change in the oxygen content of the samples is illustrated in Table 2.

The collected samples were assayed also for their content of copper, nickel and sulfur. Chemical assays show-

ed that the reduced copper does not gain in its sulfur content throughout the entire process of reduction. For instance, melt No. 21 contained only traces of sulfur throughout the process of reduction, melt No. 20 -- from 0.0043 to 0.0048 percent S, and melt No. 4 -- from traces to 0.039 percent S.

The phenomenon of overreduction of copper was observed only in two melts.

Table 2

Change in the Oxygen Content of the Samples

Time of Collection of Sample	Percentile Content of Oxygen
After the oxidization of copper	0.23
After 10 Minutes of Reduction	0.19
" 20 " " "	0.11
" 30 " " "	0.088
" 40 " " "	0.040

Technical and Economic Indexes

The indexes of the previous method of copper reduction are compared with the indexes of the coaldust method of reduction in Table 3.

As conducted under industrial conditions, the experiments with the reduction of copper with coaldust and wood have demonstrated the definite feasibility of using the coaldust prepared from the local high-ash and sulfur-containing black coals. At the Noril'sk Combine specifically, this is an economically convenient method. The consumption of wood is then cut from 0.053 to 0.015 m<sup>3</sup> per ton of anode copper, and the duration of reduction is shortened from 2.5-3 hours to one hour and 15 minutes. The consumption of coaldust amounts to 1.5 percent of the weight of the copper being refined. The resulting savings per ton of anode copper at Noril'sk amounts to 12 rubles 45 kopeykas.

The results of the studies of the reduction of copper with coaldust have been introduced into the operational practice of fire refining at the Noril'sk Copper Smelting Plant.



Table 3

Indexes of the Old and the New Methods of Reduction

Consumption per ton of Anode Copper	Reduction With Wood Only		Reduction With Wood and Coaldust	
	Amount	Cost, in rubles	Amount	Cost, in rubles
Poling Staves, m <sup>3</sup>	0.053	20.24	0.015	5.73
Coaldust, kg	--	--	13.5	1.45
Air, m <sup>3</sup>	--	--	11.0	0.44
Iron Pipe, running meters	--	--	0.019	0.17
Total	--	20.24	--	7.79

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