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ECONOMIC INTELLIGENCE REPORT

THE COAL MINING EQUIPMENT INDUSTRY OF THE USSR

CIA/RR 21
27 May 1953

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

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CIA/RR 21

(ORR Project 28-51)

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THE COAL MINING EQUIPMENT INDUSTRY OF THE USSR*

Summary and Conclusions

During the period of intensive industrialization that has characterized the Five Year Plans, the USSR has raised its output of coal more than fourfold, from 64.7 million metric tons (MT) in 1932 to approximately 283 million MT in 1951. In the attempt to gear the expansion of its coal industry to the growth of its economic system, the USSR has endeavored to mechanize what had been a hand-operated industry. In order to accomplish this end, the USSR has developed its own coal mining equipment industry and is now virtually independent of the West for coal cutters, loaders, conveyors, and mine locomotives. This accomplishment is very considerable because this equipment is a specialized kind of heavy machinery, some types of which are quite complicated in design and operation and all of which must be built to withstand hard service under grueling conditions.

Domestic production of coal cutters and coal mine locomotives probably was initiated during the First Five Year Plan (1928-32). Initial progress was slow and was characterized by numerous changes of design and failures in the field. It was the aim of the USSR during the 1930's to emulate the US in the use of chain-type coal undercutters rather than to follow the Western European practice of breaking coal out with pneumatic picks. In practice, however, as late as 1940 only about 56 percent of Soviet deep-mined coal was cut by machine, about 19 percent was broken out by pneumatic picks, and about 17 percent was blasted from the solid with powder. By Soviet ways of calculating mechanization, all of these figures were added together and reported in such a manner as to indicate that coal extraction in Soviet mines was 92 percent mechanized.

The coal mining equipment industry of the USSR obtained a great deal of experience during the 1930's and by the outbreak of World War II, if the 1941 Gosplan is to be believed, was on the verge of series production of advanced types of equipment in considerable

* This report contains information available to CIA as of 15 October 1952.

quantities. During the war, despite efforts to remove coal mining equipment plants from the Ukraine to the protection of the Urals and the Kuzbas areas, the coal mining equipment industry was disorganized. As a result, mining techniques retrogressed, and blasting from the solid and even hand mining increased once more.

The USSR emerged from the war determined to restore its coal mining equipment industry, rehabilitate its ruined mines, and complete their mechanization. In order to raise coal output from 166 million MT in 1940 to 250 million MT by 1950, the USSR proposed to build 11,000 coal cutters, 33,000 conveyors, 4,900 electric mine locomotives, and large quantities of related equipment. Following the war the evacuated equipment plants continued to operate at their new locations beyond the Urals, and the old plants in the Ukraine were re-established. The capacity of the plants was thereby increased, and mechanization also took on a new meaning: (1) new types of heavier coal cutters were devised; (2) intensive efforts were made to develop successful coal combines, or continuous miners as they are termed in the US; (3) the first serious effort was made to mechanize coal loading; (4) the conveyor system was revamped and converted from the shaker, or reciprocating, type to the scraper and belt types; and (5) a transition was begun toward heavier mine locomotives.

The coal mining equipment industry of the USSR is at present organized as Glavuglemash, the Main Administration of Coal Machine Building, under the All-Union Ministry of the Coal Industry. Glavuglemash directs the plants which produce the coal mining equipment. Thus in the USSR the coal mining industry owns and operates its own equipment building plants. The design of new equipment is entrusted to Giprouglemash, the State Planning, Designing, and Experimental Institute for Coal Mine Machinery Building, which probably occupies a staff relationship with respect to Glavuglemash and which has, in turn, regional affiliates in the major mining areas.

Although the coal mining equipment industry of the USSR is organized in hierarchical fashion, it operates in such a way as to suggest that it is integrated to a very high degree at all levels. Executives and engineers at various stages in the hierarchy frequently cooperate in the design and development of new equipment. Although the control over the industry is centralized, its operations are fairly well decentralized both geographically and functionally.

No one plant turns out every type of product produced by the industry. Instead, the plants tend to be grouped with some overlapping into cutter, loader, conveyor, and locomotive plants, a grouping which in turn is related to the types of manufacturing operations for which the plants are best suited. Integration of the plants is perhaps greater on a vertical than a horizontal level, though none of the plants, insofar as is known, operates a coal mine or blast furnace. The plants also appear to be dependent on other industries for bearings and motors. Also, it is likely that the leading type of coal loader is built for the coal mining industry by the transport equipment industry. On the other hand, the coal mining equipment industry probably sells rock loaders and pneumatic picks to other ministries. In any event, the coal mining equipment industry of the USSR has been established to serve the coal mines.

In developing the domestic coal mining equipment industry, the USSR has supplied it with much engineering talent, but it has attempted when possible to emulate the tried and tested equipment of the West. Differences in mining conditions and techniques, however, have limited the extent to which Soviet engineers could copy foreign designs without modification.

The chief difference between Soviet and US practice is that between longwall mining and shortwall mining. Briefly, shortwall mining, which is normal in US mines, takes place at the narrow ends of a series of rectangular rooms, and longwall mining, which is normal in Soviet mines, operates on the long side of a room extending for a considerable distance. Longwall mining requires equipment designed to operate in narrow spaces between the props and conveyors and the coal face. Hence there is no room at the working face in Soviet mines for the heavy coal loaders which have helped greatly to increase output per man in US mining. For this reason, although the USSR has copied such US longwall cutters as are on the market, as well as US coal and rock loaders, the Soviet coal mining equipment industry has nevertheless found it necessary to solve for itself the problem of how to mechanize completely the mining of longwall faces by designing its own longwall coal combines and cutter-loaders.

Soviet discrimination in deciding what to borrow has fluctuated widely. The USSR has copied longwall cutters as suited to its needs. In its zeal to copy US equipment, the USSR designed and built, for a time, heavy universal cutters not well suited to longwall operations and not especially suited to Soviet development work.

Not until after several hundred were built was the design abandoned. In copying from the US, the USSR has sometimes also modified designs to fit its own manufacturing capabilities. It is said, for example, to have simplified the gearing of US longwall coal cutters. In building coal and rock loaders, the USSR has followed US practices closely, although this equipment is probably of only limited usefulness in the Soviet longwall mines. It is suggestive that the simpler and lighter US types have, on the whole, been the ones used as prototypes. In the field of conveyors and locomotives the differences between the Soviet and the US methods of mining have little effect on the character of the equipment required. Therefore, the USSR has been less inventive in these areas than in some others.

Soviet coal mining equipment looks crudely finished but rugged. In practice it receives very rough treatment and probably wears out much more rapidly than does similar US equipment. An examination of the Soviet approach to the problem of designing coal mining equipment indicates that the Soviet designers are thorough in their search for Western prototypes and probably better informed about Western developments than are Western engineers about Soviet innovations. In addition, it should be pointed out that from the point of view of design, the Soviet engineers have shown considerable originality and ingenuity, although at times their enthusiasm leaves the realm of practicality.

In surveying the variety and kinds of Soviet coal mining equipment, it is necessary to conclude that the USSR now builds a full complement of underground coal mining equipment. Although the quality of the product may be somewhat inferior to that of the US counterparts, it is nevertheless serviceable. The USSR may therefore be said to have achieved a condition of independence of the West insofar as the design and manufacture of coal mining equipment are concerned.

The USSR may depend on some of the Satellites to supplement its production of coal mine locomotives; otherwise it is chiefly a supplier to the Satellites rather than a consumer from them. In contrast to the Satellites, the USSR has been self-sufficient for some time for coal mining equipment of the type treated in this report, though it has often bought small quantities of equipment for analysis and duplication. From 1941 to the end of 1950 the USSR received from the US, either in purchases or in Lend-Lease

shipments, almost $16 million worth of specialized types of coal mining equipment. From the UK the USSR in the same period purchased more than 110,000 pounds sterling of similar equipment. But these acquisitions may be regarded as incident to the war. At present the USSR is believed to be essentially self-sufficient in coal mining equipment.

From 1928-29 to 1951 the production of coal cutters in the USSR increased from 59 per year to about 1,100 per year, and the inventory was raised from only 1,154 to 4,850. The production of coal mine locomotives was increased from only 87 in 1932 to an estimated 1,700 in 1951, with an increase in inventory from 283 to about 7,400.

Of even greater significance, in 1948 the USSR introduced into its mines the Donbas coal combine, which successfully cuts, breaks, and loads coal from longwall faces and eliminates drilling, shot-firing, and the bulk of the hand-loading work that in the past has been the bottleneck holding down labor and machine productivity in longwall mining in the UK and on the Continent as well as in the USSR. Only about 20 Donbas combines are required to mine 1 million MT of coal per year as against about 36 longwall coal cutters. In addition, the combine replaces much hand labor in loading. Production of coal combines and cutter-loaders (similar machines) may have reached almost 350 units in 1951.

In addition, in 1947 the USSR began in a serious way to build coal and rock loaders for use in development work. Its annual production of these machines may have reached as high as 750 in 1951, and its inventory is said to be about 1,600 cutter-loaders. Their use in the USSR is believed to be limited chiefly to development work, where the Russians are said to be making great gains in mechanization.

At the end of 1949 the USSR claimed to have 10,000 scraper conveyors and 4,000 belt conveyors in operation in its coal mines. It is believed that most of these are of postwar construction. To have so many in operation, even though the figure is only about half of that called for by the 1946-50 Plan, would require an annual production of almost 3,000 scraper and 1,500 belt conveyors. Production of conveyors is thus estimated at about 4,500 units in 1951.

As the result of intensive building of coal mining machinery since the war, Soviet coal mines are now better equipped with modern

machinery than ever before, and the prewar inventory has to all intents and purposes been replaced. Nevertheless, the enormous self-imposed task of expanding coal output to 500 million MT by 1960 puts heavy obligations on the Soviet coal mining equipment industry. This goal implies an expansion of underground mining output by about 20 million MT per year. Total domestic requirements consist of equipment needed for expansion of coal output, for replacement purposes, and for increasing the mechanization of mining. The USSR occasionally releases data on coal mining plans but not on coal mining equipment production or plans. From the hypothesis that the USSR is committed principally to longwall mining methods, however, it has been possible to estimate, apparently with a fair degree of accuracy, what its domestic equipment requirements to meet planned increases in output will be in the next few years. On the basis of the estimate that about 36 longwall cutters or 20 combines are needed to mine 1 million MT of coal, in order to mine the planned annual increases in coal by machine, the USSR will need at least 725 additional cutters or 400 combines each year for expansion purposes alone. At present it appears that the life of a Soviet coal cutter or combine is between 5 and 6 years, which implies that about 800 to 850 coal cutters and about 75 coal combines will be required each year for replacement. Moreover, these obligations must be met before the USSR can make progress in further mechanizing the one-third of Soviet underground coal mining which is still done with pneumatic picks or by blasting from the solid.

Taking into account an estimated production in the USSR of about 400 combines and cutter-loaders during 1952 and estimated exports of 88 coal combines and 183 coal cutters to the Satellites, the Soviet Bloc demand for coal cutters during 1952 would have been about 1,300 as against an estimated supply of about 1,250. These estimates consider the retirement of worn-out machines, the planned expansion of coal output, and some allocation of equipment to the Satellites. Most of the combines now being built are for work in low- and medium-height coal seams. It is believed that no combine has as yet proved satisfactory for the important thick-seam mines of the Moscow and Kuznets regions.

Not enough is known at present about Soviet coal mining methods to permit the computation of the needs for related types of equipment as accurately as for cutters and combines. Judging from what is known of Soviet coal loading, conveying, and haulage methods,

it is estimated that about 900 coal and rock loaders were required for 1952 as compared with an expected production of about 850. The supply and demand for conveyors may have balanced at about 4,650. The demand for coal mine locomotives was figured at approximately 1,760 units, whereas the supply may have reached 1,800. The degree of reliability of these estimates is highest for cutters and combines, lower for loaders, and lower still for conveyors and locomotives.

It is probable that the USSR may have experienced minor shortages in 1952 in coal cutters and loaders and may have an adequate supply of combines and a slight surplus of mine locomotives. Although this picture is generally accurate, it should be remembered that this is an over-all estimate and may conceal imbalances within the categories. It is believed, for example, that production of lightweight car-sorting locomotives is more than sufficient, whereas heavy locomotives may be in somewhat short supply. On the whole, however, it appears that output during 1952 was adequate to demand. It should be noted at the same time that for the USSR to continue to expand its output of coal according to current plans will require annual additions of equipment, so that demand is likely to continue as strong in the next several years for most of these items as at present.

Although the manufacture of coal mining equipment requires scarce alloys, bearings, and motors, a coal combine can mine somewhere between 5,000 and 10,000 times its weight in coal per year. This kind of capital goods is therefore more demanding of engineering skill than it is of special plant facilities, materials, or man-hours. Nevertheless, inputs of these items to the Soviet coal mining equipment industry have been computed from US practice with adaptations and corrections for Soviet conditions.

By virtue of its self-sufficiency the Soviet coal mining equipment industry is vulnerable to ordinary economic warfare only through the interdiction of such components as bearings. An embargo of shipment of coal mining equipment to the Satellites will force them to lean more heavily upon Soviet supplies. Physical vulnerability is limited because of the substantial dispersion of the industry, although the industry appears to offer more concentrated targets for both bombardment and sabotage than do underground coal mining facilities.

Since the Soviet coal mining equipment industry is important both to the expansion of a peace-oriented economy and to the creation of an economic base for prolonged military operations, it is not an obvious indicator of Soviet military intentions. Conversion of the industry to arms production, however, would appear to indicate a sacrifice of long-term peace or military aims to short-term output of military end items.

I. Introduction.

A. General Description of the Industry.

Coal mining machines are defined here as devices that cut, load, or transport coal.* Each of these operations may be performed in a number of ways. Prior to the twentieth century, in the US, coal was undercut by hand. Holes were then bored into the seam, powder was tamped into the holes, and the coal was blasted down. Then it was hand-loaded into small carts that were drawn away by horses or mules on underground tramways for transfer to the surface. Once above ground, the coal was hand-sorted and dispatched to market with little or no further processing.

In the US, mine ventilation, mine pumping, and the lifting of the coal to the surface were mechanized prior to the twentieth century. Practical devices to mechanize the undercutting of coal** have been on the US market for some 60 years. By 1930 the mechanization of US coal cutting was virtually complete.*** In the same period, electric mine locomotives replaced animal power in underground transport in the US. During the 1930's, conveyors were introduced extensively to facilitate underground haulage, both in seams too thin for locomotives and cars and in areas where high continuous production

* The coal mining industry also uses drills, pumps, and ventilators, as well as elevating and coal-processing equipment. These are excluded from this report by definition, chiefly because such equipment is sufficiently general to be used for other purposes than coal mining, but also because of the lack of time to treat it in detail. Direct burning of coal underground is also excluded from the scope of this report, although it is carried on experimentally in the USSR.

** These devices will be referred to throughout this report as coal cutters. They generally consist of a continuous chain, fitted with replaceable cutting bits, powered by air or electricity, and mounted in various ways, depending upon how the coal is to be cut. They should be distinguished from pneumatic picks and coal combines, which will be defined later.

*** These generalizations apply only to bituminous coal and lignite (little lignite is mined in the US). The mechanization of anthracite coal mining in the US has proceeded more slowly because of the hardness of the coal, the thickness of the seams, and their sloping character.

was feasible. In these years, mechanization was extended to the underground loading of coal to cars and conveyors. In 1949 in the US, 91.4 percent of the bituminous and lignite coal mined underground was cut by means of coal cutters, 67 percent was mechanically loaded, and practically 100 percent was mechanically transported to the pit head. In the same year, 35 percent of the entire bituminous and lignite coal output of the US mined both above and below ground was mechanically cleaned. 1/*

In response to the demand of a fast-growing industrial system, the capacity of US coal mines was increased from about 200 million metric tons (MT) per year in 1900 to over half a billion MT by the end of World War I. To achieve this capacity, both hand mining and machine mining were extended. In other words, prior to World War I in the US, mechanization consisted less of a replacement of hand methods than a supplement to hand methods. In the US, however, from the end of World War I to the present, little increase in mining capacity has been demanded. Subsequent mechanization, therefore, has consisted of the replacement of hand operations and manpower by machine operations, all the way from coal cutting to coal processing, as dictated by careful consideration of marginal costs in a keenly competitive segment of the economy.

In the UK and on the Continent, coal mechanization proceeded at a slower rate and by somewhat different methods. In the UK, 76 percent of the total coal output was cut by machinery in 1948, only 3.6 percent was power-loaded, and 78 percent was transported underground by means of belt, chain, or shaker conveyors. 2/ Mining methods restrict European use of mechanical loading machines of the US type, and safety restrictions have limited the use of trolley locomotives underground in British mines.

On the Continent a wide variation in coal mining methods has influenced the design and manufacture of coal mining machinery. While the US converted its coal mining industry to machine cutting, the greater percentage of coal mined on the Continent was being

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broken from the coal face by means of pneumatic picks* and was then hand-loaded to tubs or conveyors. Mechanization of cutting and loading, which contributed so greatly to the superiority in output per man in US coal mining, made little headway on the Continent until the end of World War II, except in the USSR.

This contrast is generally explained on the ground that European coal seams are on the whole too deep, too thin, too thick, or too irregular in contour to permit of machine cutting. By custom, moreover, US mines are laid out by what is known as the room-and-pillar method. Rooms of considerable depth but of a relatively short width are mined in the US across the shortest dimension -- hence the application of the term shortwall to the US mining method. By contrast, most British and Continental mines are worked by means of long faces, of, say, 200 to 1,000 feet in length. From this approach the European method of mining is termed the longwall method. The short length of the face in shortwall mining, whereby the exposed roof is supported by frequent pillars of coal, makes it possible to bring heavy, mobile loading machines up to the face to mechanize coal loading. On the other hand, it is necessary to support longwall operations by means of props placed close to the face. For this reason, US mobile coal loaders have found limited favor on the Continent. Coal has had to be loaded there either by hand or by special types of equipment, of which more will be said later. Besides technical considerations, the relatively low cost of labor, strict safety regulations, fear of technological unemployment, and perhaps a reluctance to experiment with new equipment have tended to retard the mechanization of coal mines on the Continent. This situation in turn has reduced the demand for specialized coal mining machinery.

* A piece of equipment of which the most familiar example is the pavement breaker, usually hand-held but sometimes mounted, which may be used to break coal from the face without undercutting but is sometimes used to break down coal that has been undercut in lieu of the use of explosives. Such picks can be built for electrical instead of air operation. They should be distinguished from coal cutters as used in this report and from coal drills, which are used to bore holes into the coal face for the insertion of explosives. In foreign countries, coal cutters are occasionally called coal drills. Unfortunately the term pneumatic picks, which is used here in an inclusive sense, is often replaced by the terms pneumatic hammers, pneumatic perforators, pneumatic chippers, and pneumatic drills. These designations, to avoid confusion, will hereafter be referred to as pneumatic picks.

Europe, apart from the UK and the USSR, therefore builds few coal cutters or loaders of the types that prevail in the US.

Much coal mining machinery is of a specialized character, which has been designed for a single purpose. Not only is it built exclusively for coal mines, but in addition it is frequently adapted to variations in thickness, hardness, and slope of the coal seam. Coal mining equipment, moreover, must withstand heavy working loads, rough treatment, movement from place to place under adverse conditions, unskilled handling, and mine accidents, as well as the effects of corrosive moisture. These requirements dictate that coal mining machinery be built to quality standards of durability. Because of its specialized nature, the output of this equipment rarely reaches serial production. It is generally built on a piece-by-piece basis or else in small batches, in order both to meet the limited demand for a particular type and model and to permit frequent improvements in design.

As a consequence, in capitalist countries, relatively few enterprisers undertake the manufacture of coal mining machinery proper, such as cutters and loaders, although a larger number produce related coal mining supplies of a miscellaneous character. Only three manufacturers produce coal cutters in the US, and not very many more produce coal loaders or coal mine locomotives. Because demand varies, US manufacturers of coal mining machinery have sought to diversify their output by also building metal mining machinery or related products such as handling and conveying equipment. By the same token, other manufacturers, such as producers of handling and transporting equipment, have attempted to cultivate a market for their product in the coal mines. Since the manufacture of coal mining machinery requires extensive metalworking equipment, the manufacturers have also been disposed to engage in the production of general machinery, employing the necessary engineering talent, together with the free time of their specialized machinery facilities. These economic considerations most certainly affect capitalist production, and it will be seen that they have not been entirely absent in conditions of Communist production.

There are relatively few producers of coal mining machinery in the US, but there are a considerable number of consumers of this kind of equipment. Even though the price of coal is at times set by administrative rather than by market techniques, the decision to replace existing machines with new equipment or to mechanize additional

mining operations is an economic decision, which is made primarily in terms of considerations of cost. In the USSR, by contrast, the structure of both the coal mining equipment industry and the coal industry differs considerably from that in the US, and cost is but one of the considerations that determines the spread of mechanization.

B. History of the Industry.

1. Background.

Russia under the Czars was aware of and had begun to exploit its considerable coal resources. As early as 1913 the Russian mines yielded 29 million MT of coal, but labor was so cheap and so unskilled that mechanization made little headway. Soviet statistics indicate that only 1.79 percent of the output of Russian coal mines was "won" mechanically in 1913. Even this may be an exaggeration, since the USSR considers mechanization as virtually any means of coal extraction other than undercutting by hand.* In the entire prerevolutionary period, only about 40 coal cutters were imported into the Donbas region of the Ukraine, or the Donets Basin, which has always been the most advanced of the Russian coal basins. 3/** More extensive mechanization was attempted after 1918, although the equipment still had to be imported. Insofar as is known, the USSR built no coal cutters of its own before the beginning of the First Five Year Plan (1928-32). 4/ The Soviet inventory on 1 October 1928 consisted of 549 heavy coal cutters,*** 268 light coal cutters, and 71 pneumatic

* Mechanization in the USSR thus included coal mined with pneumatic picks as well as coal blasted from the face without being undercut at all. In the US it is taken for granted that bituminous coal is mechanically cut. However, there has also been a mechanization movement in the US in recent years, the object of which has been to mechanize the underground loading of coal.

** As late as 1934, at least two imported coal cutters of the pre-Soviet period were still in use in Soviet mines.

*** Reported as 550 in the summary of fulfillment of the First Five Year Plan, this figure was modified to 549 by annual reports on the accomplishments under the Second Five Year Plan (1933-37). Slight variations between reports for this period are not uncommon. By "heavy" cutters it is understood that the USSR refers to those used in production of coal as against "light" cutters used in development work.

picks. 5/ With this equipment and with a laboring force of 246,500 coal miners, 6/ the USSR, [redacted] mined 35,250,000 MT of coal in the fiscal year 1927-28. Three-fourths of this coal came from the Donbas. 7/ Over-all mechanization of coal cutting was stated to be 15.7 percent of total output. At this rate the 549 heavy coal cutters turned out 5,534,250 MT 8/* of mechanically undercut coal per year, or about 10,080 MT per machine per year, or only about 840 MT per machine per month. At this time, also, the quarter million Soviet coal miners were producing only about 144 MT per man-year, while the 522,150 US coal miners were producing 863 MT per man-year. 10/**

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2. First Five Year Plan (1928-32).

During the period of the First Five Year Plan (1928-32) the USSR pursued Western mining patterns in a more active and energetic manner. The total number of heavy coal cutters was raised from 549 on 1 October 1928 to 1,473 on 1 December 1932, a gain of almost 170 percent. The inventory of pneumatic picks, widely used in Western Europe to break coal down from the face, was increased from 71 to 9,020 (see Table 1).*** Most of these new coal-cutting devices were installed in the Donbas as before, but pneumatic picks were introduced extensively in the Moscow, Urals, Kuzbas, and Far East regions as well. 11/ Table 2**** indicates, nevertheless, that in coal cutters imports still greatly exceeded domestic production.

* Although officially reported as over-all mechanization, there is good reason to believe that this figure refers only to coal cut by means of heavy coal cutters. The 1927-28 figure given for the whole industry by Academician A.A. Zvorykin (author of numerous works and articles on Soviet mining history and methods) puts the percentage of coal mechanically cut at 16.5. On this assumption it could be figured that only 0.8 percent was cut by light machines, which corresponds to Zvorykin's figure of 0.9 percent for 1932. 9/

The 1927-28 coal output [redacted] differs slightly from the figure of 35,510,000 as given in Table 8 (p. 26, below). [redacted]

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** Even when both bituminous and anthracite productivity are combined to make a better comparison, the US figure was about 640 MT per man-year.

*** Table 1 follows on p. 15.

**** Table 2 follows on p. 17.

Table 1

Estimated Soviet Production and Inventory of Coal Cutters, Pneumatic Picks, and Electric Coal Mine Locomotives*
End of Year, 1927-28 - 1951

Units

	Coal Cutters						Pneumatic Picks 12/		Coal Mine Locomotives			
	Production 13/			Inventory a/**						Inventory		
Year	Heavy	Light	Total	Heavy	Light	Total	Production	Inventory	Production b/	Trolley 14/	Battery 14/	Total c/
1927-28				549	268	807	29	71		47	12	59
1928-29	11	48	59	761	393	1,154		1,274				
1929-30	50	74	124	1,007	409	1,416		3,322				
1931	167	124	291	1,278	322	1,600		6,190				150
1932	244	54	298	1,473	339	1,812	6,296	9,020	87	113	170	283
1933	360	12	372	1,679	294	1,973	6,054	10,764	245			
1934	362	126	488	1,754	327	2,081	9,578	12,931	161	121	308	429
1935	435	101	536				8,648		220			
1936			421						169			
1937												
1938			1,110	2,509	341	2,850	19,000					
1939				2,925	600	3,525						
1940			1,050	3,442	608	4,050	30,000 d/	18,000 d/		846	1,009	1,855
1941				850	300	1,150		e/				
1942												
1943												
1944												
1945	650	0	650	1,450	300	1,750			600	1,497	251	1,748
1946	845	0	845	2,400	300	2,700			700			2,348
1947	1,400	0	1,400	3,425	275	3,700			900			3,048
1948	1,325	0	1,325	3,950	250	4,200			901			3,750
1949	1,405	0	1,405	4,350	150	4,500			1,190			4,640
1950	1,125	0	1,125	4,600	100	4,700		f/	1,700			6,040
1951	1,100	0	1,100	4,800	50	4,850	25,000	32,000 g/	1,700			7,400

* Spaces left blank in this table indicate that data are not available.

** Footnotes for Table 1 follow on p. 16.

Table 1

Estimated Soviet Production and Inventory of Coal Cutters, Pneumatic Picks, and Electric Coal Mine Locomotives
End of Year, 1927-28 - 1951
(Continued)

a. Coal cutter inventory from Table 29 (p. 182, below).
b. Locomotive production data from Table 26 (p. 162, below).
c. Total locomotive inventory data from Table 26 (p. 162, below).
d. This anomaly of an inventory of only 18,000, following a production of 30,000, is not wholly due to rapid obsolescence. It illustrates, instead, the difficulty of differentiating between the types of pneumatic picks, which are variously reported as pneumatic drills, hammer drills, chippers, and perforators. Thus it was reported that before World War II the USSR built 19,000 pick hammers and 11,000 hammer drills. 15/ It was also reported, however, that at the same time the Donbas mines and the western regions had 11,000 to 13,000 hammer drills, pick hammers, and perforators. 16/ It is not clear [redacted] which of these categories is covered by the 1940 figures. It was estimated in the same year that about 31 million MT of coal were produced with pneumatic picks in the entire country (see Table 31, p. 184, below). In 1941, 14.1 million MT were produced outside of the Donets Basin. It is assumed that 19 million MT were produced there with pneumatic picks in 1940 and 12 million MT elsewhere. Assuming there were 11,000 pneumatic picks in the Donbas in 1940, then the production per pick averaged 1,730 MT (19 million MT divided by 11,000) in that region. Extrapolating from this production rate, then the whole country must have had about 18,000 of these devices. It should also be noted that in 1940 the Pnevmatika plant in Leningrad built its 100,000th air drill since 1929. 17/
e. The 1941 Plan called for the production of 13,000 hammer drills and 20,000 pneumatic drills. 18/
f. In August 1950 the Pnevmatika plant "recently" completed its 173,000th air pick hammer. 19/
g. Estimated. In 1951 the number of pick hammers and hammer drills increased 80 percent as compared with 1940. 20/

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Table 2

Proportion of Soviet to Foreign Coal Cutters
in the Soviet Coal Mining Industry a/ 21/
by Year of Construction
End of 1934

Units

Type of Coal Cutter	Total Number of Coal Cutters, 1934	Coal Cutters, by Year of Origin						
		1917	1918-28	1929-31	1932	1933	1934	Date of Origin Unknown
Soviet-Made	738	N.A.	22	150	131	239	135	61
Foreign-Made	1,014	2	316	400	97	43	42	114
Total	1,752	2	338	550	228	282	177	175

a. This table probably refers only to the heavy coal cutters.

Official figures show that the mechanization of coal cutting, as a result of these more intensive efforts, rose from 15.7 percent of the total output in 1927-28 to 62.6 percent in 1932.* 22/ This figure coincides closely with the estimate of Zvorykin. Zvorykin also clarifies the meaning of the term mechanization in the USSR by breaking down production as follows: proportion of deep-mined coal cut (a) by heavy cutters, 40.8 percent; (b) by light cutters, 0.9 percent; (c) by pneumatic picks, 9.4 percent; and (d) by means of blasting from the solid, 11.5 percent (see Table 3).** This indicates that in US terms the USSR had achieved a level of mechanization of only 41.7 percent in 1932 instead of the 62.6 percent claimed. Even if the use of pneumatic picks without prior undercutting be considered as forms of mechanization, then it must still be admitted that 37.4 percent of the Soviet output in 1932 must have been cut by hand as in the traditional preindustrial manner.

* Interpreted to mean percentage cut by heavy machines in 1927-28 and by all cutters, pneumatic picks, and blasting from the solid in 1932.
** Table 3 follows on p. 19.

Calculating further, from the fact that the USSR produced 64,302,000 MT* of coal in 1932, 24/ by underground methods, it would appear that 40.8 percent, 25/ or 26,235,000 MT, was cut by means of heavy coal cutters, which would yield 17,811 MT per year, or 1,484 MT per month, for each of the 1,473 heavy coal cutters in the national inventory (see Tables 1 and 3). This increased yield per machine would have amounted to about 75 percent in the 5 years from 1928 to 1932.** The first concerted efforts to build a Soviet coal mining industry thus led to considerable gains in machine mining. Soviet authors claimed that the output per coal cutter in the whole USSR in 1932 was 35,700 MT as compared with only 21,900 MT in the US. 26/ Their claims are refuted not only by published statistics of that time but also by Zvorykin's inadvertent revelation of the meaning ascribed to mechanization in the USSR.***

The Soviet inventory of pneumatic picks assigned for use of coal mines was built up to 9,020 in 1932 from a nominal number of only 71 in 1928. The production of these pneumatic picks is said to have begun in 1928-29 with an output of 29 units. It reached 6,296 units by 1932 (see Table 1). In this field, where the equipment was relatively unspecialized, comparatively light in weight, and simple in construction, as against the heavier and more complex coal cutters and coal mine locomotives, the USSR came closer to meeting its own needs in coal mining equipment during the First Five Year Plan than in any of the other branches of the mining equipment industry.

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* See Table 3. The report of the First Five Year Plan cited 63 million MT, whereas the prospectus of the Second Five Year Plan gave the 1932 output as 64.3 million MT. 23/

** A breakdown of the meaning of mechanization in the USSR in 1927-28, similar to that used in 1932, might indicate that a portion of the coal assumed to have been cut mechanically was in reality blasted from the solid.

*** To arrive at figures as high as those claimed for the USSR in 1932, it would have to be assumed that only 720 of the 1,473 heavy coal cutters had been in operation during the year. Other Soviet sources indicate that only 1,066 heavy cutters were actually in operation during the year. 27/ Calculated on that basis, the 1932 output per heavy cutter was 24,611 MT, a higher yield than was secured per machine in the US. It indicates that coal cutters were in shorter supply in the USSR and were probably operated a greater proportion of the year.

Table 3

Soviet Deep-Mined Coal Production by Methods of Extraction a/ 28/
1932-33, 1937-49

Year	Production (Thousand MT)	Coal Cutters: Combines, Cutter-Loaders, and Coal Planers		Coal Cutters: Heavy Cutters		Coal Cutters: Light Cutters		Pneumatic Picks b/		Blasting c/		Hand Mining d/	
		Thousand MT	Percent	Thousand MT	Percent	Thousand MT	Percent	Thousand MT	Percent	Thousand MT	Percent	Thousand MT	Percent
1932	64,302	0	0	26,235	40.8	579	0.9	6,044	9.4	7,395	11.5	24,049	37.4
1933	N.A.	0	0		40.9		0.8		10.8		15.1		32.4
1937	125,519	0	0	57,990	46.2	628	0.5	20,585	16.4	33,137	26.4	13,179	10.5
1938	N.A.	0	0		50.9		0.5		17.0		20.9		10.7
1939	N.A.	0	0		54.0		1.0		17.9		18.6		8.5
1940	159,691	160	0.1	88,149	55.2	1,437	0.9	30,820	19.3	27,307	17.1	11,818	7.4
1941	67,168 e/	N.A.	N.A.	35,129	52.3	537	0.8	12,896	19.2	13,568	20.2	5,038	7.5
1942	67,454 e/	N.A.	N.A.	22,799	33.8	607	0.9	11,670	17.3	20,304	30.1	12,074	17.9
1943	81,312 e/	N.A.	N.A.	23,743	29.2	488	0.6	9,920	12.2	28,622	35.2	18,539	22.8
1944	90,468 e/	N.A.	N.A.	31,121	34.4	271	0.3	8,956	9.9	39,987	44.2	10,132	11.2
1945	131,915	132	0.1	50,261	38.1	527	0.4	13,323	10.1	58,834	44.6	8,838	6.7
1946	146,644	147	0.1	60,124	41.0	587	0.4	14,518	9.9	64,963	44.3	6,305	4.3
1947	164,874	495	0.3	73,863	44.8	f/	f/	16,982	10.3	68,588	41.6	4,946	3.0
1948	188,886	944	0.5	87,643	46.4	f/	f/	19,644	10.4	75,743	40.1	4,911	2.6
1949	213,279	9,598	4.5	96,189	45.1	f/	f/	24,100	11.3	79,340	37.2	4,052	1.9

a. Tonnages given by method of extraction are calculated from reported percentages applied to production as indicated. The assumption is that percentages were applicable to the output of deep-mined coal.
b. Assumed to be dug from the solid without blasting.
c. Assumed to be blasted from the solid.
d. The figures are residual and are assumed to represent that coal which was mined without the aid of any mechanical equipment or blasting.
e. Reported percentages were based on output exclusive of the Donets Basin, which is not included in these figures.
f. Not reported separately; included with heavy cutters.

The coal miner of the past had been symbolized by a sturdy individual, garbed in miner's cap and shouldering a pick. This symbolism was dropped in the US following the advent of the mechanical coal cutter. In the USSR, however, mechanization took such a form that in photographs the pickax-toting miner was replaced by a compatriot swinging a portable pneumatic pick. Even today the Soviet press portrays the miner and his pneumatic pick as inseparable, though a recent Soviet propaganda release boasted: "Such jobs as hand pickman, tub hauler, and pony driver disappeared long ago. The underground workings are now equipped with coal combines, conveyor belts, and electric engines. Men of new mining professions -- combine operators, winch operators, operators of powerful loading machines, mechanics and electricians -- live in the mine's large, modern settlement." 29/

Mechanization of the haulage of coal from the mine face to the foot of the lifting shaft or through the outcrop in drift mines had also proceeded rapidly in the US since the turn of the century. Where mine cars had formerly been pushed by hand from the face to the main gathering entries, they were usually moved by lightweight electric locomotives by 1928, either powered by storage batteries or else taking their power from main entries through cable reels that automatically adjusted in length to the movements of the locomotive. The USSR had been singularly backward in the mechanization of underground mine haulage before 1928 or even, for that matter, to the end of the First Five Year Plan. As late as 1932 the Soviet coal industry possessed only 283 electric mine locomotives, of which 170 were powered by storage batteries. (See Tables 4 and 5.)*

"By the end of the Five Year Plan period," it was reported officially, "a great deal of work was done in mechanizing the haulage, whereas in previous years the results had been smaller." 30/ This statement is revealing. It does not appear that domestic production of electric mine locomotives was undertaken before 1932. Only 87 were built in the USSR in that year (see Table 1**).

As a result of this "great deal of work," by the end of 1932 only 17.8 percent of the coal produced in USSR mines was hauled away from the face by means of electric locomotives, and 11.8 percent was transported by rope-haulage systems somewhat like the cable cars formerly used in street railways -- a total of only 29.6 percent

* Table 4 follows on p. 21; Table 5, on p. 22.
** P. 15, above.

Table 4

Electric Locomotive Park of the Soviet Coal Mining Industry as of September 1934 31/

Units

Electric Mine Locomotives	Total as of Sep 1934	Number of Electric Locomotives Purchased			
		1917	1918-28	1929-32	1933-34 to Sep
Trolley	121	2	45	66	8
Battery	308	2	10	158	138
Total	429	4	55	224	146

mechanically hauled. On the other hand, 11.5 percent of the output was still pushed out by hand, and 58.9 percent was transported by horses (see Table 6).* The mechanization of underground transport had only begun at the close of the First Five Year Plan.

Besides initiating the production of coal cutters, pneumatic picks, and coal mine locomotives, the USSR, during the First Five Year Plan, built quantities of mine ventilators, electric winches, gas and electric safety lamps, and no doubt various other subsidiary items of coal mining equipment. Ventilators and electric safety lamps appear to have been built in the USSR for the first time during this period. Hoists and flame-type safety lamps may have been in production before the First Five Year Plan (see Table 7).** 32/

From the foregoing it may be concluded that before the advent of the First Five Year Plan in 1928, the USSR depended for equipment for its coal mines almost entirely on foreign producers of machinery. Only the lighter and simpler items such as flame-type safety lamps and pneumatic picks were produced domestically. During the First Five Year Plan period the USSR undertook to found its own coal mining equipment industry for the construction of coal cutters and coal locomotives, two of the more complex items used by the industry. This

* Table 6 follows on p. 23.
** Table 7 follows on p. 24.

Table 5

Soviet Development of Different Methods of Extracting Coal 33/
1932-33, 1937-49

Percent

Method	1932	1933	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
Hand															
Running Cars to Face by Hand	14.6	13.6	7.2	8.2	5.9	4.7	5.0	10.5	11.4	10.4	9.9	9.3			
Hand Loading	12.6	11.5	5.1	6.0	5.3	4.9	4.8	5.5	14.6	11.1	7.3	4.2			
Total	27.2	25.1	15.6	14.2	11.2	9.6	9.8	16.0	26.0	21.5	17.2	13.5	10.2	8.6	6.4
Mechanical Means and Gravity															
Conveyors	35.8	38.6	52.0	53.9	58.7	61.2	60.7	54.9	48.4	52.2	54.4	55.0	58.7	60.3	62.5
Mechanical Feeding of Cars to Face	1.7	2.1	1.2	0.8	0.8	0.7	0.7	1.7	1.9	2.0	2.0	2.7	2.9	2.9	2.9
Gravity	31.2	30.6	32.0	29.6	28.3	27.6	27.9	26.9	23.2	23.4	25.3	27.5	27.0	26.8	26.9
Scraper Winches	4.1	3.6	2.5	1.5	1.0	0.9	0.9	0.5	0.5	0.9	1.1	1.3	1.2	1.4	1.3
Total	72.8	74.9	87.7	85.8	88.8	90.4	90.2	84.0	74.0	78.5	82.8	86.5	89.8	91.4	93.6

Table 6

Soviet Development of Different Methods of Haulage
in Percent of Coal Loaded 34/
1932-33, 1937-49

	Unmechanized			Mechanized			
Year	Hand Pushing	Horse	Total	Electric Locomotive	Conveyor	Rope Haulage	Total
1932	11.5	58.9	70.4	17.8	N.A.	11.8	29.6
1933	11.1	52.0	63.1	12.9	N.A.	24.0	36.9
1937	5.0	41.4	46.4	38.8	N.A.	19.8	53.6
1938	1.7	36.7	38.4	51.9	N.A.	9.7	61.6
1939	0.8	29.8	30.6	60.3	N.A.	9.1	69.4
1940	0.7	24.1	24.8	67.2	N.A.	8.0	75.2
1941	0.7	19.8	20.5	71.4	0.5	7.6	79.5
1942	1.9	17.8	19.7	69.3	0.6	10.4	80.3
1943	3.6	14.5	18.1	73.7	0.5	7.7	81.9
1944	8.9	7.6	16.5	74.3	0.9	8.3	83.5
1945	8.5	5.0	13.5	76.0	0.6	9.9	86.5
1946	5.8	6.2	12.0	77.5	0.4	10.1	88.0
1947	3.7	5.2	8.9	79.1	0.3	11.7	91.1
1948	2.4	3.8	6.2	82.3	0.2	11.3	93.8
1949	1.5	3.0	4.5	85.5	0.4	9.6	95.5

conclusion, drawn from Soviet production, inventory, and import data, is supported by the summary report on the accomplishments of the plan:

"At the beginning of the first Five Year Plan period, the reconstruction of the coal industry met with certain difficulties owing to the weak development of the mining machine building industry ... . However, by the end of the Five Year Plan period, a solid base of a home machine building industry had been created, which assured completion of the reconstruction and the mechanization of the coal industry." 35/

Table 7

Soviet Production of Miscellaneous Coal Mining Equipment
1927-28 - 1935 36/

Units

Year	Mine Ventilators	Safety Lamps	
		Flame	Electric
1927-28	0	46	N.A.
1928-29	206	44	N.A.
1929-30	178	98	N.A.
1931	289	211	496
1932	212	161	28,057
1933	177	124	34,611
1934	89	219	2,693
1935	70	159	55,516

3. Second Five Year Plan (1933-37).

The high priority assigned to coal mining proper in the expanding Soviet industrial system during the First Five Year Plan (1928-32) was carried over into the Second Five Year Plan (1933-37). Soviet coal production was to be raised from 64.7 million MT in 1932 to 152.5 million MT in 1937, or a planned gain of 136 percent. It was stated officially that "the essential conditions" on which the further growth of the coal industry would depend during the Second Five Year Plan would be "mechanization of the whole coal industry and the consequent improvement in labour productivity." Mechanization -- by the Soviet definitions -- of cutting in the main coal trusts was to be extended from 65.4 to 93 percent. Mechanization of gathering* was to increase from 76.5 to 90 percent, and mechanization of underground haulage, including haulage "by engines with trolley wires" (underground electric trolley locomotives), was to be raised from 15 to 80 percent. It was admitted that "the weakest point hitherto has been the loading of coal, which until recently has remained absolutely unmechanized." Underground coal loading was to be at least 20 percent mechanized during the period of the new Plan.

* Probably refers to transporting of the coal from the face out of the room to mine cars in the main-line haulageways, from whence it is moved in mine cars to the elevating cage.

By use of the special Soviet interpretation of the term mechanization, superiority was claimed for Soviet technology as compared with the leading capitalist producers of coal. This superiority, it was boasted, "is characterized first and foremost by the predominance of the cutting machine in cutting operations." By contrast, it was pointed out, German mechanization was based essentially on the use of pneumatic picks. Another of the "most significant features of the superior type of mechanization" to be achieved by the Second Five Year Plan, it was asserted, was that the new mechanization was to be comprehensive, in that mechanization of cutting, gathering, and haulage would be approximately on a par, whereas in other countries mechanical progress was uneven. As a result of this "determined stand in favor of complete mechanization," together with improved administration and work methods, it was proclaimed that labor productivity in the coal mines would increase 91 percent in the coming 5-year period.

In specific terms the average output per worker per month was to be increased from 13.79 MT to 26.3 MT, a gain of 90.7 percent. It was expected that this increase would raise labor productivity measured in rubles at 1926-27 prices from 2,079 in 1932 to 3,971 in 1937, a projected gain of 91 percent. At the same time it was hoped to reduce costs 32.4 percent, thereby saving 838 million rubles, despite a planned increase in number of workers from 317,300 to 380,000, a gain of 19.8 percent. 37/

In fact, the output of coal reached only 127,968,000 MT at the end of 1937 instead of the 152.5 million MT planned (see Table 8),* representing a growth, however, of about 100 percent. Most of the gains were achieved during the first 3 years. The period affords an opportunity to examine Soviet intentions and capabilities as of that time. That more output of coal was a high-priority target is very clear. It is also apparent that it was desired to reduce the effort needed to gain each ton mined. Thus, although the output was doubled, the percentage cut by machine was raised from 41.7 in 1932 to 46.7 in 1937. The quantity broken out by means of pneumatic picks increased from 9.4 to 16.4 percent, and that blasted from the solid without undercutting was brought up from 11.5 to 26.4 percent. By these various means, collectively termed mechanization by the Soviets, mechanized cutting was raised from 62.6 percent in 1932 to 89.5 percent in 1937 as compared with 93 percent planned. Conversely, hand mining was brought down from 37.4 to 10.5 percent in the same years. Insofar as the growth of the

* Table 8 follows on p. 26.

Table 8

Soviet Coal Production 38/
1913, 1927-28 - 1952, 1955, 1960

Year	Thousand MT a/
1913	29,117
1927-28	35,510
1928-29	40,067
1929-30	47,780
1931	56,752
1932	64,690
1933	76,333
1934	94,160
1935	108,900
1936	126,400
1937	127,968
1938	132,888
1939	145,700
1940	165,926
1941	137,500
1942	77,000
1943	98,000
1944	128,000
1945	149,300
1946	164,200
1947	183,900
1948	209,650
1949	236,100
1950	262,000
1951	283,000
1952 Estimate	303,000
1955 Plan Estimate	375,000 b/
1960 Plan	500,000

a. Including lignite and all types of hard coal.
b. Stated to be 43 percent above 1950 output. 39/

Soviet coal mining equipment industry is concerned, however, it appears that the development of the coal cutter industry made relatively less progress than did the pneumatic pick industry. Only 5 percent more coal was mined by means of coal cutters, whereas 7 percent more was cut by means of pneumatic picks and 14.9 percent more was blasted from the solid. Thus while the total quantity of coal mined by hand fell from 24 million to 13 million MT (see Table 3*), most of the gains in so-called mechanization were achieved by means of pneumatic picks or blasting powder rather than by elaborate mechanisms such as mechanical coal cutters.

Consequently the number of coal cutters produced annually did not keep pace with the output of coal. Whereas 244 heavy and 54 light cutters, or a total of 298, were built in 1932, the 1935 output reached only 435 and 101, respectively, an aggregate of but 536 (see Table 1**). The intermittent gains made in production during this period indicate that output had to be held back because of troubles in the field that dictated frequent changes in design and manufacture. As late as 1934, according to the report of Zvorykin, referring probably only to heavy coal cutters, of the inventory of 1,752 machines, only 738 were of domestic manufacture.*** However, of 177 machines added to the inventory in 1934, Zvorykin reported that only 42 were imported from abroad (see Table 2****).

The production of pneumatic picks reached a high of 9,578 in 1934. The inventory of this item in 1934 totaled 12,931 units (see Table 1**). The production of mine locomotives was also expanded from 87 to 245 units in 1933. However, this peak was not achieved again during any of the succeeding years of the Second Five Year Plan (see Table 1**). The percentage of coal pushed on carts by hand fell from 11.5 in 1932 to 5 in 1937. Horse-drawn haulage was reduced in the same years from 58.9 to 41.4 percent. An experiment in rope haulage was tried,

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* P. 19, above.

** P. 15, above.

*** Production of light cutters probably never exceeded 100 to 125 per year as late as the end of 1935. At no time does their output of coal appear to have amounted to more than 1 percent of the total coal output.

From Table 2 (p. 17, above), based on Zvorykin's figures, it appears that only 135 domestically built heavy cutters were added to the inventory in 1934, which should be contrasted with the official production figure of 362 heavy cutters shown in Table 1 (p. 15, above).

**** P. 17, above.

which carried the percentage moved underground by that means from 11.8 percent in 1932 up to 24 percent in 1933. Thereafter the percentage dwindled to 19.8 in 1937. Whether this decline resulted from partial abandonment of this system or whether it is to be accounted for by the expansion of mine haulage by means of electric locomotives is not known. At any rate, the amount of coal transported underground by locomotives fell from 17.8 percent in 1932 to 12.9 percent in 1933, the peak year of rope haulage, and then rose again to 51.9 percent in 1938 (see Table 6*).

From these data it appears that while the USSR achieved some production of coal cutters, pneumatic picks, and coal mine locomotives during the Second Five Year Plan, difficulties were experienced in building equipment of the quality needed. Numerous changes had to be made in design and construction. Many more prototypes were constructed for experimental purposes than went into production. It is likely that during this period most production was in batches of a few machines at a time. In other words, the USSR, like the US, had difficulty in its initial efforts to build complex, heavy-duty items of capital goods such as coal cutters. However, the US had solved most of its problems in the production of coal cutters by 1932, at a time when the USSR was first tackling the problem. By 1932 the US was turning its attention to the mechanization of underground coal loading, a problem which the USSR did not attack until the end of the decade and which it is only now beginning to meet with any degree of success.

4. World War II.

By the end of the Second Five Year Plan (1933-37) the USSR had established a coal mining equipment industry, but it was only with difficulty that the USSR was able to build moderately complex, heavy-duty, durable capital goods of the kind needed by its coal mines. Coal was necessary in an industrial economy. To mine coal by hand required a considerable amount of labor, an amount that sometimes could be spared more by a highly industrialized nation than by a rapidly industrializing one, such as the USSR, where planning placed a premium on certain types of labor. Mechanization of the coal mines as a means of spreading the limited labor supply, therefore, has had a high priority in each of the Soviet Five Year Plans.

* P. 23, above.

It is estimated that by the end of 1940 the USSR had built up an inventory of about 4,000 coal cutters, 18,000 pneumatic picks, and about 1,850 electric mine locomotives (see Table 1*). Experimental work was underway with tractor-mounted coal cutters, coal combines, and coal loaders. By 1940, also, 56 percent of the coal output was being cut mechanically as that term is understood in the US; hand mining was reduced to 7.4 percent of the total output (see Table 3**); the amount of coal transported by hand pushing of cars had been cut to only 0.7 percent; and that moved underground by means of electrical locomotives had been increased to 67.2 percent (see Table 9***). Despite the threat of war, the coal mining equipment industry continued to receive high priorities. The 1941 Gosplan proposed that coal production be raised to 191 million MT and that for that purpose there be built 1,360 heavy coal cutters, 500 light coal cutters, 200 electric mine locomotives, 400 loading machines, 125,000 mine cars, 10,000 pneumatic picks, and a wide variety of subsidiary equipment and spare parts. 40/

The occupation of the Donbas in 1941 virtually halted production of both coal mining machinery and coal in what had been the chief producing areas for both these commodities. Coal cut by cutters in the whole country dropped to 29.8 percent in 1943, and the hand pushing of cars rose again to 8.9 percent, as reliance for coal was placed on the less mechanized areas. As the war continued, however, production of machinery was pushed behind the lines, so that mechanization began to rise once more even before the Germans were driven out of the Ukraine. 41/ The evacuation of the Donbas left a widely ruined area in which plants had been partially evacuated by the defenders and partially demolished by the invaders, and the mines themselves were flooded by the retreating German troops. 42/

5. 1945-52.

In its Fourth, first postwar, Five Year Plan (1946-50) the USSR proposed to restore the ruined mines and bring the total production of coal up to 250 million MT per year by the end of 1950, as compared with 166 million MT in 1940, an increase of 51 percent over the prewar level. To achieve this new level of production, it was planned to put into operation pits with a capacity of 183 million MT. In the Donbas alone it was planned to restore 182 large pits with a total

* P. 15, above.
** P. 19, above.
*** P. 50, below.

capacity of 67.7 million MT and open 60 new pits with a total capacity of 14.1 million MT. By the end of 1949 the Donbas was to be restored to its prewar output. Not only would this create a heavy demand for coal mining machinery, but also, insofar as the coal mining equipment industry was concerned, the Plan asserted that the many new mines to be opened would be operated in the most modern manner. It was expected, therefore, that the number of machines used in the coal industry would be increased to three or four times the prewar figure. The USSR also had in mind not only the fulfillment of its coal needs at a savings in manpower as compared with the past but also the improvement of the quality of the coal to be mined. To meet the demands of industry, it was proposed to produce 57.7 million MT of quality coking coal by the end of 1950. By that time, it was decreed, all coking coal with over 7 percent ash and all powerhouse coal with more than 10 percent ash must be beneficiated.* This would require that by 1950, 53 million MT of coking coal and 97 million MT of powerhouse coal, a total of 150 million MT of coal, would be concentrated. For efficient use, more of the output of brown coal was to be briquetted, thereby bringing the total quantity of coal briquetted up to 7.4 million MT. All new pits were to have individual or group concentration and screening facilities. To meet this goal, it was expected to build 271 coal concentration plants with a capacity of 175 million MT per year and to rehabilitate 6 existing concentration plants with a capacity of 9 million MT per year. Furthermore, it was planned to erect 26 briquetting plants with a capacity of 10 million MT per year. In order to organize the manufacture of coal-concentrating equipment, it was planned to build two new machinery plants, one in the Donbas and one in the Kuzbas. 43/

Mechanization during the period was to be increased extensively, as witness the aim to build in the factories of the Ministry of the Coal Industry 11,000 cutting machines, 4,900 electric locomotives, 565,000 mine cars, 33,000 scraper and belt conveyors, 1,600 mine lifts and winches, and 13,000 centrifugal pumps. 44/ In order to provide the mines with this considerable quantity of equipment, it was planned to erect 13 new coal mining equipment plants and to rehabilitate or restore 16 existing plants in the 5-year period. 45/ Although the 1946-50 Plan had as its objective the annual mining of 250 million MT of coal by 1950, a long-run goal of 500 million MT per year was announced by Premier Stalin early in 1946, at an election meeting on 9 February in the Stalin Electoral District in Moscow. This goal was to be achieved within the next 15 years. 46/

* Beneficiation and concentration refer to processing of coal to remove foreign matter.

Insofar as the coal mines were concerned, they met their Five Year Plan goal in the fourth quarter of 1949, more than a year ahead of schedule. 47/ In 1950 they produced 262 million MT. In 1951 the output was increased to 283 million MT and for 1952 has been estimated at 303 million MT.

The Fifth Five Year Plan (1951-55), details of which were released on 20 August 1952, provides for an increase in coal output by 1955 of 43 percent over that of 1950. This increase would bring the annual output at the end of 1955 up to 375 million MT by annual increments of about 24.3 million MT. To reach the goal of 500 million MT by 1960 would then require annual increases during the next 5 years of about 25 million MT.

The raising of coal output from a quarter to half a billion MT in a decade will require either a great amount of additional machinery or else an extensive use of additional manpower. In the Fifth Five Year Plan the USSR declares its aim to be as follows:

> "To improve systematically the methods of working coal deposits. To introduce on a wider scale the coal mining machines and equipment for the comprehensive mechanization, to aim at further technical re-equipment of the coal industry, and to insure a growth of labor productivity.
>
> "To develop in every way the mechanization of the heavy labor consuming processes in coal mining, primarily the cutting and haulage of coal and rock during the tunneling of preparatory workings, as well as to introduce on a wider scale mechanized methods of propping the walls.
>
> "To increase the commissioning of collieries' capacities by approximately 30 percent, as compared with the Fourth Five Year Plan." 48/

From this statement it may be judged that the Soviet coal industry will require in the foreseeable future not only the complete range of equipment necessary to achieve the expansion of its coal output but also enough additional combines, loaders, and conveyors to improve labor productivity in the industry. From other sections of the Plan it is also clear that there will be a strong demand for coal-processing equipment. On the other hand, it is expected to bring about some of

these increases in output by improving the operating efficiency of present equipment, as a result of what is termed the "single-cycle" movement.*

Such an ambition is realizable to the extent that the USSR has matured as a machine building country. It would not have been possible during the First Five Year Plan. Before World War II, however, the USSR had already begun to experiment with universal coal cutters; with underground mobile loading machines to break the bottleneck of hand loading, which has held down labor productivity all over the world outside of the US; and with so-called coal combines, which both cut and load coal directly without the use of pneumatic picks or blasting powder. Development work on these new devices was pressed rapidly following World War II. By the close of 1951 the inventory of coal cutters was raised from a low point of perhaps 1,100 at the end of 1944 to 20 percent more than in 1940, 49/ presaging a 1951 figure of about 4,850 cutters of all types. By raising its output of coal cutters to an average of about 1,200 per year, the prewar inventory has been completely replaced with new equipment (see Table 1**). The percentage of coal mined by means of heavy cutters, which had reached a peak of 55.2 percent in 1940, fell to a low of 29.2 percent in 1943 and rose again to 45.1 percent in 1949, the last year for which these data are available. 50/*** Although the percentage of coal mined with pneumatic picks fell from 19.3 percent in 1940 to 11.3 percent in 1949, 51/ the number of such picks in use had increased by 1951 to 80 percent above the 1940 inventory. 52/

Of greater significance in the postwar period, however, was the development of the coal combine. Some work had been done with these machines before the war, but as late as 1940 they had been responsible for only 0.1 percent of the coal output of the USSR (see Table 3****). The development of a machine that would actually cut, break, and load coal rather than merely undercut it had been a tantalizing temptation

* This movement is an efficiency campaign which strives to finish a complete operational cycle at each mining place on every working day.

** P. 15, above.

*** In 1947 the data on output of heavy and light cutters were combined. The output of the latter had dropped to but 0.4 percent in 1946.

**** P. 19, above.

to designers of mining machinery for many years. Special difficulties had retarded the successful commercialization of such apparatus, although experimental models had been tried at various times in the US, the UK, and Germany. At least three different types of coal combines had been built and tested in the USSR before 1940 but without great success. Experimental work, however, which may have been continued through the war years, was pushed intensively after the war. By 1949, almost a dozen more types of combines had been built and tested in the USSR. 53/ In the same years the leading US builders of coal mining machinery gave serious attention to the production of a commercially feasible coal combine. At least two such manufacturers have placed this kind of equipment on the market since 1945. However, the USSR has been so prolific in its drive to build a successful combine that it has designed, built, and tested more prototypes than all the rest of world together since the end of the war. Some of these USSR machines cut coal but proved too unwieldy for economical operation. Others failed to break the coal up sufficiently to move it onto conveyors. No workable solution was found until the introduction of the Donbas combine in 1948, 54/ a machine which has proved very successful. The output per coal cutter was reported as 3,050 MT per month in 1948, 55/ and by 1950 the Donbas combine was expected to meet monthly quotas of about 4,500 MT.* 56/ On occasion the Donbas combine has mined over 20,000 MT per month. 57/ The quota in some Donbas mines has been raised to almost 13,000 MT. 58/ As early as 1949, combines were producing 4.5 percent of the national output of coal (see Table 3**). By November 1951 it was claimed that every mine in the Donbas area was using coal combines and that 1 ton in 4 was being mined by coal combines. 59/ The chief limitation of the Donbas combine was that it was restricted by its inherent design to seams of approximately 0.8 to 1.5 meters (m) thick. 60/ Since this type of machine proved so successful, similar combines were being designed in 1950 to mine thinner seams, and special efforts were being made to solve the problem of building combines adapted to the mining of thick seams and steeply sloping seams. 61/

The implication of Soviet success in the development of coal combines which mine coal directly and load it at once onto conveyors, thus bypassing pneumatic picks, drilling, blasting, and hand-loading, must not be underestimated. Such an achievement could lead to impressive

* These figures probably are for machines in actual use rather than averages for the entire inventory of machines. On the latter basis the Soviet output per machine would drop by about 25 percent.
** P. 19, above.

savings both in manpower at the mine and in the input of labor and materials to the manufacture of coal mining machinery. A coal combine, capable of mining 13,000 MT per month, would have an output of 156,000 MT per year. Only 6.42 such machines would be needed to yield a million MT of coal in a year. Were it feasible to mine all working places at this average rate, including the thick places, the thin ones, the pitching seams, and the development entries, then the USSR would have needed only about 1,800 combines to produce its 283 million MT of 1951. With an inventory of only about 3,200 such combines it would be possible to achieve the 1960 goal of half a billion MT of coal.* If an eighth of the Soviet output is to be produced by the highly productive open-pit methods, then the number of combines needed would be further reduced. By contrast the USSR was able to obtain only 283 million MT in 1951 from over 4,800 coal cutters, about 460 combines, and several thousand pneumatic picks, not to mention the coal blasted from the solid or mined by open-pit methods. Widespread conversion to combine mining promises great savings both in machinery and in manpower alone, as well as in the technical advantages from rapid, concentrated exploitation of the mine face. This new Soviet technical development therefore merits close watching.

* The US now uses almost 15,000 shortwall and universal cutters to mine this amount of coal. 62/

II. Organization and Operation of the Industry.

A. Organization.

The coal mining equipment industry in the USSR is at present organized as Glavuglemash (Glavnoye Upravleniye Ugol'nogo Mashinostroyeniya -- Main Administration of Coal Machine Building) under the MUP (Ministerstvo Ugol'noy Promyshlennosti -- All-Union Ministry of the Coal Industry).* This All-Union Ministry was created by a ukase of the Presidium of the Supreme Soviet of the USSR, of 28 December 1948, that united the Ministry of the Coal Industry of the Western Regions of the USSR with the Ministry of the Coal Industry of the Eastern Regions of the USSR and the Ministry of Construction of Fuel Enterprises of the USSR.** Prior to their merger into a unified ministry, the ministries of the eastern and western regions had each contained within their respective structures a Main Administration of Coal Machine Building. 63/

By statute, the Ministry of the Coal Industry is empowered to direct enterprises and organizations of the All-Union level that are engaged in the prospecting of coal and shale deposits; in planning and constructing coal and shale enterprises, together with needed industrial buildings and dwellings; in building coal mining machinery, providing subsidiary materials and facilities; and in

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* For an organization chart, see Fig. 1, following p. 36.

** During the early 1930's the coal industry was administered by the All-Union People's Commissariat of Heavy Industry. The coal industry was independently organized as the All-Union People's Commissariat of Fuel Industry by a ukase of the Presidium of the Supreme Soviet of the USSR, of 24 January 1939. This organization included the coal, shale, and petroleum industries. It was further subdivided by a ukase of 12 October 1939 into the All-Union People's Commissariat of the Coal Industry of the USSR and the All-Union People's Commissariat of the Petroleum Industry of the USSR. The former organization was split into the All-Union People's Commissariat of the Coal Industry of the Western Regions of the USSR and the All-Union People's Commissariat of the Coal Industry of the Eastern Regions of the USSR by a ukase of 19 January 1946. Shortly thereafter, on 28 January, another ukase established the People's Commissariat of Construction of Fuel Enterprises of the USSR. These three commissariats became ministries on 15 March 1946.

the actual mining, concentrating, and briquetting of coal and shale. The Ministry is further charged with developing the coal and shale industry in conformance with plans approved by the government so as to satisfy the needs of the economy for coal and shale on the basis of the complete mechanization of production processes. Besides being held responsible for expanding the industry in order to meet national needs, the Ministry is expected to create a permanent body of qualified workers, engineers, and technicians for increasing labor productivity, for improving the quality of the product, and for lowering the costs of operation.

The Ministry of the Coal Industry is headed by a Minister with broad powers over personnel and policy, subject to guidance by a Collegium, or consulting board, appointed by the Minister, with himself as chairman, together with his vice-ministers and the supervisory workers in the Ministry. Appointments to the Collegium are subject to ratification by the Council of Ministers of the USSR. Besides drawing up prospective, yearly, and quarterly production plans for the industry, the Ministry plans for capital construction; for the introduction of advanced techniques; for the mechanization and automatization of production processes; for the necessary transportation; and for the marketing of the product, subject to confirmation by the Council of Ministers of the USSR.

The Ministry of the Coal Industry is therefore expected to produce the needed amount of coal of the required quality and to assure profits for the coal mining enterprises. These numerous responsibilities are multifarious and extensive in nature. For the purpose of this report, emphasis is placed only on the Ministry's interest in coal mining machinery. In this area the Ministry is responsible for the management of scientific research in the field. In addition, it is expected to develop and present, subject to confirmation of the Council of Ministers, designs for new basic machinery and mechanisms intended for series production, as well as proposals for the discontinuance of production of obsolete machinery and mechanisms. 64/

In the USSR, in other words, the coal mining industry has the status of an independent enterprise. The coal mining equipment industry, by contrast, is a subsidiary of the coal mining industry proper and may be regarded as an enterprise erected primarily to serve the coal mining industry. The Ministry of the Coal Industry was there-

S-E-C-R-E-T

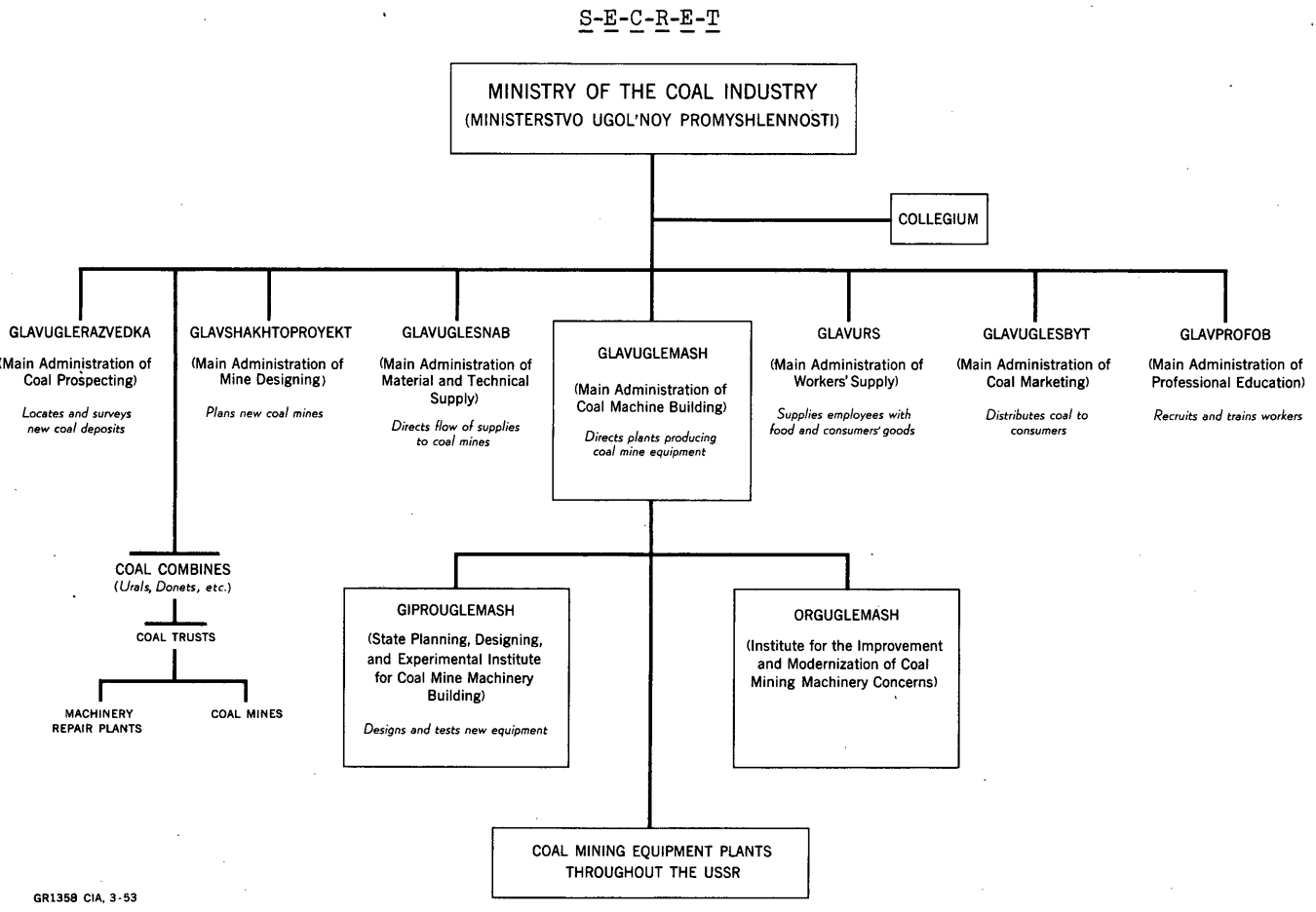

Figure 1. Organization of the Coal Mining Equipment Industry of the USSR. 65/

S-E-C-R-E-T

fore expected to organize and supervise the coal mining machinery plants as well as the coal mines themselves. In its coal mining machinery plants the Ministry is responsible for selecting personnel at the various levels; for the introduction of new and progressive techniques; for the management of production in all of its details; for the allocation of materials, fuel, and power; for the establishment of work norms and technical norms; for the setting of prices; and for the financing of the enterprises. Moreover, the Ministry is also expected to direct socialist competition established to develop creative initiative among workers, engineers, and technicians so as to increase labor productivity, fulfill the production plans ahead of schedule, improve the quality of products, increase the profits, and provide above-plan accumulations of capital. In addition, it is held responsible for the physical well-being and proper utilization of the workers. 66/ In a sense, therefore, the Ministry is directed to produce at a profit mining machines in one of its enterprises, which it then sells to itself for use in the production of coal. The Ministry is thus both buyer and seller of its own products.

Glavuglemash, it is understood, supervises the management of the Soviet coal mining equipment plants, subject in turn to the Ministry of the Coal Industry. Under Glavuglemash, there were at the end of World War II some 16 mining equipment plants. The Fourth Five Year Plan (1946-50) called for the rebuilding and rehabilitation of these 16 plants and the construction of 13 new plants. 67/ The industry also possesses a much larger number of repair shops, which, however, are located either in the mines directly or under the various mine trusts rather than under Glavuglemash.

Although Glavuglemash directs the building of coal mining machinery, both it and its predecessors have delegated the design and testing of new equipment to more specialized organizations. Little is known as to the present details of its operation. When mining machinery in general was built by the People's Commissariat of Heavy Industry, back in the period of the Second Five Year Plan (1933-37), that organization turned over responsibility for design and testing to Gormashproekt, which may be translated as the Mining Machine Project. Toward the end of 1938 this agency was ordered to concentrate its research on coal mining machinery. It was then redesignated Uglemashproekt, or the Coal Mining Machinery Project. Originally located in Moscow, Uglemashproekt is said to have moved to Kizel in the Urals in 1941. Uglemashproekt was administered by a director, aided by a chief engineer and a chief technologist, through a number of departments

and offices. The chief engineer, with the assistance of an Economic Planning Department, drew up yearly and five-yearly plans for the development and manufacture of coal mining equipment. These plans were coordinated in turn with the

1. Main Administration of Coal Machine Building, attached to the People's Commissariat of the Coal Industry.
2. Main Administration of the Coal Industry.
3. Main Administration of Coal Mine Construction.
4. Division of Plans and Production of the People's Commissariat of the Coal Industry.
5. Scientific Technical Council of the People's Commissariat of the Coal Industry.

Uglemashproekt, it is reported, was responsible also for the design, construction, and testing of new equipment for the coal industry. It functioned as a servant of other organizations within the industry in the development of new apparatus. Requests for appropriations of funds for each project were referred back to the commissariat or organization that had initiated the activity. Senior engineers were placed in charge of the various projects as chief construction engineers, and they were provided with necessary technical and construction personnel. Specialists from manufacturing plants and construction firms were invited in as consultants. Copies of blueprints were kept on file in a central archives for reference purposes. Test models were built under the supervision of the inventor. The latter, it has been stated, was not held responsible for the success of his ideas until they passed into the model stage. Thereafter he was held accountable for the performance of his model, even though its lack of success may have been due to poor materials. Uglemashproekt also had a construction department and testing laboratory. More than a a dozen different coal mining machinery items have been evidenced as having been designed and tested by Uglemashproekt between 1939 and 1941, ranging from drills to coal loaders. The organization is also said to have engaged in research and construction of models of various machinery for military use, particularly for the air force. 68/*

* Personnel of Uglemashproekt were reportedly paid either fixed salaries or sums based on the amount of work done. The chief construction engineer was said to have been paid a monthly base sum plus 3 rubles for each sheet of finished drawings for his projects, together with 5 percent of the difference between the estimated and the actual cost of production when the latter was lower, together with commissions ranging from 1 to 5 percent of the total cost of the project, depending on how good a rating was given to the finished machine.

Today the lineal descendent of Uglemashproekt is Giprouglemash (Gosudarstvennyy Proyektno-konstruktorskiy i Eksperimental'nyy Institut Ugol'nogo Mashinostroyeniya -- State Planning, Designing, and Experimental Institute for Coal Mine Machinery Building). New machinery is usually designed by (1) Giprouglemash, (2) regional research and planning institutes, or (3) individual mining engineers on the staff of district combines, trusts, or mines. Thus one reads in the Soviet press that Giprouglemash has developed a new coal combine, denoted the UKT-1, for seams too thin to be mined by the Donbas combine. 69/ Or it may be disclosed that the Donets Scientific Research Institute of Coal has designed the new UKMG-1 thin-seam coal combine in cooperation with the Gorlovka Mining Equipment Plant imeni Kirov. 70/

B. Operation.

The centralized, hierarchical character of the organization of the Soviet coal mining industry, to which the coal mining equipment plants are attached as service organizations, has contributed much to the integration of the design and manufacture of coal mining equipment. It is clear that the personnel of central and regional organizations (see Appendix A) have cooperated closely in the design and manufacture of equipment, as is also true of the executives and engineers of administrative, design, and manufacturing units. Both formally, in terms of its structure, and informally, in terms of the dynamics of its operation, the coal mining industry is therefore integrated to a very high degree. Its purpose is to build in its own plants the specialized equipment that it needs to operate its coal mines.*

From a manufacturing point of view, however, no attempt has been made to concentrate the building of all equipment in a single, integrated plant. Instead, it will be seen, plants are distributed regionally, corresponding to the dispersion of the various coal mining basins, and with regard also to their respective manufacturing capabilities. To date, therefore, the most important plants have been located in the Donbas and Urals areas, where both mining and industrial

* One exception has been the S-153 mobile loader, which is built for the Ministry, at Sverdlovsk, by the Ministry of Transport Machinery (see III, below). By the same token the coal industry may occasionally sell mining equipment to other industries: for example, to the metal mines.

activities have been concentrated and developed to a relatively intense degree. Even within these areas, however, coal mining machinery plants have tended to specialize in the manufacture of related products rather than to work toward a high degree of horizontal integration. As a result, coal cutters and combines are generally built in one plant, coal mine cars and locomotives in another, and underground conveyors in still other establishments. This arrangement may be substantiated by the logic that coal cutters require much close machining, whereas the manufacture of haulage and conveying equipment calls for metal stamping and sheet-metal operations of a less precise character. Nevertheless, all plants appear to carry on various subsidiary manufacturing operations related to their facilities and skills on a basis comparable to that of similar enterprises in capitalist countries.

If horizontal integration has been held in check, however, vertical integration has been pushed to a considerable extent. Each of the major plants appears to have its own casting department, employing one or more cupolas and rendering it independent to a high degree of outside services in pattern making, casting, and preparation of castings for final machining. By the same token, heat-treating facilities are well distributed throughout the plants as required. No instance has been found, however, of coal mining machinery plants' possessing captive coal mines or ore supplies. Nor has any evidence been discovered of the plants producing their own pig iron.

Definite limits have been placed on the degree of self-sufficiency of each plant. Motors and controllers are generally procured from outside the industry. It would appear that standard types are used to a considerable extent, though the types probably have been developed with special regard to the needs of the coal mining industry. By the same token, no evidence has been found that would indicate that the coal mining machinery enterprises are meeting their own needs for precision bearings. The evidence, on the contrary, indicates that they are dependent for such items on the bearings industry. From the point of view of vulnerability, therefore, it may be said that depriving the coal mining machinery plants of bearings and motors would impede their production of new equipment almost as much as if they had been the subject of direct attack. Replacement bearings, it may also be indicated, are quite essential to the continued operation of coal mining machines in the field. An indirect attack of this type, however, would not wholly interdict the flow of other spare parts, on which the coal mining industry is very dependent for the maintenance of existing production norms.

III. Current Design and Technology in Soviet Underground Coal Mining.

A. Factors Conditioning Design.

Although there are many ways to approach the problem of designing equipment for mechanical mining, the methods employed must give heed to certain basic conditions which in practice serve as limiting and conditioning factors. First and foremost of these controlling influences is whether or not it has been customary to mine by means of longwall or shortwall methods (see Fig. 2*). Geological conditions determine to a considerable degree whether the roof over the coal seam is favorable to longwall mining. In practice, however, the custom of the country probably decides more than any other single factor whether or not coal is mined from long faces or by means of the room-and-pillar method. Generally speaking, longwall mining results in the extraction of a greater percentage of the coal and therefore may be said to conserve natural resources. In return it requires more careful scheduling of work operations, close control of the roof, and more preparatory work. To some extent, therefore, the saving effected in natural resources is compensated for in lower productivity per man employed. This differential in favor of shortwall methods depends, however, upon the fact that until recently most serious efforts to design coal mining machinery have been directed at shortwall operations. Recent British, German, and especially Soviet attention to the design of longwall mining equipment may in time overcome the economic handicaps which have in the past retarded the mechanization of long-face workings.

Attention is given in this report to coal mining methods only to the extent that they influence the demand for and the design of mining machinery. Consider, for example, two different mines, one a shortwall operation and the other a longwall, but each with the same annual output of coal. In the shortwall mine it will be necessary to undercut a relatively larger number of short faces than in the longwall mine. Since a machine can undercut the coal at a shortwall face in a few minutes, it is necessary, to avoid its being idle while the coal is drilled, shot, and loaded, that it move from room to room throughout the working period. Shortwall cutters thus have to be built with this kind of portability in mind. For this reason, they are frequently mounted on

* Following p. 42.

rails, tractors, or rubber tires in the US.* In longwall mining, on the other hand, no time is lost in moving machines from room to room. Cutters merely move back and forth along the same coal face. Longwall cutters, however, must be designed to operate in the narrow space between the face and the props that support the roof. It should be noted, nevertheless, that in longwall mines the cutting of haulageways, entryways, and other preparatory work takes on the aspects of shortwall operations and tends to require that each mine be equipped with a certain number of shortwall cutters or other specially designed preparatory equipment.

Coal cutters should also be adapted to the character of the local coal seams. Coal that is hard to cut may require special alloy steel cutter bits and extra-heavy motors. There are times when it is desirable to make the cut, or kerf, in the middle or top of the seam. At other times a vertical shearing cut is indicated. Ordinary coal cutters are not suited for this service, but on mounted cutters the bar is often placed in a special position. Moreover, the cutter bars can also be fitted in such a way as to permit their being operated from a number of different positions. Such cutters are known as universal machines. By the same token the type of coal desired may condition the kind of coal cutter employed. For coking purposes, lump coal is demanded. Where fine coal is wanted, as for stoker operation, conditions often favor the rapid, universal cutters, sometimes known as arcwall cutters, even though the sweeping circular cut which they make requires that the coal be shot down so hard as to break it up too fine for coking purposes.

Longwall mining also imposes different loading and haulage problems than does the shortwall system. In US shortwall mines it is now customary to load coal mechanically either by the use of mobile loaders, which feed onto chain or belt conveyors, or by means of duckbill loading heads attached to shaker conveyors. The short length of the face facilitates such operations. Since the roof is supported by pillars of coal, there is usually ample maneuvering room for mobile loaders. As the room is worked out, new sections are added to the loading ends of the conveyors. Conveyors are thus replacing mine cars and locomotives for work in the rooms, especially in low coal, thus eliminating the necessity of laying track in the rooms. In many installations the coal cutters and conveyors are

* Or are provided with self-propelled trucks for movement from room to room.

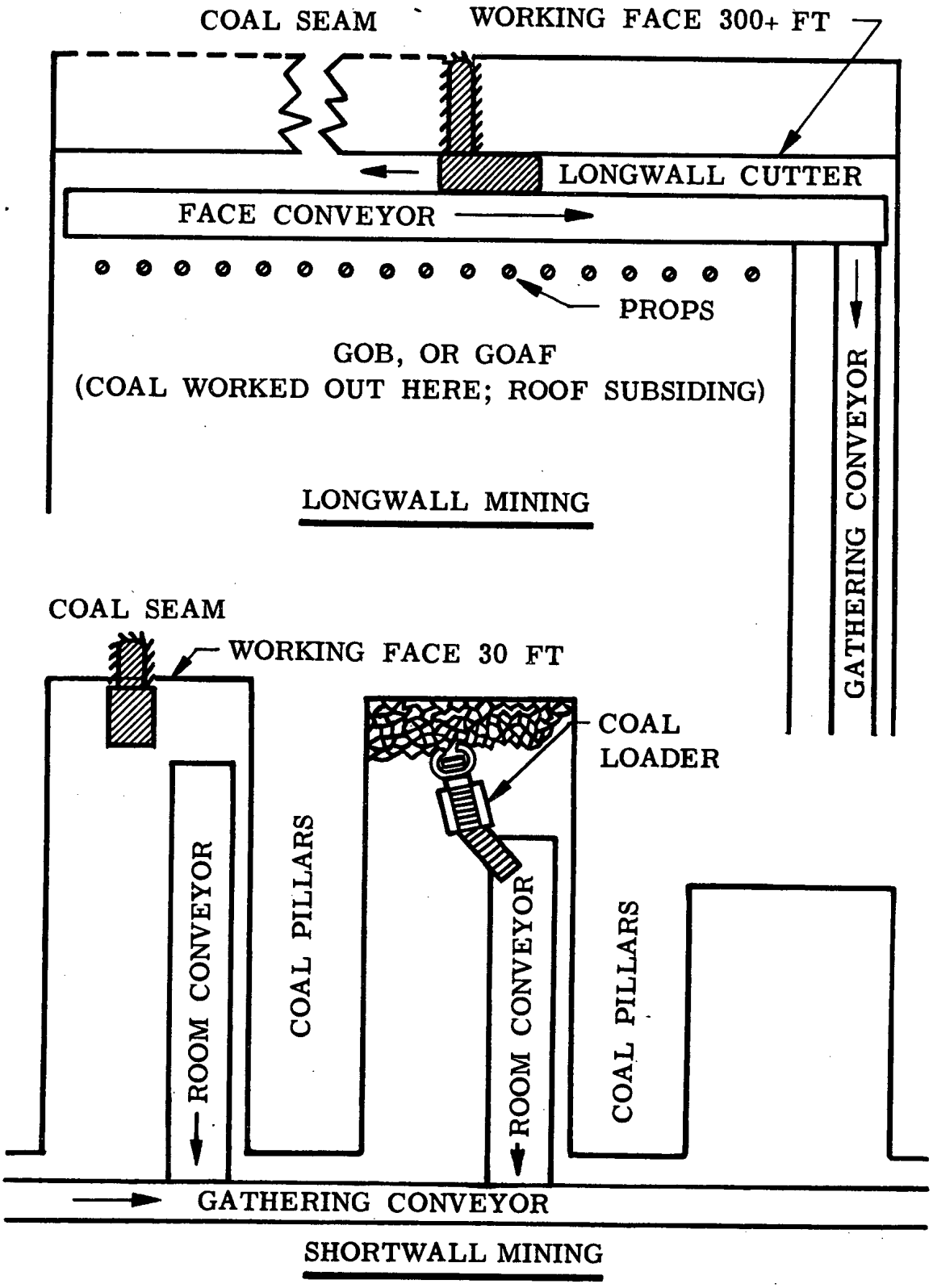

Figure 2. Comparative Coal Mining Methods.

mounted on tractors or rubber tires. So-called self-propelled shuttle cars have also been introduced, mounted on rubber tires or caterpillar tracks, which receive the discharge from mobile loaders and shuttle it out to main-line haulage stations for mechanical transfer to conveyors or regular mine cars.

In longwall mines, by contrast, the coal must be loaded from a face of several hundred feet, along which working space is restricted by the necessary roof supports, thus usually precluding the employment of mobile loaders or shuttle cars. In the UK and on the Continent the tendency has been to load by hand to face conveyors which discharge to main-line haulage systems. Observers are generally agreed that this hand loading constitutes the major bottleneck or obstacle to the increase of coal production and labor productivity in European mining. Moreover, as the work progresses, the entire face conveyor must be moved forward every working cycle by the depth of the coal cut. To cope with this problem, hydraulic and pneumatic jacks are frequently used to reset the conveyor line as the work advances.

The length of the working face in longwall mining facilitates the concentration of men, supervision, and equipment, but productivity has been held down by the lack of suitable loading machinery. Various designers have tried to break this bottleneck by rendering the mining operation more continuous. Between separate coal cutters and loaders on the one hand and true combines or continuous miners on the other lies an intermediate type which may be termed the cutter-loader. Such machines undercut the coal in the usual manner. After it has been blasted down or broken down with pneumatic picks, or merely allowed to fall of its own weight where conditions are favorable, the same machine, or its twin, is converted into a coal loader which passes once more along the coal face to load the fallen coal onto a conveyor. Such machines do not ordinarily break down the coal themselves. Moreover, they divide the mining operation into three or more cycles, of which they perform only the first and the last steps.

A number of these machines, usually consisting of modifications of standard coal cutters, were tried in Soviet mines even before World War II. Thus the MP-3 was built up from a GTK-3M longwall cutter, the bar of which was fitted with a flight of scrapers arranged to move the previously cut and blasted coal onto the usual face conveyor. The MP-3 was tried experimentally in the Donbas before the war, but it was found difficult to blast the coal into sufficiently small lumps for the machine to move it effectively onto the conveyor. 71/

A variation was the BNU, designed by Giprouglemash, a trial model of which was tested in 1948. This machine also consisted of a GTK-3M, modified by the addition of a flight of scrapers similar to the MP-3. In operation the seam is undercut by means of a regular cutter that runs on the side of a chain conveyor very close to the face. Next, the coal is blasted out, so that about 39 percent falls onto the conveyor. Then the BNU makes a pass along the face. Its chain further breaks up the coal while its scrapers move another portion -- of, say, 40 to 45 percent -- onto the face conveyor. The remaining 20 to 25 percent is then hand-loaded onto the conveyor. Tests revealed faults in construction and design of such an extent that further experimentation was canceled. 72/

Of more significance have been the efforts to design combines, or continuous coal miners, capable of really mining the coal from the face and depositing it directly onto face conveyors, thus eliminating the intermediary drilling, blasting, chipping, and hand-loading operations. Perhaps the simplest machine that accomplishes all of these objects is the coal planer, or coal plow. At the end of World War II, industrial intelligence teams found that a number of coal planers (Kohlenhobel) were in use in the Ruhr. Designed to be drawn along the edge of the face conveyor by means of a winch, these heavy planes sheared off a few inches of coal as they proceeded. The coal fell directly onto the conveyor and was transported out of the room without the need of hand loading except for cleaning-up operations. 73/

Although the coal planer is a form of coal combine, its use is limited to rather low, soft coal. The coal planer may almost be thought of as a heavy tool rather than a machine. At least two true coal combines, the DEMAG and the Eickhoff, had reached the testing stage in Germany by the end of World War II. The DEMAG* employed the usual undercutter, together with a vertical shearing jib, driven by a separate motor, which also operated a loading device and a short belt conveyor that transferred the coal to the regular face conveyor. 74/ The Eickhoff,** after undercutting the coal in the usual manner, broke it away from the face by means of a horizontal breaker bar tipped with a circular shearing device. Conveyors built

* Built by Deutsche Maschinenfabrik, AG (DEMAG), Duisberg.
** Built by Eickhoff Gebr., Maschinenfabrik und Eisengiesserei, GmbH, Bochum.

into the machine transferred the cut coal through the props to the face conveyor. Although this model did not cut close enough to the floor to be successful, it is reported that Eickhoff has attempted to overcome original faults in design in its subsequent models. 75/

In the UK, similar combines have been built by at least three manufacturers. The Logan combine is equipped with four cutting chains, one of which is located at the top, one at the bottom, and two in vertical positions, in addition to a conveyor. 76/ The Meco-Moore machine* employs three cutters, one at the top, one at the bottom, and one at the rear of the face for shearing purposes, together with a breaker bar and a conveyor. According to Soviet sources, which follow these developments closely, 38 Meco-Moore machines were in operation in 1948. 77/ The Joy machine,** known as the "Gloucester Getter," is described [redacted] as employing two undercutter bars together with a vertical shearing bar to sever the coal from the face. Any coal not broken down by these means is detached by a trailing plow, which also guides the loose coal onto a flight conveyor. 50X1

As in certain other fields of invention, the USSR claims priority in the design of coal combines. According to its assertions, Soviet engineers designed the first combine for working soft seams in the 1920's. It also asserts that in 1930 a Bureau for Planning Coal Combines was established in Khar'kov, which designed a number of combines, including machines with contour bars articulated in two planes so that the same cutter chain could make both horizontal and shearing cuts. The Soviet story is that during the occupation of the Donbas, German engineers purloined Soviet combine technology, brought it back to Germany, and applied it to the German Eickhoff equipment. [redacted] also charges the British with appropriating Soviet combine designs. 50X1

It is significant that the USSR does not level this accusation at the US. Indeed, the Soviet author asserts that this survey of foreign coal combines must be limited to European countries, since the combines developed in the US are used almost

* Built by the Mining Engineering Company, Ltd., Worcester.
** Built by Joy-Sullivan, Ltd., London, the UK subsidiary of the Joy Manufacturing Company, with its main office at Pittsburgh, Pennsylvania.

exclusively for shortwall development work in rooms. 78/ At least two such combines have been placed on the US market in recent years.* Both are essentially mobile coal loaders that have been equipped with cutting heads to break coal away from the seam and transmit it to self-contained conveyors for transfer by room conveyors or by other means. These US continuous miners are high-production machines that may be expected in a few years to achieve further increases in US labor productivity.** 79/ Although they could be used in development work in the USSR in the opening up of new mines and the preparation of longwall rooms, the new US continuous miners would be too cumbersome for use in European longwall operations. In this field of the development of continuous longwall miners the USSR is, therefore, still on its own, so to speak, and can borrow little from US technology.

In the remaining underground operations of transporting the loaded coal from the working face to the mine tipple, the differences between longwall and shortwall mining tend to disappear. Formerly all countries used small mine cars, or tubs, that were pushed out of the rooms by hand or animal power. In the US, narrow-gauge electric locomotives took over this function early in the twentieth century. Special lightweight gathering locomotives were built for this purpose. To avoid extending trolley wires to the working face and to do away with the necessity of bonding the rails, which acted as return conductors, these gathering locomotives were fitted with long power cables arranged so as to pay out or take up automatically on a reel as the locomotive left the entryway and

* That is, the continuous miner of the Joy Manufacturing Company and the "Colmol" of the Jeffrey Manufacturing Company, Columbus, Ohio.

** Production of the 105 continuous miners in regular operation in the US in November 1951 is said to have averaged 170 to 190 short tons per shift, with 300 to 400 short tons per shift not uncommon. Production per machine is so high that conventional conveying methods have proved inadequate to carry the load. It has been reported that machines have sometimes worked only a third of a shift, waited for haulage facilities another third, and been held up by other causes the remainder of the time. In this respect, longwall mining offers a considerable advantage because of the greater quantity of coal that is mined before it is necessary to move the conveyor. In longwall mining, however, the whole conveyor must be advanced, whereas in shortwall work it is necessary only to extend the length of the conveyor.

gathered the loaded cars from the rooms. Storage-battery locomotives achieved similar results, especially in rooms troubled with mine gas. Heavier electric locomotives are used to haul trains of cars from assembly junctions to the bottom of the tipple. In the US, more recently, locomotives are yielding to portable conveyor systems, especially in rooms and secondary entryways as well as in low-coal operations. Locomotives have been less used in the UK and on the Continent than in the US. Regulations have often precluded the use of trolley locomotives. Longwall faces demand that the track be shifted by the depth of each cut made into the face. For this reason, endless rope haulage has been much used in European coal mines. Conveyors also have been popular there, especially along the longwall faces, since they can be moved more easily than track.

Although locomotives and conveyors are therefore employed in somewhat different ways in longwall and shortwall operations, the equipment used in both is relatively similar. On the whole, the trends, especially in conveyor design, have tended to follow common lines both in the US and in other coal mining countries.

B. Soviet Coal Mining Machines in Current Production.

1. Longwall Coal Cutters.

Three types of longwall coal cutters are known to be in production in the USSR: the KMP-1, the MV-60, and the GTK-35.

The KMP-1* is said to have been developed during World War II and to have gone into production shortly thereafter. It is mass-produced at the Kopeysk Mining Equipment Plant imeni S.M. Kirov.** 80/ Field comments on this machine indicate that it is a heavier version of the Joy Manufacturing Company's US-built CLE-5 longwall coal cutter. 81/ The KMP-1 was accepted for serial production in the USSR in 1947 after tests by a technical council of the coal industry, which also approved its use in coal mines of the eastern and western regions of the USSR, as then organized. It was recommended, however, (a) that the upper limits of the drive speed be increased, (b) that the cable capacity of the drum be also

* K refers to Kopeysk; M, to power; P, to pulsating; 1, to first model.

** For the Soviet name of this and other plants referred to in text, see Appendix B.

increased, and (c) that the length of the machine be reduced by the use of a smaller electric motor. At the same time, it was charged that its greatest fault lay in the poor quality of its manufacture by the Kopeysk plant. 82/ The KMP-1 is rated at 64 horsepower (hp) on a 1-hour full load as against 50 hp for its Joy prototype (see Table 9).* 83/

The KMP-1 has proved successful in the field. A Soviet press report in 1951 asserted with self-satisfaction that miners in the Donbas were paying high compliments to the KMP-1. Some machines, it was reported, were cutting 16,000 to 18,000 MT per month. 84/ Such conditions are, no doubt, very exceptional and several times more than the over-all average and norm. Nevertheless, this was the only standard longwall type coal cutter shown by the USSR at the 1951 Industrial Trade Fair at Helsinki, Finland. [redacted] the machine was strongly built of steel castings, with good workmanship and finish. Cutter picks and cutter chain blocks were forged, controls were centralized, and the motor was enclosed in a flashproof housing. All of these characteristics indicate attention to design.** 85/ 50X1

The MV-60 longwall coal cutter*** (see Fig. 3****) was designed by engineers N.A. Shuris and A.I. Chevnenko of Giprouglemash. Nine machines were built in 1946-47 by the Gorlovka Mining Equipment Plant imeni S.M. Kirov. 86/ After tests in the Kirovugol' Trust of the Ministry of the Coal Industry of Eastern Regions, it was announced in September 1947 that the machine was so long and so high as to make it difficult to maneuver in tight places or in coal lower than 0.65 m thick. Faults were found in its reversing mechanism and in the clutch. Most serious, it was reported that the design permitted the machine to slip, once the power was disconnected, when working on angles of 18 to 20 degrees or more. It was also found that the machine delivered only 50 to 55 percent of its rated 57-kilowatt (kw) power input. Although numerous changes had been made during the tests, the machine was referred back for further development. 87/

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* Table 9 follows on p. 50.

** The KMP-1 was displayed with alloy steel rather than with carbide-tipped bits. Carbide bits, however, are available in the USSR. At the Helsinki fair they were used on the Donbas combine. Production of the KMP-1 machine in 1952 may have reached 500 units (see Table 21, p. 138, below).

*** M refers to power; V, to cutting; 60, to 57 kw (as originally rated).

**** Following p. 94.

Field evaluation indicates that the MV-60 was designed along the lines of the Joy Manufacturing Company's British-built E-60 longwall coal cutter. Again, the Soviet machine is larger, heavier, and somewhat overpowered. 88/ It was meant to be a heavy-duty machine, suitable for cutting very hard coal and for achieving a high rate of production in soft and moderately hard coal. Its size and weight make it impractical for coal of less than 0.6 m thick. Since it is built up in sections, with a separate power unit, it has proved useful as a component around which to construct coal combines. In fact, the very successful Donbas combine has been designed around the power section of the MV-60. 89/

The initial criticism of the design of the MV-60 led to a harsh attack on it in the Soviet press, but the machine was defended by A.F. Zasyad'ko, Minister of the Coal Industry. 90/ Reports that it went into mass production in 1948 at the Gorlovka plant may be regarded skeptically. Although production of 300 had been scheduled for 1947, 91/ it is doubtful if manufacture on any considerable scale took place until late in 1948. By July 1949 the ratchet feed had been redesigned in the interest of stability and endurance.* Improvements had also been made in the ventilation of the motor in order to bring it up from an achieved continuous rating of 12.5 kw to its rated continuous capacity of 30 kw. 92/

It is therefore probable that the MV-60 did not go into production in any considerable quantity before 1949. Press reports in the middle of 1949 indicate that the Donbas was receiving increased numbers of the novel MV-60, 93/ but no official production figures have been released on this machine since that time.** A 1951 report on one installation indicated that in 10 months the machine had cut 130,000 MT, which amounted to 161 percent of the norm, suggesting that the norm for the MV-60 in 1951 in this seam was about 5,000 MT per month, 94/ or considerably above the 1948 norm of 3,050 MT for coal cutters in the USSR as a whole. 95/

* The number of speeds was cut from six to four. Whereas the previous top rate of feed had been 1.40 m per minute, the new top speed was reduced to 1.08 m per minute.

** Production in 1952 is estimated at about 450 units (see Table 21, p. 138, below).

Table 9

Technical Characteristics of Soviet Coal Cutters*

	Unit	Longwall Cutters			Shortwall Cutters	Universal Cutters
		KMP-1 96/	MV-60	GTK-35 97/	ShVD-48	VTU-1 a/**
Length (without Bug Duster)	mm	3,260	3,174 b/	2,685	1,600 c/	6,620 d/
Width	mm	750	720	685	1,290	1,300
Height (Maximum)	mm	370	400	305	680	1,440 e/
Length of Bar	m	1.6, 2, 2.4, 2.8		1.6-2.2	2.4	3
Depth of Cut	m		2-2.5			
Kerf (Thickness)	mm	140	120-140		140	
Weight	MT	3.2	3.5 f/	2.5	3.0	6
Feed Speed	m per min	0-0.86	0.27, 0.54, 0.81, 1.08	0.2, 0.4, 0.6, 0.8	0.63	
Feed Maneuvering Speed	m per min	8.6	14.5	12.0	5.8	
Rope Diameter	mm	15-17	17-19	15-17	17-18	
Drum Capacity	m	25	25	30	20 g/	
Haulage Force, Working	MT	5	7.0	5.0	6.0	
Regular Cutter-Chain Speed	m per sec	2.1	1.9	2.0	2.34	2.0, 2.4, 2.8
Retarded Cutter-Chain Speed	m per sec	1.05				
Feed Section Dimensions (HtxWtxL)	mm	360x750x845				
Feed Section Weight	kg	777				
Motor Dimensions	mm	350x700x1,216				
Motor Weight	kg	900				
Cutter Section Dimensions (Less Bar)	mm	370x720x1,200				
Cutter Section Weight	kg	994				
Bar Dimensions with Chain	kg	402				

* Spaces left blank in this table indicate that data are not available or not applicable.
** Footnotes for Table 9 follow on p. 51.

Table 9
Technical Characteristics of Soviet Coal Cutters
(Continued)

	Unit	Longwall Cutters			Shortwall Cutters	Universal Cutters
		KMP-1 95/	MV-60	GTK-35 97/	ShVD-48	VTU-1 a/
Motor	type	MA-191/11	MA-191/11	MA-191/35		MA-191/8
Hourly Capacity	kw	47	65	35	35 h/	47
Continuous Capacity	kw	21	30	20		26
Speed	rpm	1,475		1,465	960	
Starting Moment	kgm	69	120			
Voltage	v	380	380	380	380	380
Bug Duster Turning Speed	rpm		258			
Controller	type			KRV-3006 B	KRV-3006 B	
Plug Connector	type			ShV-9765	ShVD-9603	
Starter	type					
Prices 98/	rubles	43,500	49,000	20,000 i/		

a. Other characteristics: (1) Speed of movement on caterpillars (m per sec): (a) working, 0.8; (b) maneuvering, 16.8.
(2) Rotating speed of cutter head (degrees per min): (a) working, 38; (b) maneuvering, 638.
(3) Swing speed of bar (degrees per min): (a) working, 12.6; (b) maneuvering, 244.
(4) Pressure of treads on floor (kg per sq cm), 2.1.
b. The third digit is illegible in Soviet sources.
c. Length of body without bar.
d. Over-all length; length without bar, 3,785 mm.
e. Minimum height, 1,090 mm.
f. With 2-m battery.
g. Two drums.
h. Half-hourly capacity.
i. The price is for the GTK-3M, the previous model.

While struggling with design problems on the MV-60, the Gorlovka plant concentrated on the production of the older GTK-3M longwall coal cutter,* a relatively light-duty cutter designed for both development work and regular duty in coal faces. In addition, it was planned with such other uses in mind as the cutting of loose shale, chalk, salt, tuff, and shell-rock limestone. As compared with the 3.2-MT KMP-1 or the 3.5-MT MV-60, the GTK-3M weighed but 2 MT and was correspondingly lower in height, length, and width. 99/ It was reported as having but half the capacity of the new MV-60. 100/

By 1950 the GTK-3M, which it was deemed had become obsolete, was replaced with the further modified GTK-35,** a longer, narrower, and heavier machine. Both machines are of the same height. The height of 0.305 m adapts it to coal as low as 0.4 m. The power of the machine was stepped up from 25 to 35 kw to adapt it to work under hard-cutting conditions. The obsolete clutch and gear shift for the control of the rate of feed was replaced with a ratchet arrangement that has four working speeds, with a greater range than the predecessor machine and more like that of the KMP-1, though not so powerful as the MV-60. The GTK-35; moreover, is reported to employ a cutter bar of the same design and dimensions as does the heavier MV-60. All three of the postwar longwall cutters are equipped with "bug dusters," which are screw-like devices that remove the loose coal cuttings and dust from the kerf so as not to interfere with the operation of the cutter bar and to keep the kerf clear for blasting and breaking down of the coal. 101/ Forty of the new GTK-35's were to be ready for shipment from the Gorlovka plant by Miners' Day, at the end of August 1951.*** 102/

In summary, in the field of longwall coal cutters the USSR now has in production at Kopeysk, in the Urals, the KMP-1, a standard longwall coal cutter; and at Gorlovka, in the Donbas, there are in production the heavy coal cutter MV-60 for hard cutting and high production, together with the thin-seam coal cutter GTK-35 (see Table 21****).

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* G refers to Gorlovka; T, to heavy; K, to rope; 3, to third model; M, to modernized. This machine was an advance over the older GTK-3.

** Designations are the same as for the GTK-3M except that 35 refers to 35 kw.

*** Production in 1952 is estimated at 300 units.

**** P. 138, below.

2. Shortwall Coal Cutters.

Although the USSR mines most of its coal seams by means of the longwall method, it has for some time felt the need for a shortwall coal cutter capable of use in development work. Several of the light coal cutters designed in the early 1930's were intended for such service, but for one reason or another none was ever widely accepted.* After the war these were succeeded by the ShVD-46, which was designed for both development work and shortwall mining in dipping seams more than 0.85 m thick where the face extended from 3 to 4 to 15 to 20 m in length and where the slope was moderate. This machine does not appear to have been produced in any great numbers. 103/ Instead it was succeeded in 1949 by the ShVD-48, which has also been described as experimental and which, insofar as is known, has not yet gone into regular production either. 104/

Shortwall coal cutters pose quite a problem in the USSR. Development seams, being intended to open up longwall rooms, are located too far from one another to permit the movement of the machine from place to place in the mine. Production per machine is thus held down because the machine remains idle while the coal is broken down, loaded, and made ready for the next cut. One answer would be to design a light-duty shortwall coal cutter and be content with low production. This alternative, however, would not satisfy the demand for the rapid development of new places so as to keep up with the growing demand for coal. An alternative is to adopt some form of mounted cutter for preparatory coal mine operations.

3. Universal Coal Cutters.

In the USSR, some development passages are cut with universal coal cutters. In the US they were formerly mounted on rails to permit of free movement about the mine and to facilitate rapid operations. In recent years they have been mounted on tractor treads and even on rubber tires. In the US the standard shortwall coal cutter pulls itself across the face by means of power-operated cable drums. Track-mounted universal cutters are built to swing the cutter bar across the face so as to make a fan-shaped cut. For this reason, they have been called by the trade name, "arcwall" cutters. Tractor- and tire-mounted cutters have greater maneuverability, which permits them to make cuts with rectangular corners that are usually

* Reference is made here to the DL machine built by the Gorlovka plant in 1932-33 and to the BSh and the LVSh-2, all prewar models.

more desired. The head of the universal cutter, moreover, is so jointed as to permit its being rotated to make bottom, top, or vertical cuts into the coal or, if preferred, to do all of these. Universal machines have contributed to the high level of production in US shortwall mining.

In the USSR the Gorlovka plant turned out the GVU caterpillar-mounted universal coal cutter for development work back in 1939. Its improved successor, the VTU-1* (see Fig. 4**) passed its tests successfully in 1941 but did not go into production until after the war. Produced at the Voroshilov Arms Plant No. 4 in Krasnoyarsk, beginning about 1946, 105/ this machine was introduced into the Moscow basin in the spring of 1949, and by August it was reported that 50 were in successful operation in that area. 106/ The VTU-1, weighing approximately 6 MT, is mounted on caterpillar treads and is equipped with a 47-kw motor. It can cut from the floor to a height of 1.44 m, and in the upper position the bar can be swung 360 degrees. This machine was not intended to cut in low coal, and it is too wide for satisfactory longwall operation. As designed, it was meant for use in the high coal of the Moscow and Kuznets basins and, more generally, for development work.

In room work the VTU-1 has been recommended to serve two or three faces. Actually it could serve half a dozen or more shortwall faces, were they located close to one another as in US practice. It has been recommended, also, that this machine be worked in conjunction with the S-153 mobile coal loader. Time study has shown that if it takes the VTU-1 an hour to cut a face, then the coal can be loaded in about 2 to 2.5 hours. Allowing liberal time for the proposing and other operations, a full cycle of work can be completed easily in a single shift, ensuring a 3-m advance into the face. By careful organization of the work it is claimed that two cycles can be completed in a single shift, which would permit an advance of 18 running meters in 24 hours. 107/

It is apparent that the heavy VTU-1, although it may satisfy past Soviet standards, would not be earning its keep by US practice, where it would move from place to place in the mine, cutting a number of rooms in a single shift preparatory to blasting

* V refers to cutting; T, to heavy; U, to universal; 1, to first type.

** Following p. 94.

and loading on other shifts. In fact, it has even been criticized in the Soviet technical press as too heavy, awkward, and overpowered. 108/ It is believed, therefore, to have been withdrawn from production. This act places Soviet designers in somewhat of a dilemma. For development work they have vacillated between lightweight and heavyweight equipment. Lightweight equipment is not very productive. Heavy universal coal cutters are productive only when they can be used a high proportion of the working day, but it would appear doubtful from a theoretical point of view if any coal cutter will solve the Soviet problem. The answer lies instead in a special combine, designed particularly for entry work in high coal. Evidence is already at hand that the USSR, flushed with the success of the Donbas combine, will seek to extend combine mining to thin seams, pitching seams, and development work. In the latter field, in particular, the coal combine brings about continuous mining, thereby permitting a piece of equipment, granting that haulage facilities are adequate, to operate to its capacity during a maximum period of time instead of working intermittently and standing idle during the breaking-down and loading portions of the mining cycle.*

4. Cutter-Loaders.

After several unsuccessful prewar efforts to build cutter-loaders, the USSR in 1947 developed the VPM-1 cutter-loader,** consisting of a standard longwall cutter, to the bar of which a plow-shaped shield has been fastened (see Fig. 5***). The coal is undercut by means of a longwall cutter, riding along the edge of a chain-type face conveyor. Since the bar is tilted downward, a triangular-like section of coal is left uncut. Cuttings are carried by the chain onto the conveyor. Then the coal is blasted down in the usual manner. The cutting and blasting operations deposit about 35 percent of the coal on the chain conveyor. Next, the VPM-1, a standard longwall cutter with attached moldboard, makes a pass along the face, thereby transferring another

* An approximate estimate of the Soviet needs for different types of coal cutters can be made in terms of the wartime Lend-Lease program. Scheduled shipments in 1945 from the US to the USSR were to be 320 longwall cutters, only 54 shortwall cutters, and but 20 mounted-type universal cutters. 109/

** The VPM-1 was designed by Engineer V.P. Martynenko.

*** Following p. 94.

40 to 45 percent of the coal onto the conveyor. Finally the triangular section remaining uncut along the floor is broken up by hand. This coal and other loose coal missed by the loading cycle, totaling 20 to 25 percent, must be loaded by hand. However, the effectiveness of the VPM-1 improves with the thickness of the seam and has been used most extensively in seams more than 4 feet high, for which the USSR has as yet no completely successful coal combine. 110/ As recently as 1951 it was in use in the Rostov, Molotov, Karaganda, and Vostseib coal combines. 111/ The VPM-1 is believed to have been built only at the Kopeysk Mining Equipment Plant in the Urals 112/ (see Table 23*).

5. Coal Planers.

The simplest of combines is the coal planer (see Fig. 6**). Postwar tests of earlier models led to the development of the US-4*** in 1947-48. The planer, or plow, consists of two massive steel castings which can be joined rigidly or flexibly by means of a hinge. Flexible joining is preferred, as it permits the planer to follow closely the uneven contour of the coal seam. Detachable steel shearing blades and auxiliary breaking blades are bolted to the body. Inclined surfaces are fastened to the ends to scrape up the coal that falls onto the floor. The weight of the planer itself is about 2.5 MT.**** It is pulled back and forth along the face by means of a winch located at either end of the room. In operation the planer rides along the ground between the face and the frame of the face conveyor. As it operates, it exerts a force of 3 to 5 MT against the conveyor, which is held in place by pneumatic jacks resting on screw braces. The planer shears a strip from the face about 0.2 m wide and 0.45 to 0.65 m high. Under favorable conditions the remainder of the coal is brought down by pressure. Otherwise it must be blasted down or broken out by means of pneumatic picks. Coal broken down by the shearing action is automatically carried onto the conveyor by means of the moldboard contour of the planer and its attached scrapers. After each cut is completed, the

* P. 149, below.
** Following p. 94.
*** U refers to coal; S, to shaver; 4, to fourth model.
**** It is 4.65 m long, 0.57 m wide, and 0.45 m high without the auxiliary breaking blade, or 0.65 m high with the breaking blade.

pneumatic jacks move both the planer and the conveyor forward until contact is again made with the face. The jacks are then reset, and the planer is hauled back across the face for another cut.

The coal planer is supposed to make a shearing cut of 100 m in length in 15 minutes, which in a seam 1 m thick brings down 20 MT of coal. Allowing for movement of the conveyor and other operations, the planer may complete one cycle per hour and, theoretically, eight cycles per shift. If it accomplishes this rate of production, it is capable of mining 160 MT per 8-hour shift. Allowing as many as 15 to 20 men for the performance of various operations around the planer, production would still be in the neighborhood of 8 to 10 MT per man at the face, which is a very high output.* 114/

The US-4 coal planer, designed by Giprouglemash engineers, was built, insofar as is known, only at the Voroshilovgrad Mining Equipment Plant imeni Parkhomenko in the Donbas area. Ten were reported as having been built from summer to December 1948. 115/ Another lot was expected on 1 April 1949.** 116/ Since that time little or nothing has been said of the planer in the Soviet press. It is therefore likely that it plays a rather insignificant part in Soviet coal production.***

6. Coal Combines.

The keen Soviet interest in continuous coal miners, dating from before World War II, has led to the experimental development of some 20 coal combines.**** Of this considerable total, however, all but a very few have been abandoned as unsuccessful. Consideration here will be given only to those known or suspected to be in production at the present time. All of those discussed attempt to mine coal from the face and load it onto the face conveyor without the use of intermediate hand-loading operations

* Despite these theoretical possibilities, it is rated at only 200 to 400 MT per shift in the 1948 Soviet catalogue of coal mining machinery. 113/

** This lot was to be produced at the Kirov plant -- probably the Kirov plant at Gorlovka in the Donbas.

*** It does not appear in the 1949 Soviet catalogues of coal mining machinery.

**** Fourteen models were listed in a 1949 Soviet publication. 117/

or secondary loading cycles. The machines fall into two main categories: one group employs a series of curved cutter bars,* and a second group is designed around a ring-shaped cutter bar.**

a. Makarov Coal Combine, KM-4-5-6.

The Makarov coal combine (see Fig. 7***), developed by S.S. Makarov for use in the thick seams of the Karaganda Basin, consists essentially of a stack of two or three longwall coal cutters equipped with curved cutter bars.**** It was designed by Makarov in the Experimental Design Bureau of the Eastern Giprouglemash. This bureau, established in August 1945, has been under Makarov's direction. It had a small but well-equipped machine shop, located on the premises of the Karaganda Mining Equipment Plant imeni Parkhomenko. 118/ Makarov's shop tested three early models of his design and drew up plans for the KM-4-5-6 combine, of which a number were produced. By using stacks of two or three component longwall cutters and other adjustments, the Makarov cutter can be adapted to seam heights varying from 1.15 to 2.5 m. Straight cutter bars and cylindrical breaker bars operate between the curved bars. The machine is pulled across the face by means of the feed section of a KMP-1 longwall cutter, and cuttings which accumulate at the bottom are removed by a mechanical bug duster. To settle the dust that would be raised by the action of so many cutters, the machine is equipped with a device to throw a fine water spray against the coal face.*****

* These are modifications of regular chain-type coal cutter bars, or jibs. The bit blocks that make up the chain are redesigned so as to be jointed for vertical as well as horizontal movement, permitting the ends of the bars to be curved upward or downward to enable the bar to make both a longitudinal and a vertical or shearing cut into the coal face.

** The ring, consisting of a rectangle with rounded corners, may be thought of as an open-type cutter bar that has been stood on end. Bits are inserted into the face of the bar in such a way that three or four of its sides come into contact with the coal at once so as to cut out a section of the coal face instead of merely slicing into it as does the standard cutter bar.

*** Following p. 94.

**** In early models the GTK-3M machines were used as the basic components. In later ones both the GTK-3M and the KMP-1 machines were used.

***** Such sprays are also used on US continuous coal miners.

The Makarov combine cuts to the depth of 1 m. The cut coal is caught by a built-in flight conveyor which transfers it to the regular face conveyor, thus eliminating the need for hand loading. 119/ It is rated at from 35 to 50 MT per hour, depending on its height, from which one would expect its monthly productivity to be extremely high. 120/ In practice, however, a good deal of time is lost, though it has been said to have cut 10,000 MT per month. 121/

Although the Makarov combine can cut a great amount of coal, its weight of from 7.2 to 10 MT makes it cumbersome and difficult to maneuver. 122/ In order to simplify getting it down the shaft and into the mine, it has been recommended that its upper bar be hinged. 123/ Miners have not been overly happy with it. Reports show that machines have been allowed to stand idle after they had mined out a given work area instead of being promptly moved to new places. These machines have then been cannibalized for their component parts, a danger to which the Makarov combine is peculiarly subject, since it is made up of standard longwall coal cutters. 124/

In fact, the manufacture of the Makarov combine at Karaganda, which has been essentially a coal conveyor plant, consisted in the first instance of the adaptation of standard longwall coal cutters for use as combines. Although the machine won a Stalin prize for its inventor in 1947, 125/ it is doubtful if it was ever built in large numbers.* The probability is that its bulk and unwieldy character mitigated against its extensive adoption despite the influence of its designer. Since March 1950 there has been little reference to it in the press.** Makarov has been reported as having invented a caterpillar-mounted hewing and loading machine, which may be taken as further evidence that his earlier combine was not widely accepted*** (see Table 22****).

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* At least 20 were reported as standing idle in 1946, 126/ and 14 were said to have been at work in 12 Karaganda mines in 1947. 127/

** Few references to the Makarov combine have been noted since it was reported to have set a record of 11,588 MT per month in March 1950. 128/

*** This new Makarov combine, nicknamed by the miners the "underground tankette," is reported as capable of producing 13,000 MT per month. No technical details have been received as yet. 129/

**** P. 142, below.

b. Donbas Coal Combine.

In contrast to the complicated and cumbersome Makarov machine, the Donbas coal combine (see Fig. 8*) has proved to be the most successful of Soviet continuous miners. Developed in 1948 by Giprouglemash engineers and built as the GUK-1 combine at the Gorlovka Mining Equipment Plant, it was first tried in the Mine No. 3-bis of the Chistyakovantratsit Trust.** It was reported that its average monthly output and the productivity of its operators were double that of a regular coal cutter. 130/ For simplicity of design the Donbas combine, as it is now called, appears very attractive as compared with earlier combines. It is built around a ring-type cutter bar, which had been tried in the USSR before World War II and which resembles a standard chain cutter that has been stood up on one of its long edges.*** The cutter bar is driven by the power section of the heavy MV-60 longwall cutter. The cross section of coal removed by the cutter chain is broken up by a cylindrical breaker bar equipped with shearing disks. A short flight conveyor, powered by a separate 13-kw motor, throws the broken coal onto the usual face conveyor.

The Donbas combine has been described as intended for use in coal of soft and average hardness, without marked deposits of hard pyrites, quartz, or other impurities and without intermediate bands of rock requiring separate extraction. It makes a cut 1.4 m deep, though on special order it may be had with a greater cutting depth. The cutter is built in heights from 0.71 m to 0.83 m or more, depending on the thickness of the seam. A worm-type bug duster moves the cuttings onto the conveyor. The machine pulls itself along the face by means of a cable drum driven by the main motor with a choice of four speeds. Carbide-tipped cutter bits are employed, as in heavy-duty US machines. Controls are grouped centrally, by means of a magnetic starter, and the electrical system is flashproofed. The model displayed at the Helsinki fair in June 1951 was built of heavy steel castings and made a good impression on the observer. Seen running, though not under load, in a simulated coal vein, the gearing noise and control efficiency appeared reasonable. 131/ It may be significant that it was the only combine shown by the USSR at the Helsinki fair.

* Following p. 94.

** The designers were V.N. Khorin, A.D. Sukach, A.I. Bashkov, M.F. Gorshkov, and others, each of whom received a Stalin prize.

*** For the Soviet ring-type coal cutter, VK-1, see Fig. 9, following p. 94.

Although its 6.5 MT make the Donbas combine a heavy machine, it is simplicity itself when matched against the awkward Makarov combine. In many ways it answers the problem of continuous mining in longwall seams, and only two inherent disadvantages are apparent. On any given machine there is little possibility of varying the height of the cut.* In thick seams, such as the Kuzbas, these combines have sometimes been used in pairs. 133/ It would also appear that the combine is not reversible but will have to flit back to its starting place in order to begin a new cycle.

If these are drawbacks, they are minor as compared with the potentiality of the Donbas combine. It is clear, however, that it is not a universal machine. Others will be needed for thick, thin, pitching, and irregular seams. Nevertheless, by the end of 1950 it was said to be averaging 4,556 MT per month. 134/ Early in 1952, one team cut 16,000 MT in a mine whose quota was 12,740 MT per month. The average productivity of the Donbas combine may now be in the neighborhood of 5,000 MT per month,** and there is reason to believe that its output will continue to increase. 135/

The Donbas combine, insofar as is known, has been built only at the Kirov works in Gorlovka*** (see Table 22****). Although there has been discussion of serial production, there is

* It is not impossible that this problem of adapting to seams of variable thickness may some day be solved by a combine such as the MBK-1, which resembles the Donbas combine in many respects. The MBK-1 employs two standard cutter bars, one above the other, in lieu of the ring-type cutter bar. The upper bar is adjustable to the height of the coal seam. Such an arrangement has definite possibilities in thin coal. This machine was designed by Giprouglemash around the heavy MV-60 cutter. Trial models were built in 1948, but no series production is yet known to have occurred. 132/

** Although ordinary longwall cutters have often exceeded this tonnage in the USSR, it must be remembered that this output is probably achieved by the use of large gangs of hand loaders. The combine breaks the hand-loading bottleneck and makes a great saving in productivity per man which is not revealed by the tonnage figures.

*** Designs may have been made available, however, to mining machine plants in certain Satellite countries (see IV, below).

**** P. 142, below.

reason to believe that it has been placed into production with a caution born of the failure of previous combines, suggesting that initial production was in batches and that modifications in design have been made between batches.* 136/ After tests of a revised model were made in the thick seams of the Moscow Basin, it was determined that a special combine would be more productive for these conditions. 137/ Production was reportedly stepped up in 1951. 138/ Early in 1952, word was released that an automatic regulator had been developed for the Donbas combine by a group of scientists of the Mining Institute imeni M.M. Federov of the Academy of Sciences of the Ukrainian SSR. By adjusting the speed automatically to the hardness of the coal being cut, it was stated that this device increased the productivity of the combine from 0.27 running meters per minute to 0.35 to 0.40 m per minute. 139/ In the spring of 1951 the Gorlovka plant began series production of the Donbas 1 combine, a revised version of the original machine, equipped with a more efficient dust-allaying unit and other modifications. 140/ Still further changes were made subsequently by designers of the Gorlovka plant in collaboration with scientists of the Donets affiliate of Giprouglemash. In an attempt to bring about a reduction of the dust created by the working of the machine, the breaker bar and shearing disk were replaced with a special device on which a cutter chain was mounted. Experimental models of the new version were to be sent to the mines in 1952. 141/

Changes of this character may be regarded as normal incidents in the development of a new piece of machinery. The Donbas combine was the culmination of a series of efforts on the part of the USSR to build a successful longwall coal combine. Unable to borrow such a design from more advanced industrial countries, the USSR was in a sense required to solve this problem independently by means of its own resources. That it has been able to work out a solution to this problem by itself should be taken into careful consideration in evaluating the present state of the Soviet capital goods industry in particular and the state of Soviet technology in general.

Since the Donbas combine was kept in hand from a design point of view by adapting it to coal seams of approximately

* The first batch was shipped in 1948; the second was scheduled for early 1949; by 30 May 1951, reference was made to the fourth series, which, it was stated, had been in production for over a year; the fifth series was started in the spring of 1951.

1 m in height, it does not solve the problem of continuous coal mining in special seams. Several other combines have, therefore, been developed to round out the complement of Soviet continuous miners.

c. Coal Combine, VOM-2M.

There is as yet no counterpart of the Donbas combine for coal seams of the next order of thickness of from 1 to 2.5 m in depth, such as would be useful in the Kuzbas and Mosbas.* Work has been underway for a number of years on such a machine, and it may be on the verge of success, but evidence to date indicates that it is still to be regarded as experimental. The machine, the VOM-2M, as well as its predecessors,** is described here more because of its possible future intelligence significance than its present importance. Whereas the Donbas combine consists basically of a ring-type cutter laid on its side so as to make a relatively low and deep cross section into the coal, the VOM-2M consists also of a ring-type cutter which has been stood on end in order to effect a relatively high and shallow cross section.

The vertical cutter chain of the VOM-2M is looped in such a way as to dispense with the breaker bar of the Donbas combine. The cutter chain is driven by the body of an MV-60 longwall cutter, which is run on its side so as to minimize the space between the coal face and the props. The height of the cutter bar is said to be adjustable from 1.3 to 2.5 m. The bar can be lowered for additional clearance in tramming. The cut averages 1 m in depth. In operation the looped bar is supposed to cut out a cross

* From the Moscow region, word came early in 1952 that a number of Donbas combines had been received in 1951 and that while the Donbas combine was not a bad machine, it was far from suited to conditions of the Mosbas. It was complained that although Mosbas engineers had proposed the design for such a combine 3 years before and that Giprouglemash had been commissioned to work out such a design 2 years before, the task was still unfulfilled. 142/

** The VOM-1 and the VOM-2 (see Fig. 10, following p. 94). The former was built at the Kirov plant in Gorlovka and tested in 1945-46 in the Moscow coal combine. This plant also introduced the VOM-2 in 1948-49 in the same region. After tests, the VOM-2M was built in 1950. In a general way these machines are similar to the German combine built by Soest-Ferrum, Duesseldorf, although the latter is a double-chain machine. 143/

section, which is transferred to the face conveyor by a plowshare similar to that employed by the VPM-1 cutter-loader. For coals that do not break up easily of their own accord, a variant type of loader of the active cyclic, grizzly variety is provided.* What this machine loses because of the shallow character of its cut, it regains by virtue of its ability to cut coal over 2 m thick. Unlike the Donbas combine, it is readily adaptable to coals whose thickness varies considerably. For special conditions, five different cutter bars are available. Tested in the thick Karaganda seams in March and April 1951, it reportedly averaged about 7,350 MT per month, an output of about 4.3 MT per miner per day. Although the machine was credited with having raised the output by 35 percent and the productivity per miner by 15 percent, it appears to have operated for less than half of the working time of the shift, suggesting that operational difficulties were encountered, occasioned by an immaturity of design and manufacture. Mention of this machine in the Soviet press is so infrequent as to imply that it has not yet been perfected sufficiently to have achieved quantity production 144/** (see Table 22***).

d. Development Coal Combine, PK-2M.

For the rapid and efficient development of new mining areas and for the extension of existing workings and the opening up of new faces, the USSR needs a good shortwall coal cutter, a proved universal mounted cutter, or else a shortwall-type continuous miner, such as the new Joy and Jeffrey machines of the US. An experimental model of such a machine, similar to the Joy continuous miner, was

* The loader unit is powered by a separate 23-kw motor. The weight of this combine, depending on the type of cutter and loader employed, ranges from 4 to 5 MT.

** Soviet statements concerning this combine illustrate how closely and carefully their claims must be evaluated. In 1949 it was asserted by Tass that the VOM combine had completely mechanized coal mining in the Moscow coal fields. 145/ The impression given was that it had mechanized all coal mining throughout the Moscow coal fields. In 1950 the Soviet press admitted that the VOM was being used only in two or three mines of the Moscow Basin, and there only as an ordinary cutter without the loading unit. 146/

*** P. 142, below.

tried in the USSR in 1941.* Whereas the Joy machine employs a battery of short, special cutter chains as a cutter head mounted on a boom, the Soviet equivalent used only a pair of standard coal cutter chains 1 m or so apart. The chains can be swung sidewise, and their effective height can be adjusted by variation of the angle that they make against the floor. The original model of this machine weighed 9.6 MT, was powered by three separate motors, and delivered coal cut from the face through a self-contained conveyor to the entry conveyor or cars. 147/ Redesigned after the war by Giprouglemash, another experimental model, designated the PK-2M, was built by the Kopeysk Mining Equipment Plant imeni Kirov in 1950 and sent to the Kopeyskugol' trust for trial in one of its mines. 148/ Another was sent to the Moscow Basin. After tests it was pronounced most suitable for horizontal development work of all experimental combines of its type. 149/**

e. Steep-Pitch Coal Combine, KKP-1.

Steeply pitching seams have always been difficult to mechanize. In the USSR they have been worked principally with pneumatic picks by terrace methods. When possible, the coal is moved out in chutes by gravity. To mechanize the mining of such seams, the USSR has experimented with the KKP-1 combine (see Fig. 11***) since at least 1949. 151/ Trials conducted in the Donbas were much publicized in 1950 and 1951. 152/ The combine consists of a heavy frame on which is mounted a circular disk fitted with three special cutters instead of the usual chain and picks. The frame is suspended in such a way that the disk shears the coal at an angle instead of in terraces. Gravity carries the cut coal down a chute and at the same time allows the machine, guided by a hoist, to settle to the bottom of the seam as the cutting proceeds. With its usual avidity the Soviet press has proclaimed the KKP-1 as the

* The PK-1, two models of which were built in 1941 by the Voroshilov Arms Plant in Krasnoyarsk.

** In addition to the PK-2M, the USSR has been developing the PPK-1 combine for horizontal development work in rock, which, it is said, cuts a circular cross section 3 m in diameter and which has been fitted with a device to handle liquid gangue or other waste products. It has been built experimentally at the Kopeysk Mining Equipment Plant imeni Kirov in the Urals. 150/

*** Following p. 94.

world's first pneumatic-powered coal combine. 153/* It has been reported that where used this machine has increased output by 2.5 times and has done the work of 20 to 25 miners with pneumatic picks. Output of the machine is said to have averaged 5,000 MT per month in one mine. [redacted] it was in production at the Gorlovka Mining Equipment Plant and was being supplied to a number of coal mines in the central Donbas 155/** (see Table 22***). 50X1

f. Thin-Seam Coal Combine, UKMG-1.

For low coal 0.35 to 0.6 m thick, unsuited to the higher and heavier Donbas combine, the USSR has been actively developing several special combines. Of these, the UKMG, designed by the Donets Scientific Research Institute of Coal in cooperation with the Gorlovka plant, may be thought of as a simplified Donbas combine. The principle of the ring-type cutter bar, characteristic of the Donbas combine, is retained, but the breaker and flight conveyor are replaced by a series of blades mounted on the cutter chain. Coal removed from the face by the cutter chain is shunted over to the face conveyor by the moving blades. 157/ Tests of the machine were completed at the Gorlovka plant in December 1951, 158/ and five of the machines were finished on 9 February 1952. 159/ According to the only press report of their operation in the field, the experimental model, working seams from 0.4 to 0.45 m thick in the Budennovugol' trust, is completing an entire cycle of the face each shift. 160/****

* The Leningrad Pnevmatika Plant has built a number of experimental models of a new 30-hp pneumatic motor to run combines on sharply sloping seams. Air drives have commonly been available for mining machine use in the US and elsewhere for many years as alternates to electric motors. 154/

** Credit for the invention of the KKP-1 has been given to A.V. Topchiev, director of Giprouglemash, A.A. Pichugin, F.M. Balykov, and others, all winners of Stalin prizes. It was thus designed by a blue-ribbon cast and no doubt represents a serious attempt to mechanize the mining of steeply pitching seams. 156/

*** P. 142, below.

**** Technical specifications of this machine have not yet been received. It is similar in appearance to the ring-type combine, or Rahmen-Schraemlader, of Soest-Ferrum, Duesseldorf. 161/

g. Thin-Seam Coal Combine, UKT-1.

Another Soviet attempt to build a low-coal combine is the UKT-1, intended for seams only 0.4 to 0.7 m thick (see Fig. 12*). This machine, first mentioned in the press in 1950, was designed by Giprouglemash at its experimental plant and unveiled in 1951. In differing radically from both the Donbas and Makarov combines, it shows a remarkable similarity to the US-built Jeffrey "Colmol" insofar as the cutting principle is concerned. In fact, it might be termed a longwall version of the Jeffrey machine, since it uses for cutters a set of eccentric rotating bits similar to those of the "Colmol." Coal broken down by these bits is thrown directly onto the face conveyor without the aid of an intermediate conveyor. The body of the machine, which trails behind the cutters, appears to be a modified section of a standard longwall coal cutter. The narrow width of the coal cutter body permits the machine to operate in the limited space between the face and the conveyor, thereby facilitating very close timbering as required by longwall work. Built at the Svet Shakhtera Mining Equipment Plant in Khar'kov, this combine was reported as having boosted miners' productivity 1.5 times in tests in the Donbas coal seams. According to press statements, the Khar'kov plant was scheduled to send dozens of the new machines to mines throughout the country in 1951.** 162/

In summary, it may be said that the Donbas combine has been accepted as standard for coal of medium thickness and is in greatest production of all the Soviet coal combines. The Makarov combine for thick seams is too unwieldy and probably will be replaced by an improved machine, perhaps the VOM-2M. For low coal the USSR has both the UKMG-1, still under development, and the somewhat more seasoned UKT-1.*** Both are relatively new and may have to be improved and modified, but they have good possibilities. In the hard-to-mine pitching seams, emphasis has been upon the KKP-1 steep-pitch combine, driven by the air motor, despite certain inherent drawbacks in design. Finally, for development work, the PK-1 is available, though it appears to need further refinement.

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* Following p. 94.

** For designing the UKT-1, Stalin prizes were awarded in March 1951 to A.D. Gridin, Ye.I. Kudryashev, A.A. Pichugin, and Y.Ya. Markulov.

*** Reference should also be made to the Gornyak combine, another experimental low-coal machine reported in 1952. 163/

7. Mobile Coal Loaders.

The USSR experimented with underground mobile coal loaders before World War II, but series production of these machines dates from the end of the war. It should be understood that although the USSR is very serious about mechanizing coal loading, these mobile loaders, so common in the US, are too bulky for use in longwall coal mining. The USSR intends to mechanize the loading of longwall faces by means of coal combines. Mobile coal loaders are, therefore, of use to the USSR either in the few shortwall mining areas or principally for development work. It is for this reason that they are often spoken of in the USSR as coal and rock loaders. Two general types are in production and use: the rocker shovel and the mobile conveyor type. Both are similar to equipment that has been on the US market for a number of years.

a. Rock Loaders, UMP-1, EPM-1, and PML-5.

Rock loaders, rock shovels, or "mucking shovels" are used in the US chiefly in loading rock from ore mines to mine cars. In the USSR they are employed in both underground metal mining and coal mining. Their use in coal mining is limited chiefly to development work. Like their US prototypes, these shovels consist of a bucket-type loading device, a self-propelled chassis on flanged wheels, and a discharge conveyor. They move forward on the rails to the coal face, which has been previously drilled and blasted. By maneuvering the vehicle, this material is worked into the bucket, which is then elevated and dumps onto the self-contained conveyor. The conveyor transfers the load to a narrow-gauge mine car. In the US this equipment is generally pneumatically powered. In the USSR, both electric and air-driven models are produced. The UMP-1 (see Fig. 13*) and the EPM-1 (see Fig. 14**), developed between 1948 and 1950, driven by electric motors, are of comparable output and differ chiefly in the manner in which the bucket is operated*** (see Table 10).**** The lighter weight PML-5, driven by two pneumatic

* Following p. 94.
** Following p. 94.
*** The UMP-1, powered by a single 20.5-kw motor, had a productivity of 30 to 40 cm per hour; the EPM-1 is operated by two 10.5-kw motors and is rated at 30 to 45 cm per hour.
**** Table 10 follows on p. 69.

Table 10

Technical Characteristics of Soviet Rock Loaders* 164/

	Unit	UMP-1 (OM-510)	EPM-1	PML-5
Length				
In Working Position	m	6.82	2.4	2.35
In Traveling Position	m	6.43	1.75	
Of Chassis without Bucket and Conveyor	m	3.6		
Width				
In Working Position	m	1.65	1.6	1.32
In Traveling Position	m	1.29	1.4	
Height from Railhead				
In Working Position	m	1.8	2.07	2.2
In Traveling Position	m	1.6	2.05 a/**	
Weight	MT	8.5	5.03 b/	2.75
Productivity	cu m per hr	30 to 40	30 to 45	20

* Spaces left blank in this table indicate that data are not available or not applicable.
** Footnotes for Table 10 follow on p. 71.

Table 10

Technical Characteristics of Soviet Rock Loaders 164/
(Continued)

	Unit	UMP-1 (OM-510)	EPM-1	PML-5
Motor	type	MA-144-2/6	2 like KTSA	2 air motors
Capacity	kw	20.5	10.5 each	10 each c/
Speed	rpm	985	670 synchronous	
Voltage	v	220/380	110/775	
Track Width	mm	600;900	550;575;600	600
Bucket Capacity	cu m	0.15	0.2	0.2
Loading Front	m	3.0-3.5	2.2	2.0
Travel Speed	m per sec		0.79	
Wheel Base	mm		960	
Working Reach of Bucket				
Below Railhead	mm	175		
Above Railhead				
Standard Boom	m	2.15		
Long Boom	m	2.34		

Table 10

Technical Characteristics of Soviet Rock Loaders 164/
(Continued)

	Unit	UMP-1 (OM-510)	EPM-1	PML-5
Tramming Speed				
Forward	m per sec	0.73		
Reverse	m per sec	0.54		
Conveyor Belt Speed	m per sec	1.3		
Price 165/	rubles	52,300	50,000	25,000 d/

a. With shovel up; 1.52 with shovel down.
b. In operation on horizontal; 4.04 in operation on incline.
c. Hp; atmospheres of operating air pressure, 4.5 to 5; air consumption, 4 cu m per minute.
d. Latest price available is for the PML-4 (1948).

motors, resembles the EPM-1 in construction.* The first two machines were designed by Giprouglemash and are built at the Tomsk Electromechanical Plant imeni Vakhrushev and the Toretsk Mining Equipment Plant imeni Voroshilov at Druzhkovka, respectively. The PML-5, on the other hand, was originally reported to be series produced in a plant of the Ministry of Transport Machine Building.** 166/ [redacted] 50X1
[redacted] its manufacture has been undertaken by the Svet Shakhtera 50X1
Mining Equipment Plant at Khar'kov. 167/ The EPM-1 was considered good enough to show at the Helsinki fair in June 1951. 168/ These machines are believed to be in current production. They are, however, scheduled for further improvement, and, in accordance with the encouragement given to mechanization of the coal industry, newer types are under development*** 169/ (see Table 24****).

b. Coal Loaders, S-153 and O-5.

Underground coal loaders in use in the US today are generally of the mobile conveyor type, such as the Joy 8-BU. By far the greater percentage of the 4,348 mobile coal loaders in underground use in US bituminous and anthracite coal mines in 1951 were of this type. The US has built as many as 700 of these machines in a single year. 170/ In the US, although these machines have been mounted on rails, caterpillar treads, and rubber tires, the caterpillar-mounted type is in greatest current production. These machines are employed in the US for shortwall mining, and, as such, they move from room to room under their own power to load coal that has previously been undercut, drilled, and shot. The machines load onto mine cars, conveyors, or rubber-tired shuttle cars. In the USSR these machines, being too bulky for longwall loading, are employed as are rocker shovels, in the loading of coal in preparatory work.

* The PML-5 is driven by a pair of 10-hp air motors and is rated at 20 cm per hour. The weights of the machines in MT are UMP-1, 8.5; EPM-1, 5.03; and PML-5, 2.75.

** The PML-4 was built in 1950 at the Kommunist Mining Equipment Plant at Krivoi Rog. The PML-5 was probably built there too. In 1952 it was scheduled to go into production at the Svet Shakhtera Mining Machine Plant in Khar'kov.

*** For example, the Yegorev, of which the first five were built at Alma-Ata in 1951; the Kizel L-1 and BCh-3 loaders, built at Stalinsk in Western Siberia; and the ASP-2. No technical descriptions of these machines have yet been received.

**** P. 153, below.

Series production of this type of equipment, designated the S-153 coal loader (see Fig. 15*), began in the USSR in 1947, probably at the Sverdlovsk Transport Machinery Plant. The machine is caterpillar-mounted. Two mechanical arms grab the coal and pass it onto a single-chain scraper conveyor, which in turn delivers the coal to mine cars or an entry conveyor. The gathering head can be raised or lowered by hydraulic means. It is also possible to swing the end of the unloading conveyor 45 degrees in either direction. Rated at 50 MT per hour, this machine is just short of 1 m in height and weighs 4.24 MT, which puts it in the class of the lightest-weight, low-coal models, as this equipment would be rated in the US 171/ (see Table 24**).

At the Svet Shakhtera plant in Khar'kov the USSR also builds the O-5 coal loader, designed by D.G. Onika. It has a somewhat more elaborate loading head, which discharges to a self-contained belt conveyor, in contrast to the scraper conveyor of the S-153 and the US prototypes. The O-5 is rated at 80 MT per hour and is 1.2 m high, although it weighs only 4.7 MT. Unlike the S-153, it is powered by two electric motors.*** 172/ Less notice of this loader appears in the Soviet press than of the S-153 -- which may be justification for believing the latter machine to figure more prominently in Soviet production (see Table 11).****

At the end of 1951 it was reported that the Soviet coal industry had 70 times as many loaders for preparatory work as in 1940. 173/ As late as August 1951 it was reported that the loaders were being used in the mining of almost one-third of all horizontal development drifts. 174/ As long ago as 1950 it was claimed that within the next 2 or 3 years the use of the UMP-1, the PML-5, and the S-153 coal loaders would bring the mechanization of rock and coal loading up to 85 percent in mines being reconstructed. 175/

Although both the S-153 and the O-5 mobile loaders were designed for the underground loading of coal, they can also be used for the loading of other loose, dry materials of similar

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* Following p. 94.

** P. 153, below.

*** The 26-kw motor of the GTK-3 cutter is used to drive the gathering head and crawlers, and a separate 1.75-kw motor drives the conveyor belt.

**** Table 11 follows on p. 74.

Table 11

Technical Characteristics of Soviet Coal Loaders* 176/

	Unit	S-153	O-5
Length	m		
Over-All		6.32	
With Conveyor to Unload to Cars			7.00
With Conveyor to Unload to Conveyors			6.50
Width	m		
Gathering Head		1.6	
Machine		1.59	
Working			2.2
Maneuvering			1.2
Height	m	0.92	1.2
Weight	MT	4.24	4.7
Productivity	MT per hr	50	80
Motor	type	MA-173-F2/4	MA-191/3M a/
Hourly Capacity	kw	23.5	26
Continuous Capacity	kw	17.0	
Maximum Lift of Head above Floor	m	0.35	
Maximum Lowering of Head below Floor	m	0.15	
Speed			
Linear	m per min	17.5	
Maneuvering	m per min		10.4
Working	m per min		1.65
Belt Conveyor	m per sec		1.0

a. Conveyor Motor TAG-22/4, 1.75 kw.

* Spaces left blank in this table indicate that data are not available or are not applicable.

physical characteristics, either underground or above ground. Having in its possession both rocker shovels and conveyor-type loaders of its own manufacture that have been tested and are in series production, the USSR may be thought of as being in a good technical position from the point of view of both design and manufacture to break the bottleneck of hand loading in the development of new coal mine passages. When added to its complement of coal combines and cutter-loaders for use in the mining of longwall faces, this equipment, built in quantity, and if properly used and maintained, should enable the USSR to increase greatly its coal output and at the same time reduce the amount of labor assigned to coal mining.

8. Underground Coal Mine Conveyors.

a. Shaker Conveyors.

Before World War II the USSR used large numbers of shaker conveyors in its coal mines for transporting coal from the face to gathering conveyors. Although these conveyors are simpler to build than chain or belt conveyors and are the least expensive of the three types, they have their limitations. Shaker conveyors work well on downgrades but are limited to upgrades of a very few degrees. Although suitable for moving coal out of an area, they are less satisfactory for moving materials into an area. When shaker conveyors are used, it is therefore necessary to provide a supplementary transportation system to bring in supplies such as pit props and tools. Zasyad'ko, Minister of the Coal Industry, announced early in 1951 that the shaker conveyors, formerly employed for conveying coal, had a low productivity, were unreliable, and restricted the productivity of the new machinery. They were, he said, being replaced by chain,or scraper, conveyors, which had been developed in 1948 and 1949. 177/* Current production of coal mine conveyors in the USSR, it is believed, consists chiefly of the chain and belt types.

* Although the USSR had developed at least half a dozen types of shaker conveyors in the DK series, only the DK-5, rated at 17 MT per hour, and the DK-19, rated at 49 MT per hour, were listed in the 1948 Soviet coal mining machinery price list. 178/

This replacement of the shaker conveyors also eliminates the duckbill loading head from serious consideration in Soviet coal mining. The USSR experimented with a new duckbill loader, the KUP-48, as late as 1948, when several were built at the Svet Shakhtera plant in Khar'kov. 179/ This design employed a flexible feed. The duckbills, however, would be of more use for end loading than side loading. This factor limits their applicability to development work rather than to outright production.

b. Chain, or Scraper, Conveyors.

Chain, or scraper, conveyors are used extensively in Soviet coal mines. As their name implies, they consist of an endless steel chain to which scrapers are attached and which move coal by scraping it along a trough. Such conveyors are rugged, are relatively easy to move about, can move coal up grades of 35 degrees, and may be reversed so as to bring materials to the coal face. 180/ For these reasons, they are employed most extensively in the USSR as face conveyors. In this service they run parallel to the mine face and can be designed as long as most longwall faces. So used, the entire conveyor must be moved after each advance into the coal seam. This operation may be accomplished by hand or by the use of air-driven jacks. They are also used in preparatory passages, however, and wherever else shortwall mining methods are employed. In such instances the troughs are extended, and new sections of chain are added after each advance of the coal face. The fact that, by the end of 1951, chain conveyors comprised 90 percent of all Soviet coal mine conveyors indicates the extent to which shaker conveyors have been replaced and suggests that rubber belt conveyors have found only a limited use in the Soviet coal mines. 181/ The chain and scrapers ride in dismountable steel troughs, about 2.5 m in length. The conveyor is generally powered by an electric motor of from 4.5 to 29 kw or more, depending on conveyor length and rated tonnage per hour. This motor is mounted on a portable driving head, which may weigh as much as 1 MT or more. Tension is taken up in the conveyor tail. Flashproof motors are widely used on this and other Soviet coal mining equipment. 182/

More than a dozen models of scraper conveyors have been built by the USSR. Scraper conveyors are widely used in Europe and the US, and Soviet designs do not appear to differ radically from Western practices (see Table 12).* Models believed to be in current production include the ST_2-5, which delivers 45 MT per hour over the short span of 29 m. The ST_2-11 was designed to deliver 60 MT per hour in horizontal seams of 70 m in length or up to 100 m on the level, with a reduced output. On downgrades it is said to be capable of operating up to a distance of 150 m. For longer distances, ST_2-11's can be used in tandem. The ST_2-11, which is reported to be capable of serving dipping seams up to 20 degrees and mounting seams up to 30 degrees, can function in coal as low as

* Table 12 follows on p. 78.

0.65 m thick. The ST_2-11 was severely criticized in the Soviet technical press in May 1950 by two of the designers of the Donbas coal combine,* who charged that its capacity of 60 MT per hour required that the combine be held down to its second speed of 0.54 m per minute. At its third speed of 0.81 m per minute, they asserted, the combine could produce 65 to 80 MT per hour even in a seam of only 0.8 m in thickness.** They also objected that the ST_2-11 could operate for a distance of only 100 m, whereas 82.6 percent of the Donbas mine faces ran longer than 100 m. 183/

For coal faces in slightly sloping seams of 1 m or more in thickness, the rugged STR-30*** (see Fig. 5****) was designed with a capacity of 60 MT per hour and a total length of 100 m. Its construction permits the blasting of coal from the face onto the conveyor itself, thus eliminating much of the loading operation. Originally it was intended that the conveyor be taken down after each cycle and reassembled in the new position. Later, mechanical means were devised to move the conveyor intact. To facilitate this movement and to adapt to irregularities in the seam, the STP-30 was developed, characterized by troughs with articulated joints, which permit an adaptation to the slope of 4 degrees per trough. On both of these conveyors, two chains are used, and the flights are fastened between the chains. 184/ For low coal the SKT-6 single-plane conveyor was put into production at the Svet Shakhtera plant in Khar'kov in 1950. It is rated at 25 MT per hour, can be extended to 100 m, and is only about 0.4 m high. 185/

The USSR displayed three of its newer scraper conveyors at the Helsinki fair in June 1951. For use in thin coal seams, the low-capacity 25-MT-per-hour SKT-36 conveyor was shown. It featured the same model flashproof motor as the SKR-11 with push-button control. For medium capacity loads, the SKR-11 conveyor of 50 MT per hour was exhibited. This conveyor may be reversed to transport timber

* V.N. Khorin and A.D. Sukach.

** Khorin and Sukach maintained that the inadequacy of the conveyor was even greater in a seam of 1.2 to 1.4 m, where at second speed the combine could produce 70 to 90 MT per hour.

*** S refers to scraper; T, to conveyor; R, to dismountable; 30, to kw. Its chief designer was Stalin prize-winner Nikolay Deomidich Samoylyk of Giprouglemash, who also designed several other scraper conveyors.

**** Following p. 94.

Table 12

Technical Characteristics of Soviet Scraper Conveyors* 186/

	Unit	ST-5	ST_2-5	ST_3-5	STS-5	ST-10	ST-11	ST_2-11	STP-30	STR-30	STZ-11	SKT-6
Production of Coal on Horizontal	MT per hr	50	45	50	30	30	60	60	120 a/**	120 a/	65	25
Length	m	29	29	49.5	50	60	70	70	100	100	70	100
Speed	m per sec	0.6	0.54	0.56	0.5	0.62	0.525	0.4	0.34 0.515	0.34 0.515		0.3
Motor	type	TAG-32/4	TAG-32/4	TAG-32/4	TAG		MA-143-1/4	MA-143-1/4	MA-144-2/4	MA-144-2/4		MA-143-1/4
Motor Power	kw	4.5	4.5	4.5	4.5	8.0	11.4	11.4	20.5 & 29	20.5 & 29		
Driving Head	mm											
Length		1,500	1,618	2,445	1,500		2,630	1,630	1,927	2,032		1,970
Width		1,025	1,490	1,532	910	945	1,136	1,185	1,550	1,466		1,094
Height		605	580	575	650	475	740	560	900	900		403
Weight	kg	420	484	660	320		1,045	1,039	1,526	1,565		757
Tension Head	mm											
Length		830	830	830			1,600	1,600	1,805	1,170		
Width		580	580	580			790	790	820	1,104		
Height		320	320	320			296	296	380	378		
Weight	kg	111	111	116			167.5	167.5	185	262		

* Spaces left blank in this table indicate that data are not available or are not applicable.
** Footnote for Table 12 follows on p. 79.

Table 12

Technical Characteristics of Soviet Scraper Conveyors 186/
(Continued)

	Unit	ST-5	ST_2-5	ST_3-5	STS-5	ST-10	ST-11	ST_2-11	STP-30	STR-30	STZ-11	SKT-6
Scraper Chain	mm											
Length		70	70	70	40		80	80		80	80	
Length between Scrapers		490	490	490			480	480	800	489		
Scraper Height		65	65	65			50	50				
Trough Dimensions	mm											
Length		2,500	2,435	2,435	2,435		2,740	2,740	1,500	1,545		
Width		500	500	500		485	524	524	820	600		800
Height		238	238	238		325	252	252	220	188	230	97
Weight	kg	83	91	91			103	103	150	122		

a. [redacted] See Table 13, p. 81, below.

50X1

or other materials to the mine face. For heavy-duty work, such as in connection with the new coal-cutting and loading combines, the SK-20, a high-capacity conveyor, was demonstrated, capable of moving up to 130 MT per hour.* A side wall was fitted to the troughing to act as a backstop when used with a continuous mining machine. An observer of these three conveyors at the Helsinki fair reported them to have been built of mixed welded and bolted construction and to be of fair quality. 187/ It was planned that in 1951, new, heavier, and longer scraper conveyors would be designed, suitable for working with the increasing number of coal combines 188/ (see Table 25**).

c. Belt Conveyors.

Belt conveyors can be built to serve greater distances than scraper conveyors, and belts also consume less power and operate more quietly. Belt conveyors, however, also cost more to build, and unless they are handled carefully, the belt is subject to expensive damage. Present indications are that the USSR does not employ belt conveyors so extensively as it does scraper conveyors. It does, however, build a series of belts, for face, development, and gathering locations. The RT-5 and RT_3-5 are rated at 60 MT per hour over a distance of 30 m on a level grade. They employ three-ply belting 600 mm in width. The RTZ-15 is rated at 100 MT per hour under similar conditions (see Table 14)*** and is said to be capable of operating over a distance of 200 m with a four- or five-ply belt 700 mm wide. This length would suffice for more than 90 percent of the longwall faces in the Donbas. 189/ For coal seams of more than 1.2 m in thickness, where the output is relatively high, the RTU-30 conveyor has been developed, said to be capable of delivering 80 to 180 MT per hour, depending on the size of the driving unit used.**** This conveyor requires a belt 700 mm in width and can be extended to 300 m. It is said to be capable of working elevations up to 15 degrees. In

* Thus the SK-20 was rated as even more productive than the SK-30 which Khorin and Sukach cited as a possible answer to the need for a longer and more productive conveyor for use with the new combines (see Table 13, which follows on p. 81). The SK-30, built experimentally at the Svet Shakhtera plant in Khar'kov in 1950, was rated at 100 MT per hour but was said to be capable of hauling coal for a distance of 180 m on a downgrade of 10 to 12 degrees.

** P. 160, below.

*** Table 14 follows on p. 82.

**** With motors of 15, 21.5, and 29 kw, this conveyor is said to be capable of speeds of 0.67, 1.0, and 1.5 m per second, respectively.

Table 13

Comparison of the Soviet SK-30 Scraper Conveyor with Earlier Soviet Types 190/

	Unit	ST_2-11	SKR-11	STR-30	SK-30
Coal per Hour	MT	60	60	70-100	100
Length of Coal Haul along a 10°-12° Dip	m	100	100	130	180
Speed of Scraper Chain	m per sec	0.4 0.525	0.4 0.525	0.34 0.51	0.51
Breaking Load of Scraper Chain	kg	16,500	16,500	23,000	23,000
Side Height of Unit from Ground	mm	252	265	197	220
Size and Weight of Units					
Upper Chute (Reshtak)					
Length	mm	2,560	2,530	1,420	1,470
Width	mm	524	574	700	735
Height	mm	161	169	95	219
Weight	kg	53.3	53.9	84.7	45.5
Lower Chute					
Length	mm	2,640	2,530	1,465	1,470
Width	mm	506	512	700	728
Height	mm	177	172	156	186
Weight	kg	50.24	51	73.6	40.8
Motor	type	MA-143-1/4		MA-144-2/4	
Capacity	kw	11.4		29	
Speed	rpm	1,470		1,480	
Voltage	v	220/380		220/380	

Table 14

Technical Characteristics of Soviet Belt Conveyors
for Face and Development Work 191/

	Unit	Type of Conveyor		
		RT-5	RT_3-5	RTZ-15
Production on Level	MT per hr	60	60	100
Length	m	30	30	200
Belt Speed	m per sec	1.0	1.0	0.75/0.9
Belt Width	mm	600	600	700
Belt Ply		3	3	4-5
Motor Power	kw	4.5	TAG-32/4-4.5	14.5
Drive Dimensions	mm		MA-171-2/4-5.3	
Length		1,850	1,980	3,070
Width		896	1,160	2,075
Height		446-550-672 a/*	650-760-870 a/	800

a. Footnote for Table 14 follows on p. 83.

Table 14

Technical Characteristics of Soviet Belt Conveyors for Face and Development Work 191/
(Continued)

	Unit	Type of Conveyor		
		RT-5	RT_3-5	RTZ-15
Tension Head	mm			
Length		410	930	1,650
Width		1,026	1,046	1,100
Height		245	270	440
Length per Section	mm	2,070	2,028	2,000
Weight of Drive Section with Motor	kg	522	552	1,370

a. According to the position of the head, equals lower, middle, or upper.

addition, several longer, heavier-duty conveyors have been built, such as are suitable for gathering together the delivery of several of the secondary conveyor units. There is also evidence that the USSR builds conveyors suitable for lifting coal up a considerable slope and out of the mine to the pit head without the use of cages and cars. Where high output is needed, such as for collecting the coal from several feeder belts, the RTU-250, with a 1,000-mm belt, is rated as having a capacity of 250 MT per hour.* 192/ In 1950 the Svet Shakhtera plant in Khar'kov was reported to have begun production of a newer belt, the LKU-250, also rated at 250 MT per hour and especially designed for operation on slopes. Working on an 8-degree slope, this conveyor is rated at 250 MT per hour over a distance of 200 m.** 193/ The USSR also builds a conveyor of 300 MT per hour, the RTU-300, which requires a 1,200-mm belt, can raise coal 18 degrees, and span a distance of 150 m.*** 194/

In summary, it may be concluded that in designing equipment for conveyor coal mining, the USSR has been as active as it has in the designing of cutters and loaders. It has rejected the easy-to-build shaker conveyors for the more productive scrapers and belts. At the same time, it has emphasized the more rugged scraper conveyors rather than the still more productive but also more temperamental belt conveyors**** (see Table 25*****).

9. Coal Mine Locomotives.

Because the USSR mines principally by means of longwall methods, coal mine cars are not ordinarily brought to the coal face.

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* The RTU-250, with a 61-kw motor, moves at 1.07 m per second and can be operated at elevations of 15 degrees.

** This conveyor requires an MA-146-1/6 motor, of 46 kw, and a belt 900 mm wide. Two drive pulleys are employed, together with a gravity takeup system. It is assumed that all of these conveyors are of the semitrough type. No information has been received as to types of idlers or idler bearings used on this equipment. It is not known, therefore, whether use is made of precision bearings.

*** The RT-300, with a 61-kw motor, operates at 1 m per second and can be operated at an elevation of 18 degrees.

**** If the idler angle is too great, a belt conveyor becomes unstable; if too small, tonnage is lost. The USSR also builds a group of belt conveyors for use in open pits. 195/

***** P. 160, below.

If this were done, the rails paralleling the mine face would have to be moved forward after each advance into the coal seam. Since conveyors are more easily moved than tracks, conveyors are therefore used at the face in horizontal seams. In sloping seams, gravity chutes are extensively employed (Table 5*), limiting the use of mine cars and locomotives to main-line haulage and to the transport of coal from development passages that are destined to become mine haulageways. For these purposes, the USSR has been building an extensive array of coal mine locomotives since before World War II.

At least three kinds of trolley-type coal mine locomotives are believed to be in production for main-line haulage in Soviet mines. These range in weight from 6.5 to 14 MT and are built in gauges from 550 to 900 mm, depending on their weight. All are driven by two motors. In power these machines extend from the 41.2-kw hourly rated, 6.5-MT locomotive to the 92-kw, 14-MT model (see Table 15).** Power per ton of weight is roughly comparable to US equipment. It does not appear, however, that the USSR builds coal mine locomotives in the size range of the heaviest US models. The bulk, if not all, of these heavy-duty Soviet locomotives are built in the Toretsk Mining Equipment Plant imeni Voroshilov at Druzhkovka in the Ukraine and at the Aleksandrovsk Mining Equipment Plant imeni Voroshilov at Kopi in the Urals. Motors are supplied by the Moscow Dynamo Electric Plant imeni Kirov. 196/

For light duty, such as the spotting of coal mine cars, the USSR builds a 3.2-MT single-motor locomotive with a two-wheel drive and an 11.4-kw motor. For service in gassy mines, two medium-weight storage-battery locomotives are available, weighing 8 and 8.5 MT, respectively, with power ratings of 15.2 and 18.2 kw. A small 2-MT storage battery spotting locomotive is also built, at the Gornyak Mining Equipment Plant in Kutaisi, for miscellaneous tasks where trolley service is deemed inadvisable (see Table 15).

In the field of mine locomotives, several Soviet post-war developments are of importance. It is definitely planned to

* P. 22, above.
** Table 15 follows on p. 87.

increase the electric mine locomotives in size so as to enable them to haul larger cars and longer trains. To make this possible, it was declared in 1951 that the mine haulage systems must be revamped. Light rails are to be replaced with heavier track, and track is to be laid on gravel ballast to permit use of the new 10- to 14-MT locomotives. 197/

Of considerable importance technically has been the development by the USSR of alternating-current (AC) mine locomotives. These machines, employing polyphase squirrel-cage motors, make it unnecessary to convert the AC delivered to the mines to direct current (DC) for traction purposes, thus saving the cost of motor generator sets or rectifiers. Because condensers are used in starting these motors, the locomotives have been termed condenser locomotives in the Soviet press. The first condenser-type mine locomotive was built in 1943 under the direction of S.A. Volotkovskiy* and was operated for about a year in the Yegorshinugol' trust. After the war, in 1946, another condenser locomotive was designed by Giprouglemash and built by the Moscow Power Institute imeni Molotov in collaboration with the Moscow Dynamo Electric Plant. After it had been tested in the Donbas, a series of condenser-type locomotives was built. Stalin prizes were awarded in 1949 for the development of this new type of locomotive,** one model of which was believed to be in production in 1950. Denoted the KE-1 and built around the mechanical part of the 6.5-MT II-TR-2 locomotive, this machine weighs the same as its DC counterpart and exerts approximately the same tractive force. 198/ If continued references in the press are an acceptable indicator, these machines are proving acceptable in practice. 199/

Another recent Soviet experiment is the combination trolley and storage-battery locomotive. Such machines could be converted to battery operation in gassy places and back to trolley operation in the gas-free sections of their run, thus presumably prolonging the life of the storage batteries. A series of such combination locomotives was designed by Giprouglemash and built experimentally at the Toretsk locomotive factory at Druzhkovka in

* At the V.V. Vakhrushev Mining Institute at Sverdlovsk.
** The awards were shared by Professor V.E. Rosenfel'd, Academician V.S. Kulebakin, Engineer O.A. Nekrasov, and others.

Table 15

Technical Characteristics of Soviet Electric Coal Mine Locomotives* 200/

		DC			AC Condenser Type KE-1			Battery Locomotives		
	Unit	II-TR-2 II-TR-3	YU-10-600 YU-10-900	IV-TR-4	2p12	2p6	DC Car Spotters 1-TL-1m	II-AR-1	II-AR-2	AK-2 "Karlik"
New Designation (GOST 5048-49) a/**		7KR-600 7K9-900	10KR-600 10KR-750 10KR-900	14KR-900			3KR-600		8ARV-900	
Weight	MT	6.5 & 7	10	14	6.5		3.2	8.0 b/	8.5 b/	2
Gauge	mm	550-600 & 750-900	600 & 750-900	900	600		600	500-600	750-900	500,575,600
Length	mm	4,070	4,260	4,810	c/		2,660	4,100	4,100	1,905
Width	mm	1,044 & 1,344	1,070 & 1,370	1,320			920	1,044	1,344	895
Height	mm	1,500	1,450	1,500			1,400	1,480 d/	1,480 d/	1,180 d/
Number of Driving Axles		2	2	2			2	2	2	2
Wheel Base	mm	1,100	1,100	1,650			792	1,100	1,100	650
Minimum Turning Radius	m	7	7	10			4	7	7	
Wheel Diameter	mm	650	650	760			650	650	650	430
Gear Ratio		6.92	6.92	7.08			6.92	6.92	6.92	
Power, Hourly Ratio	kw	41.2	41.2	92	9.5	19	11.4	15.2	18.2	2.05, 2.15
Specific Power	kw per MT	6.3	4.12	9.56	6.5 e/	15 e/	3.8	2.3	2.6	
Tractive Force, Hourly	kg	1,460	1,460	2,680	1,480	1,370	480	1,080	1,080	160,196
Traction Coefficient		0.225-0.208	0.146	0.19	0.76 f/	0.88 f/	0.16	0.165	0.165	0.08, 0.1
Speed, Hourly	km per hr	10.3	10.3	12.4	4.72	10.2	8.3	5.0	6.3	4.35, 5.9
Tractive Force, Continuous	kg	370	370	650	950	1,050	175	320	320	
Speed, Continuous	km per hr	16	16	19	5.07	10.5	12.0	8.0	9.5	
Number of Traction Motors		2	2	2	2 g/	2 g/	1	2	2	1
Motor	type	DK-801A	DK-801A	DK-802A	MAK-51-6/12		DK-800B	DK-800A	DK-800A	MT-1-V
Voltage	v	250	250	250	385	380	250	100	120	
Hourly Capacity	amp	95	95	210	26	36	55	44	44	97
Continuous Capacity	amp	34	34	84	17	27.5	25			40
Speed										
Hourly	rpm				422	910				
Continuous	rpm				454	934				

* Spaces left blank in this table indicate that data are not available or are not applicable.
** Footnotes for Table 15 follow on p. 89.

Table 15

Technical Characteristics of Soviet Electric Coal Mine Locomotives 200/
(Continued)

	Unit	DC			AC Condenser Type KE-1		DC Car Spotters 1-TL-1m	Battery Locomotives		
		II-TR-2 II-TR-3	YU-10-600 YU-10-900	IV-TR-4	2p12	2p6		II-AR-1	II-AR-2	AK-2 "Karlik"
Battery								EP-370 EZhN-350	EP-370 EZhN-350	EP-250
Number of Elements								50/80	60/96	20
Average Discharge Voltage	v							98	118	40
Capacity	amp-hr							370/350	370/350	250
Where Built		Toretsk	Aleksandrovsk	Toretsk	Toretsk	Toretsk	Aleksandrovsk			Gornyak
Price 201/	rubles	36,000	38,000				27,000	34,000	34,000	30,000

a. A new standard for electric mine locomotives, GOST 5048-49, provides that, henceforth, trolley-type electric mine locomotives shall bear the letters KR, preceded by the weight in metric tons and followed by the gauge in millimeters. Thus the II-TR-2 becomes the 7KR-600. Under the new GOST, explosion-proof storage battery mine locomotives will bear the designation ARV; those for use in gas-free mines will be denoted ARN; combination types are to be termed AKR (A refers to storage battery; K, to contact; and R, to mine). Weights and gauges will be indicated in each case by the new GOST.
b. Including battery.
c. The KE-1 is built around the mechanical parts of the II-TR-2 locomotive.
d. Including battery box.
e. Continuous power rating.
f. Power coefficient.
g. Squirrel-cage type.

the Donbas. The fact that they are in the two-motor class and weigh approximately 8 MT puts them in the middle range of Soviet locomotive weights. Series production of two was begun by the Toretsk plant, but production was halted in 1949. This measure, it was stated, was temporary, taken to devise a method to charge the batteries from the trolley line while the machines were in operation.* Whether production has been resumed is not known. 202/

It may be concluded that the USSR has had enough experience to produce satisfactory electric coal mine locomotives, although it does not build so many sizes as are built in the US. Emphasis is being placed on the development of larger types, although these would be regarded as of middle size in the US. US machines may also contain more engineering refinements in the way of hydraulic sanders, air brakes, special insulation, and roller bearings. However, in the building of AC locomotives and combination trolley-battery locomotives, the USSR indicates its willingness to experiment with new equipment designed to achieve operating and constructional economies (see Table 26**).

10. Coal Mine Cars.

The manufacture of coal mine cars is a simpler operation than the production of any of the foregoing types of machinery. In the case of mine cars, the essential objective is to produce them economically in sufficient quantity to meet needs and of such a rugged structure as to withstand hard service. It is known that the USSR builds mine cars by assembly-line methods. 203/ It also

* These machines were denoted the II-TAR-1m and II-TAR-2m. Another pair in the same range, but with cabs at each end, has been designed at the Aleksandrovsk Mining Equipment Plant imeni Voroshilov at Kopi in the Urals. Whether these are in production is not known. They are denoted the II-TAR-4 and II-TAR-5. Combination trolley-battery locomotives are not unknown in the US.
** P. 162, below.

builds them in large quantities and in more plants than any of the machinery hitherto discussed. It builds a number of models and sizes, the most common ranging from 1 to 3 MT in capacity in both dumping and nondumping styles. 204/ Between 1941 and 1950 the number of large cars increased by 40 percent, and the number in the 1-MT class rose by 4.5 times. 205/ Whether these cars are as rugged as those built in the US or whether they last as long is doubtful.

11. Conclusions.

From the sheer variety of coal mining machines designed since the end of World War II by the USSR, it is apparent that the mechanization of coal mining is a matter of high priority. Engineering talent and research facilities have been extended to the coal mining equipment industry with an almost lavish hand. There is no doubt that the USSR is familiar with the experience of the West in this field and that where possible it has followed in Western footsteps. Where its technology has deviated from that of the West, it has not hesitated to strike out on its own to design equipment suited to its special needs. Specifically, the USSR has given more attention than any other nation to the development of continuous miners for longwall mining. In coal of medium height it has been successful; in low coal its machines show practical possibilities; and in high coal it still has much work to do. At the same time, it has deemed it worth the effort to design special machinery for steeply pitching seams and for entry driving. If this last effort succeeds, the USSR may be able to dispense with coal and rock loaders such as are used in the US.

Where Western designs have been suitable to its needs, the USSR has not hesitated to borrow. Thus its coal loaders and coal mine conveyors, locomotives, and cars emulate conventional Western practices. In general, the USSR has copied the smaller and lighter machines. Since the war it has built heavier and more powerful locomotives and longer and more commodious conveyors. Its heavy locomotives, however, are still of middle weight by US standards. Likewise, its conveyors are not yet up to the productive capacity of its continuous coal miners.

In its effort to achieve the maximum mechanization of coal mining, the USSR has made many mistakes and has had to abandon some designs entirely. Almost every machine that it has produced has had to be modified and improved over a period of several years before proving acceptable for production. Regardless of this drain on its economy, however, the USSR has abided by its decision to develop its own coal mining equipment industry and to meet by mechanical means its plans for the production of coal.

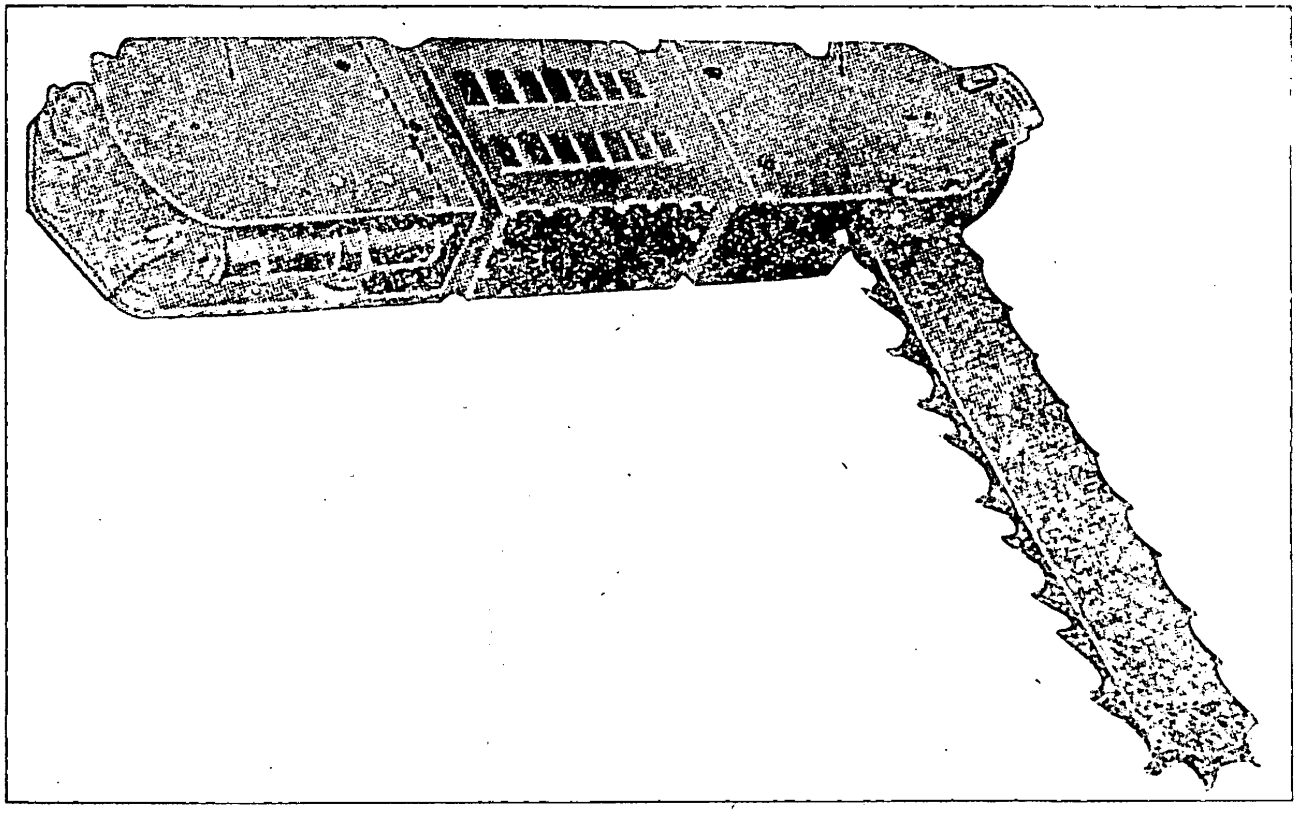

Figure 3. Soviet Longwall Coal Cutter, MV-60.

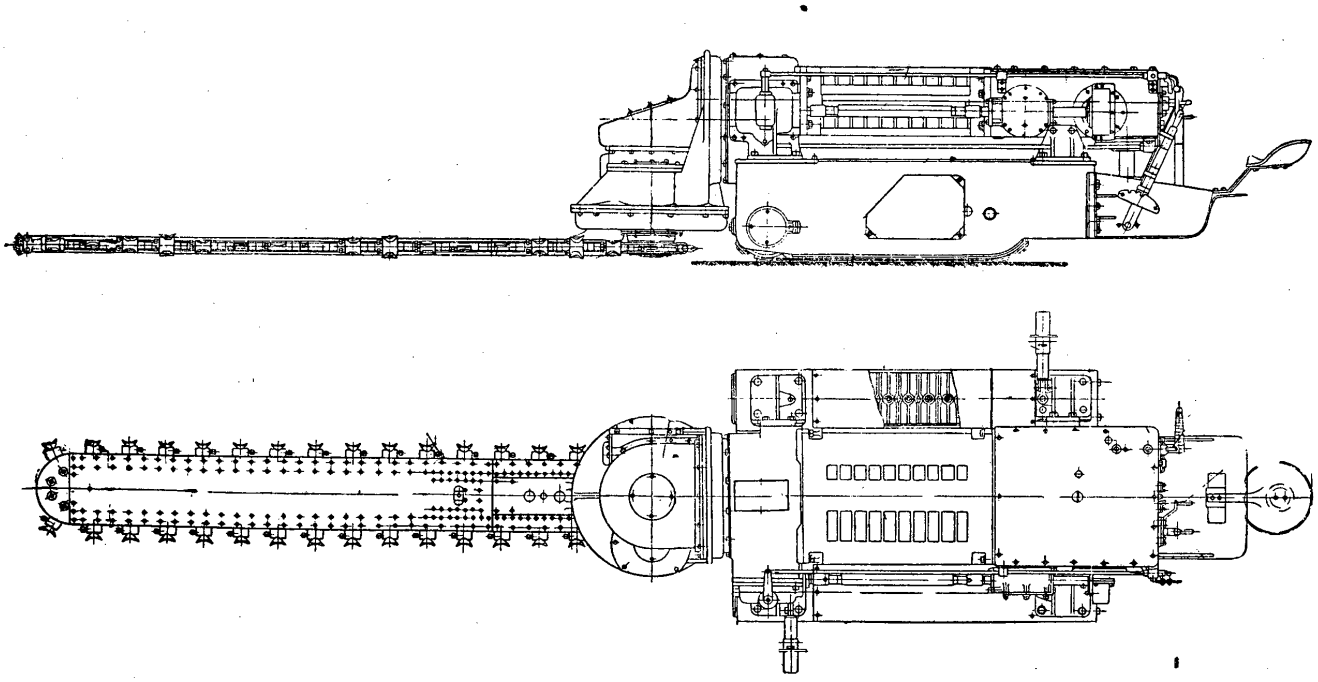

Figure 4. Soviet Universal Coal Cutter, VTU-1.

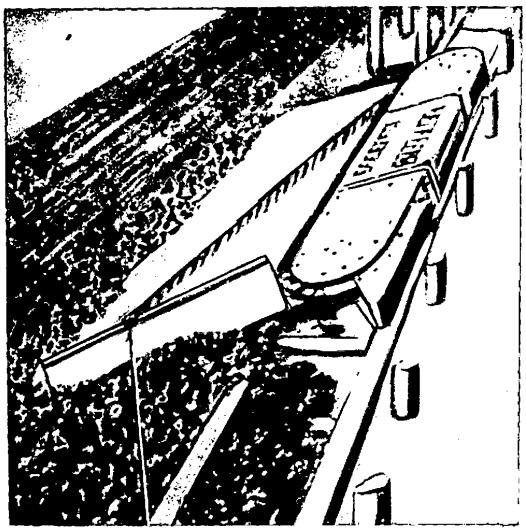

Figure 5. Soviet Cutter-Loader, VPM-1, on Soviet Scraper Conveyor, STR-30.

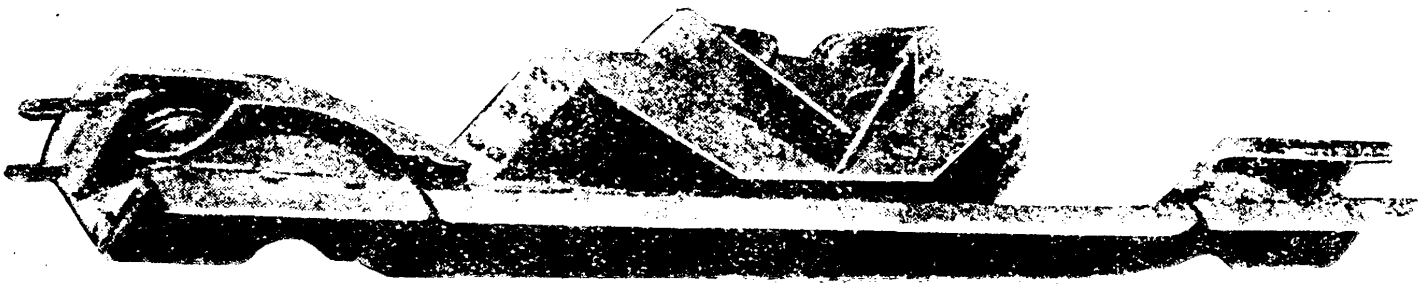

Figure 6. Soviet Coal Planer.

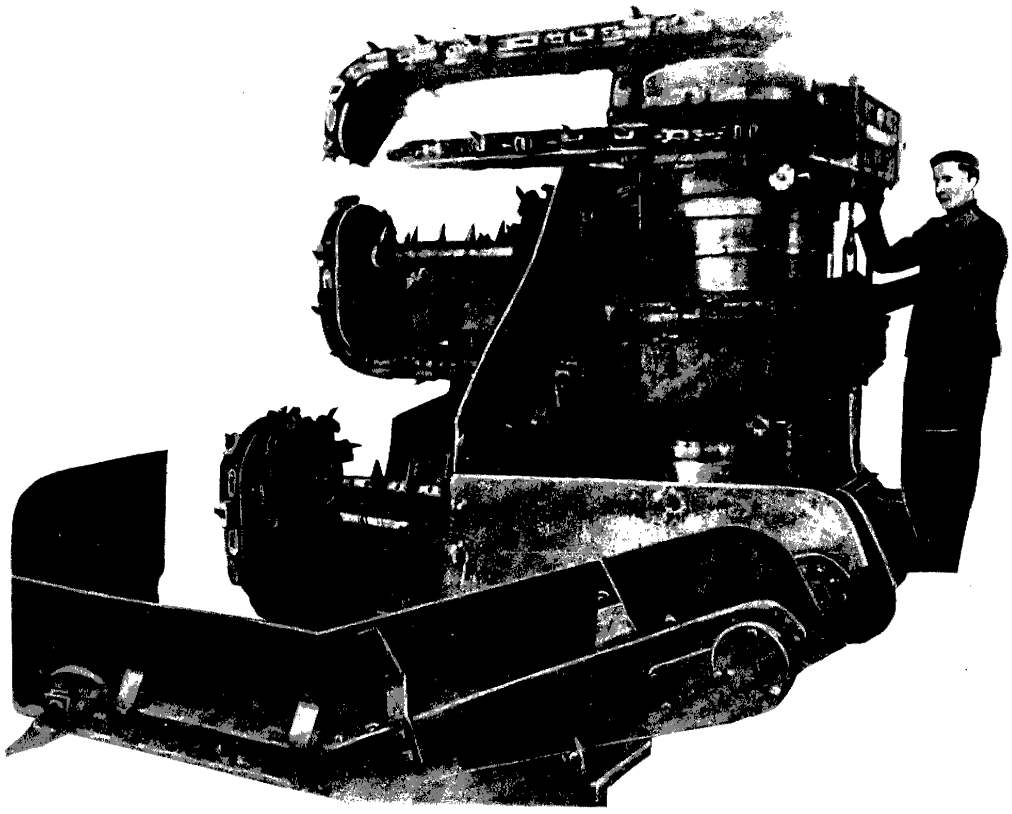

Figure 7. Makarov Coal Combine.

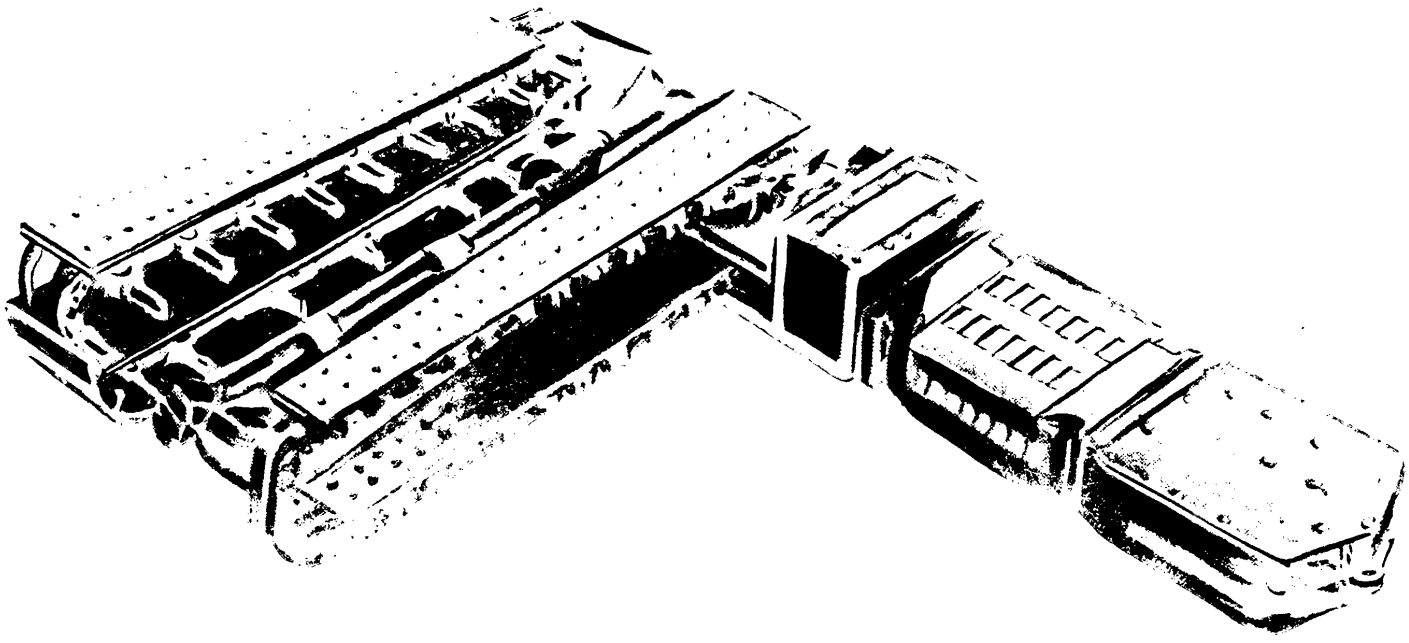

Figure 8. Donbas Coal Combine.

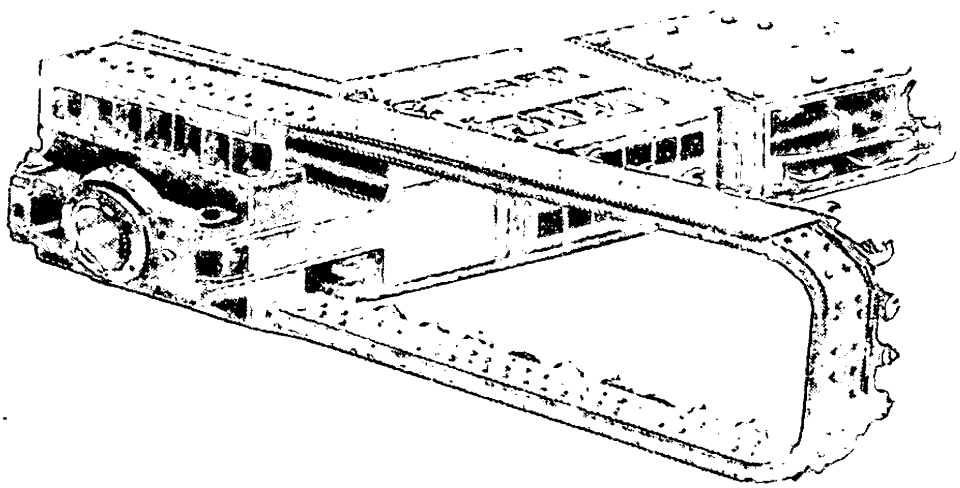

Figure 9. Soviet Ring-Type Coal Cutter, VK-1.

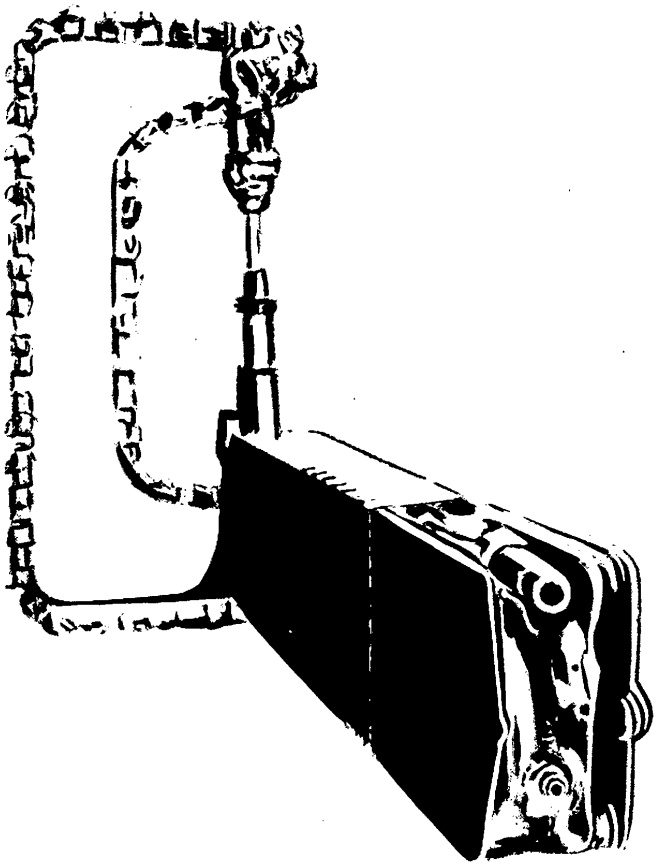

Figure 10. Soviet Coal Combine, VOM-2.

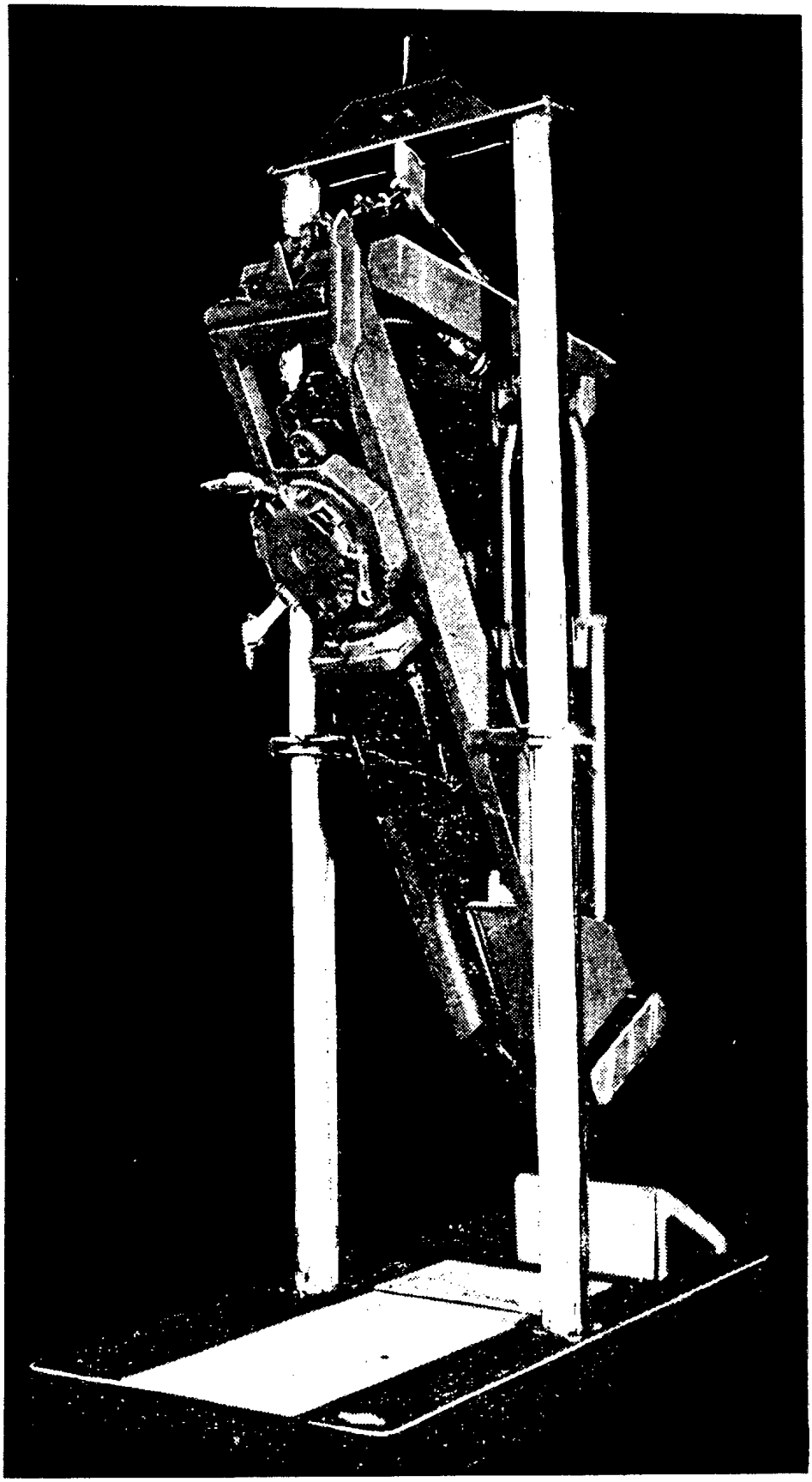

Figure 11. Model of the KKP-1, Soviet Pneumatically Driven Combine for Working Steeply Pitching Coal Seams.

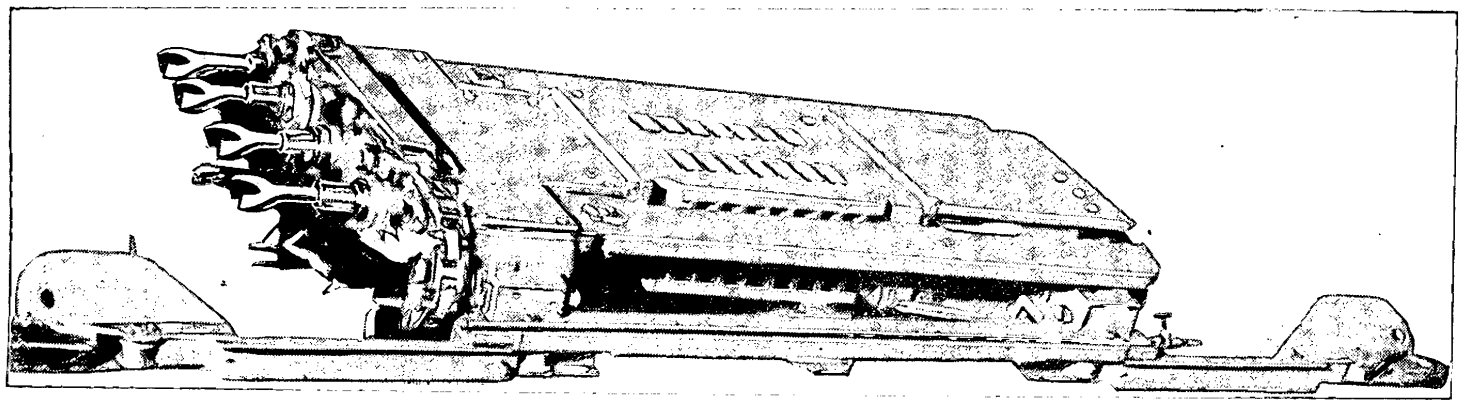

Figure 12. Soviet Coal Combine, UKT-1, for Working Thin Coal Seams.

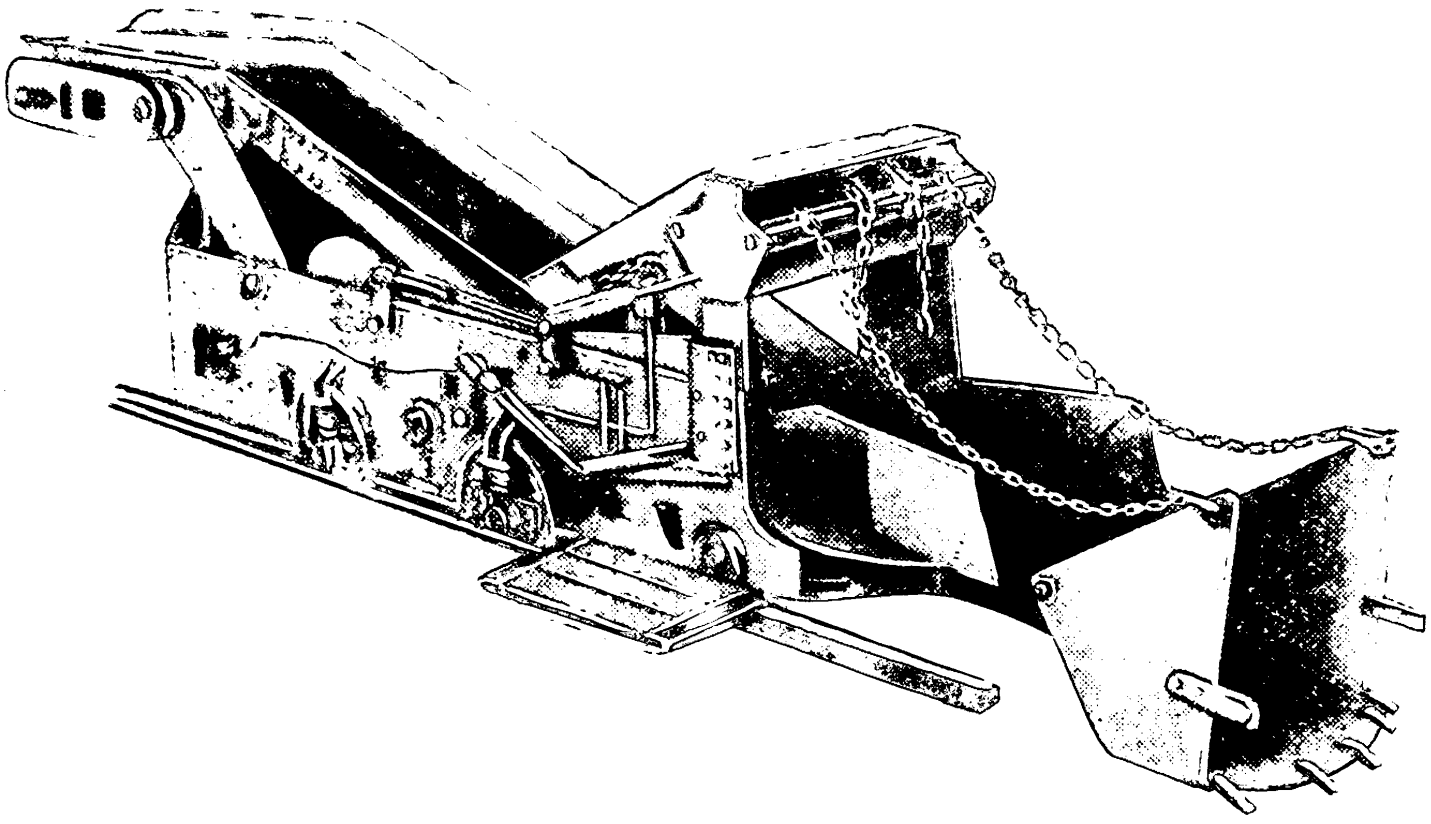

Figure 13. Soviet Rock Loader, UMP-1.

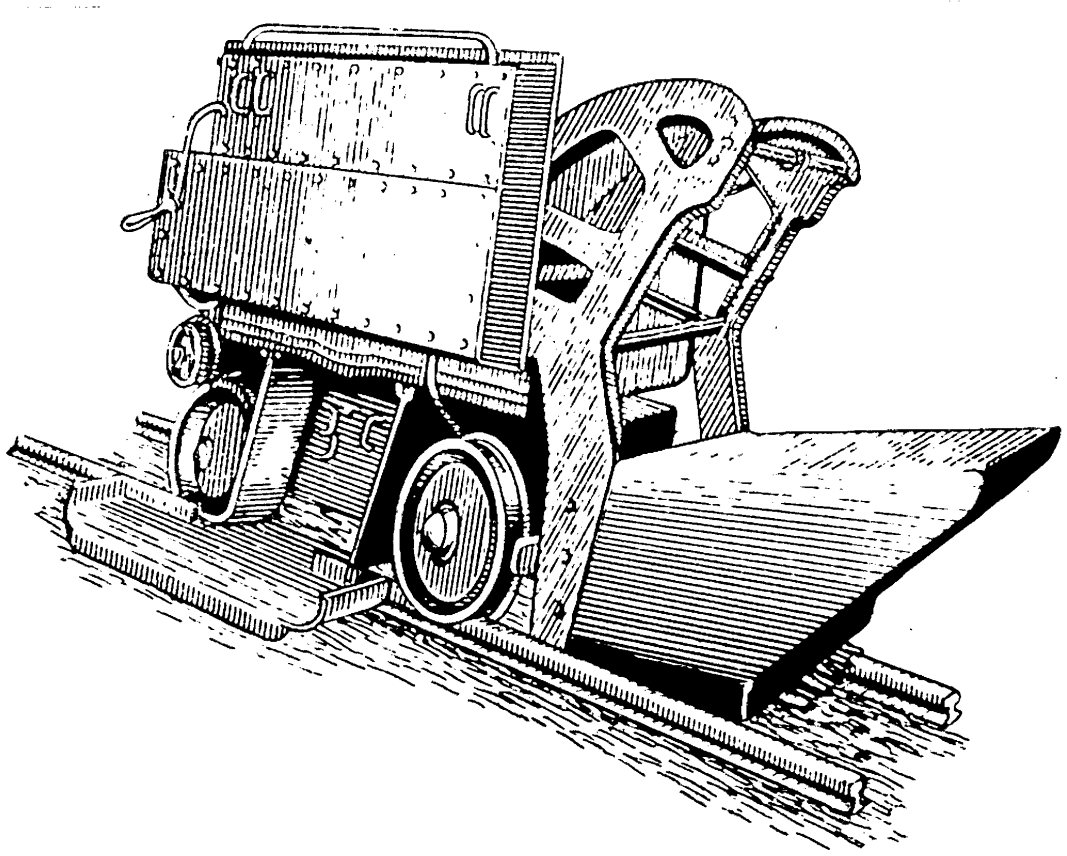

Figure 14. Soviet Rock Loader, EPM-1.

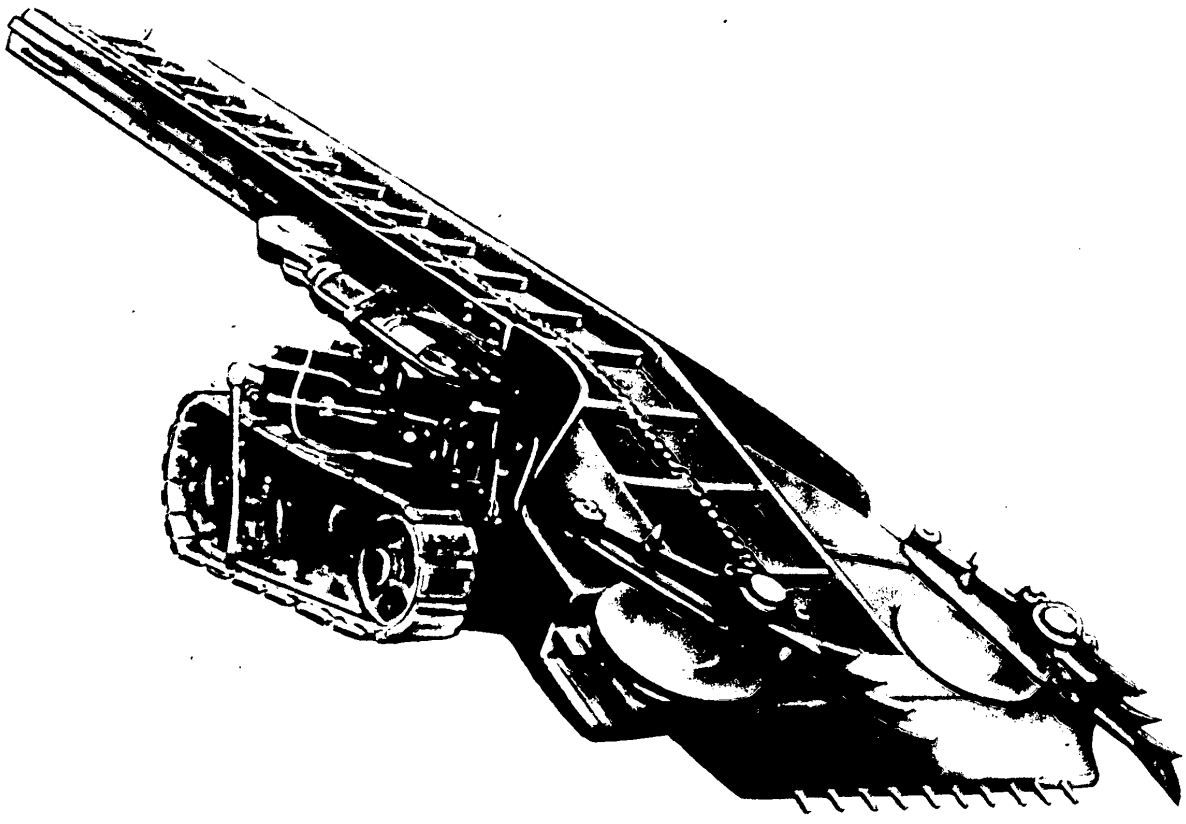

Figure 15. Soviet Coal Loader, S-153.

IV. Requirements.

A. Domestic.

As the result of intensive building of new coal mining machinery since the war, the Soviet coal mines are now well equipped with modern coal cutters, loaders, conveyors, and locomotives. Newly devised coal combines are also entering the mines in considerable numbers. This new equipment has replaced obsolete and worn-out machinery, has augmented labor productivity, and has at the same time helped to increase the annual output of coal. It is believed, however, that the Soviet coal mines do not have any reserve stockpiles of new machinery, nor do the Russians have so much machinery in service as to enable them to expand the output of coal to the extent of the 24 million or 25 million MT per year called for by the national plans,* without receiving generous annual increments of new equipment.**

Of Soviet intentions regarding the coal mining machinery industry during the current Five Year Plan (1951-55), little is known directly except that the government must assist the coal mines to expand output as required by the plan. Although no plan has been published for the coal mining equipment industry per se, it is believed from available knowledge of Soviet mining methods and the recent performance of Soviet coal mining equipment that an estimate can be made of the needs of the USSR for coal mining equipment.

Such a calculation must take into account (1) planned increase in output of coal, (2) allotments for the replacement of worn-out equipment, and (3) allocations for the extension of mechanization. In the case of coal cutters, requirements can be computed from known outputs per machine. From a knowledge of the number of cutters in actual use it is possible to reason to an approximation of the number of operational coal faces. Knowledge of the number of operational coal faces may in turn assist in estimating the number of preparatory faces, together with the number of face conveyors. From these data,

* See I, above.

** By means of the "single-cycle" movement, already referred to, the USSR hopes to reorganize and schedule production in such a way as to improve the over-all efficiency of equipment now in the mines. The object of this effort is for every crew to complete an entire mining cycle in each working day, which would require that each longwall face be cut, broken down, loaded, and prepared for the next advance. Sizable gains have been reported as a result of this drive, but it does not yet appear to have had drastic effects on over-all output per machine. 206/

further estimates can be made of the requirements for both loaders and locomotives. If export needs also be considered, it may be possible to arrive at a rough estimate of the total number of machines that must be produced each year to meet Plan requirements in the USSR and to cover the needs of the less industrialized Soviet Satellites.

In the instance of coal cutters and combines, productivity may be estimated from data on percentage of coal extracted by each method (see Table 3*), together with annual inventories (Tables 1** and 29***). The annual productivity of Soviet heavy coal cutters since 1946 has ranged from 31,233 MT in 1946 to 23,178 MT in 1949, the last year for which reliable data are directly available.**** Soviet press statements claim a 16-percent increase in productivity for the first quarter of 1951 as compared with the equivalent period of 1949. 207/ If these figures be generalized for the whole of both years, then the 1951 productivity may be assumed to have been of the order of 28,000 MT. On this basis it can be reasoned that about 36 cutters would be needed to mine 1 million MT of coal and that about 725 cutters would be needed each year through 1955 to mine the planned annual increments of 20 million MT.***** These requirements would be subject to some downward adjustment, depending on how much further it is possible to increase the output per cutter.

This calculation is complicated, however, by the fact that the USSR is rapidly increasing the proportion of combines to cutters. Back in 1949 the 300 combines****** in use during the year mined 9,598,000 MT, or about 32,000 MT per machine. The output per combine is said to have exceeded that of cutters by 32 percent in the first quarter of 1950, which is compatible with the computed 1949 output per cutter. [redacted] in 9 months of 1950 the output per combine actually in use averaged about 4,556 MT per month, or about 55,000 MT per year. 208/ In August 1951 the

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* P. 19 , above.
** P. 15 , above.
*** P. 182, below.
**** Calculated from Tables 1 and 3 (pp. 15 and 19, above), using inventories for the middle of the year.
***** Assuming that of the 24 million MT, 4 million MT will be mined from open-pit operations.
****** Includes planers and cutter-loaders. See III, above, for technical characteristics of these machines.

efficiency of combines was reported to have increased almost 60 percent in 2 years. 209/ At the close of 1951 the efficiency of combines for the year was said to have risen 19 percent. 210/ It is estimated that this would bring the output of combines up to 65,000 MT per year at the end of 1951. At this rate, only 16 combines would be needed to mine 1 million MT of coal. However, since there is a fine difference between output figured against total inventory and output per combine in use as reported by the USSR, it may be assumed that the need would be closer to 20 combines per million MT.

In any event, it may be reported that to mine 20 million additional MT of coal per year, the USSR has the choice of building about 725 longwall coal cutters or about 400 coal combines.* Since it is the announced purpose of the USSR to increase further the mechanization of coal mined both in entryways and from face operations, there will be an additional demand for coal cutters and particularly for coal combines. According to one statement, it is planned that,by the end of 1954, 70 percent of the loading of coal at the face will be mechanized. 211/ This plan is significant, though ambitious, because the measure of the mechanization of the loading of coal at the working face is also a good indicator of the number of combines in use at the face.** At current rates of combine productivity this program would require an inventory of the order of 4,000 combines and would for technical reasons entail the replacement of most of the cutters.*** It is therefore suggested that this plan be written off as a long-run goal which will not be achieved by 1955. In view, however, of the realities of the supply situation over the last several years, it is not unlikely that the USSR may be planning to augment the number of combines in domestic use by 200 to 275 units per year during the remainder of the present Five Year Plan (1951-55) while at the same time maintaining a high production of standard longwall coal cutters. In such an event, the object would be not only to meet the planned expansion of coal output but also to mechanize the portion of the output now cut by pneumatic picks or blasted from the solid, a quantity that might still have totaled 30 to 35 percent of the entire product at the end of 1951.

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* A range of at least plus or minus 10 percent should be applied to these estimates.

** Reasoned from the fact that coal loaders are too cumbersome to use at longwall faces. Therefore, Soviet longwall faces are loaded either by hand or by coal combines.

*** If 70 percent of the coal cut at the face is mechanically loaded, it is necessarily loaded by combines. Therefore, only 30 percent would be cut by standard longwall coal cutters.

How many machines will be available to extend mechanization depends in turn on the quality of the present inventory of equipment. If future replacement demands are high, then there will be little opportunity to substitute new equipment for operations now performed by hand methods. In fact, replacements have been unusually high in the postwar period. It is believed that this condition resulted not only from a deliberate effort to renew all the prewar equipment but also to dispose of the machines that were built in haste shortly after the end of the war. In the case of coal cutters it is estimated that the prewar inventory was finally disposed of during 1948. Generous retirements, however, were also made subsequent to that time, probably resulting from an effort to replace the lighter cutters such as the GTK-3 and 3M models with the heavier KMP-1 or MV-60 machines. Current Soviet retirement rates appear to be based on a longevity of only 5.6 years. US manufacturers have advised that although their equipment will last 20 years, it is general practice to replace it after only 10 years. 212/ If it continues to be necessary for the USSR to replace coal cutters at the rate of 18 to 20 percent per year, the Russians may find it difficult to provide enough new cutters to meet the need for expansion and still achieve progress toward complete mechanization. The likelihood is that strong efforts will be made to improve design, to build longer life into the equipment, to educate miners in machine care, and to improve the machine maintenance policy.*

Practical coal combines have not been in use long enough for much evidence to be available as to their lasting qualities. The early experimental models were generally short-lived. Although the Donbas combine is relatively simple in construction, it is undoubtedly more subject to wear than the heavy MV-60 cutter, which is one of its component parts. It is hardly likely that combines will last more than 5 years under Soviet conditions. At current rates, therefore, the requirement for Soviet coal mining machinery includes an allowance of not much less than 800 to 850 replacement cutters and 75 replacement combines per year.

* Elaborate overhaul schedules have been established, which, if carried out, would probably extend considerably the life of Soviet coal cutters. Under hard cutting conditions these provide for weekly overhauls, for current overhauls eight times per year, for intermediate overhauls three times per year, and for annual capital overhauls. 213/

In summary, then, it may be stated that to mine 20 million additional MT of coal per year by underground methods from 1952 until 1955, the USSR will need each year about 400 combines or 725 coal cutters. It will have had to replace during 1952 approximately 75 combines and 825 coal cutters. Any additional production will be available for the modernization of older methods of coal mining or for export purposes. In evaluating the strength of demand as between coal cutters and combines, it is clear that the die will be cast in favor of the latter. Not only do combines produce more coal per unit of inputs into machinery but also they mechanize coal loading and therefore release labor for other purposes.

On a regional basis the Donbas area is to date the most mechanized in terms of both cutters and combines. Hence within the Donbas the primary need will be for new types of combines, such as the UKT-1, the UKMG, and the Gornyak, to mechanize mining in thin seams. There is also a need for a combine such as the experimental KKP-1 to operate in steeply pitching seams, where pneumatic picks are currently used and where the output per man is low. In the Moscow and Kuznets basins there is still a strong but apparently unrequited demand for a combine to mine the thick seams to which the Donbas combine is poorly suited. Should the VOM-2 or similar machine be perfected, it will find a good market in these areas.

The requirements for loaders, conveyors, locomotives, and other equipment cannot be computed so closely or so directly as can the requirements for cutters and combines. Indirect calculations can be made, however, based in part on the number of cutters and combines and in part on the character of Soviet mining methods. It has been reasoned in this report that under longwall mining conditions the coal and rock loaders are used chiefly in development work.* Opening of the preparatory passages by present methods is slow work, which does little more than keep up with the progress of the mine face. The preparatory passages are so far apart that cutters and loaders assigned to such places cannot shuttle from point to point in the mine as in shortwall work and cannot operate continuously as in longwall work. To mechanize the mining of preparatory passages with presently available equipment would therefore require that one cutter and one loader be assigned to each place. The number of such places, it is reasoned, would be approximately the same as the number of

* See III, above.

operational coal faces, thus tying up much costly equipment from which little increase in productivity could be secured from either men or machines. For the time being, therefore, it appears to be economical for the USSR to use pneumatic picks and blasting powder in the preparatory passages in lieu of coal cutters.

Loading in these preparatory places is to be accomplished chiefly by means of the smaller rock loaders of the EPM-1, the UMP-1, and the PML-5 types rather than by the more elaborate S-135 or O-5 coal loaders. As many rock loaders will therefore be needed as there are mine faces. Calculated from the number of cutting machines and combines in actual use,* it would appear that there are approximately 4,200 faces where coal is mechanically cut. For the reasons just indicated, there might be a long-run need for about 4,200 loaders, weighted very heavily, however, in favor of the rock loaders rather than the coal loaders. This figure might well be increased to 5,000 if an allowance is made for machines not in service at any given time.

When it is noted that the inventory at the end of 1951 consisted of only about 550 coal loaders and 1,050 rock loaders, it will be seen that there is still a large backlog of unsatisfied demand for loaders. In practice, actual demand apparently has been determined more by administrative procedures and socialist plans than by technological considerations alone. Demand in this instance, therefore, appears to be less important than production and availability.

If, however, it be assumed that it is the intention of the USSR to mechanize the loading at the new places that are opened up in order to meet the plan for the expansion of coal output, then it might be reasoned that the number of faces in operation each year will have to be increased by about 550.** If it also be assumed that the same use factor operates on both cutters and loaders, this figure may be accepted as an estimate of the number of loaders needed each year for the additional preparatory passages. Allowing a retirement of 150 units in 1952 by extrapolation from previous years would establish

* About 5,700 cutters and combines at the end of 1951 in the total inventory, less an approximation of 25 percent to determine those actually in use (Tables 1, p. 15, above, and 29, p. 182, below).
** That is, a range of about 500 to 600. Based on estimates of 237 combines and 293 cutters, as developed in detail in VI, below.

a demand for 700 loaders for domestic purposes merely to replace worn-out equipment and keep up with the expansion in output.*

In contrast to the operation of coal loading, the conveying and transporting of coal from the working face to the lifting cage has already been mechanized, partly by means of conveyors and partly by means of locomotives. Requirements in this area are therefore related to planned expansion of coal mining, technical plans for modernization of the equipment, and replacement needs. In new installations it is likely that the coal will be moved from the face by scraper conveyors. In the entries it will be handled either by scraper conveyors or by long belt conveyors. At the main haulageways the coal may be transferred to cars for removal to the lifting cage. In any event, it is probable that at least one scraper conveyor will be needed for each operating coal face.** If the Donbas mines are typical, the median face length is between 125 and 150 m. Until recently the USSR did not have scraper conveyors suitable for hauls of more than 100 m and had to use shorter units in tandem for long-face work. Now the SK-30 is said to be capable of being extended to 180 m, which should be adequate for about 75 percent of the Donbas faces (see Table 13***).****

It has been calculated above that about 4,200 faces were being cut mechanically at the end of 1951. It is practically certain that face conveyors are also being used at the faces that are still mined by means of pneumatic picks, but it is difficult to tell from Soviet figures just how many faces are still being mined by this method. At the end of 1949, however, it is known that over 10,000 scraper

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* See Table 24, p.153, below, for the inventory and production of coal and rock loaders. The practice of US mines, as judged from statements by US manufacturers of this equipment, is to count on a life of 5 years for the coal loaders. On this basis, the life of Soviet equipment should not be rated at much more than 3 years. 214/ Replacement demand is therefore likely to rise after a few more years.

** A few mines may be using belt conveyors at the coal face.

*** P. 81, above.

**** In 1950, Donbas face lengths were reported as follows: up to 100 m, 17.4 percent; 100 to 125 m, 27.2 percent; 125 to 150 m, 19.5 percent; 150 to 200 m, 27.2 percent; and over 200 m, 8.7 percent. 215/ It is likely that as the combines become more efficient, the length of the coal faces will be extended. Because of the pressure to finish a complete cycle of work per shift, this lengthening of the face will amount to a work speed-up. It will result, of course, in a demand for still longer face conveyors.

and more than 4,000 belt conveyors were in operation. 216/ Because this equipment is mostly all postwar, it is reasoned that annual increases in inventory have been 2,000 scraper and 1,000 belt conveyors.* If this demand continues, then it may be expected that requirements for new conveyors to meet replacement** and expansion needs will run from 2,500 to 3,500 scraper conveyors and 1,000 to 2,000 belt conveyors per year for the next several years. Of these figures, 500 to 800 are allowances for the expansion of output.***

Soviet requirements for mine locomotives are conditioned in turn by the increase of coal output; the mine rehabilitation program, which calls for the replacement of light 7-MT equipment with 10- and 14-MT units; and the program to replace hand pushing of single cars with lightweight 2-MT gathering locomotives. On the basis of about 2 locomotives to each mine face, 700 to 900 medium or heavy locomotives may be needed each year to keep up with expansion of coal output. Retirement, which is calculated on the basis of a 10-year life for the USSR as against a 20-year basis for the US, has been taking about 300 to 350 units in recent years and may be expected to increase. About 600 lightweight gathering locomotives have been going into the coal mines per year as per plan. This brings the total demand up to about 1,750 units per year. This trend may continue for a few years before declining slightly when an adequate inventory is attained, owing to the fact that locomotives last longer than other types of undergound equipment and are more susceptible to

* In 1951 the industry had 140 percent more conveyors than in 1940. 217/ Estimates for the 1940 total for the Donbas range from 5,500 to 8,000. 218/ It is estimated that the whole USSR had about 12,000 conveyors in 1940. It should be noted that most of them were of the now obsolete shaker type.

** Chain conveyor life in the US may be estimated at 15 years for the drive and about 2 years for the trough and chain. Belt conveyor drives are given a 20-year life in the US; the sections and idlers are rated at about 15 years; and the belt at about 5 years. Soviet equipment may last about half as long as US equipment. 219/

*** Based on the assumption that the inventory will increase annually by 237 combines and 293 cutters, or 530 machines in all. This is discussed in detail in VI, below. Correcting for 75-percent use factor gives about 400 faces to be added per year. Each face will need at least one conveyor.

rebuilding than are cutters or loaders (see Tables 1* and 26**).***

B. Export.

In addition to meeting almost all of its own needs for coal mining machinery, the USSR now finds it necessary to assist the Satellite countries to meet their requirements for coal mining machinery. These requirements are extensive because of the emphasis being given to coal mining in every one of the Satellites.

Moreover, it is the clear intent of the USSR to encourage the extractive industries of the Satellites as well as to hasten the industrialization of those members of the Soviet Bloc that are now primarily agricultural. This policy has created a strong demand for coal mining equipment among the Satellites, which has been augmented by the imposition of Western export controls. Because of the relatively unindustrialized character of most of the members of the Bloc, a large part of the demand must be met by exports from the USSR. To alleviate this pressure, however, the USSR has

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* P. 15, above.

** P. 162, below.

*** Pneumatic picks, mine cars, ventilators, pumps, and processing and miscellaneous equipment were excluded from the scope of this report by definition. Since mine cars are so numerous as to constitute a large part of mining machinery inputs, it may be mentioned that the postwar Five Year Plan (1946-50) scheduled the production of 565,000 coal mine cars, 220/ suggesting a demand in the neighborhood of 115,000 cars per year during the postwar years. Once the prewar equipment was replaced, demand might have fallen to as low as 100,000 units per year, with a range of 75,000 to 125,000 units per year. It is calculated that Soviet cars made approximately 2 trips per shift and that about 150,000 cars are used per shift. Expansion of output may demand 15,000 new cars per year.

Mechanization does not seem to have greatly reduced the demand for pneumatic picks in the USSR. The 1951 inventory was stated to be 80 percent above that of 1940, which would have brought the 1951 total up to about 32,000 units. Judging from prewar practice, it would take an annual production of 20,000 to 25,000 units to maintain such an inventory (Table 1, p. 15, above). 221/

encouraged each of the Satellites that possesses any industrial potential to build coal mining machinery from Soviet designs.*

In the following pages an effort will be made to estimate the coal mining equipment requirements of the Satellites. As in the case of the USSR, estimates will be based in part on stated plans for the expansion of coal mining. In each instance, some consideration will be given to mining conditions, mining technology, and industrial potential. It is outside the scope of this report, however, to engage in basic research on any of these factors. Detailed information on the coal mining conditions and technology of the Satellites is available, though not yet in organized form. Information on the coal mining machinery industries of the Satellites is also available, but its exploitation is also beyond the scope of this report. Until reports are written on these subjects, no great reliability can be attached to any estimate of the demand that the Satellites will make on the USSR for coal mining equipment. The following computations represent, therefore, a summary of information at hand. They constitute a starting point for further research rather than a summary of finished intelligence. As in the case of the USSR, it should also be noted that the theoretical need for machinery is not the same as the immediate demand. The coal mines of the Satellites must compete for capital goods with the coal mines of the USSR as well as other industries in the Soviet system. The decisions as to how much equipment will be allotted to the Satellites in any one year are in large part administrative decisions made by responsible agencies in both the Satellites and the USSR.

1. Albania.

Albanian coal production amounted to only 75,000 MT in 1951 222/ and is, therefore, too small to justify detailed consideration. Even this country, however, is attempting to develop

* However much the USSR may wish to dominate and integrate the economies of the Soviet Bloc, it has shown no disposition to reduce the Bloc nations to a colonial status, engaged only in agricultural or extractive operations. If the coal mining machinery industry is a representative instance, Soviet intentions would appear to be to encourage economic integration on a regional basis, using the old Satellite national boundaries for the present, at least, as economic regions.

Satellite coal production in 1951 totaled 359 million MT as compared with only 282 million MT in the USSR. However, much was of low quality.

its hydroelectric, oil, and coal resources. The Albanian press reported in January 1952 that mining machinery continued to be received from the USSR. It was also noted that special training was necessary to acquaint miners with the technique of using such machines. 223/ It has been estimated that the USSR might have allowed Albania a single coal cutter in 1952, but the number allotted might have been increased to two or three.

2. Bulgaria.

Bulgarian coal deposits are chiefly of a low-quality lignite and to date have been mined by relatively primitive methods, featuring the use of pneumatic picks. Nevertheless, Bulgaria raised its coal production from 4 million MT in 1948 to about 6.5 million MT in 1951, almost the 1953 goal. Under a revised plan it was proposed to raise the output in 1952 by 10.1 percent over the 1951 figure. 224/ Bulgaria has engaged in research to determine ways to process the low-quality lignite into briquettes for use in thermoelectric plants and into powder for railroad locomotive stokers. 225/

There is no evidence that Bulgaria is building coal cutters or combines. The first combine allotted by the USSR to Bulgaria is said to have been received in August 1951 by Bulgaria's largest mine, the Maritsa. 226/ The same mine received three more in the summer of 1952. 227/ Late in 1951 it was announced that a coal loader patterned after the Soviet-built S-153 had been completed at the Stalin Machine Construction Works at Dimitrovo. This plant was said to be producing such machines during the first quarter of 1952. 228/ Bulgaria may thus have been expected to build small quantities of coal mining equipment in 1952. It was nevertheless happy to receive any such equipment as was allotted to it by the USSR.*

3. Czechoslovakia.

Czechoslovakia raised its coal production from 41.3 million MT in 1948 to about 48 million MT in 1951. However, this total amounted

* Bulgaria's only known imports of coal mining equipment from the US since World War II consisted of 72 rock drills, valued at $61,014, shipped in 1947. 229/ Under a 1947 agreement, Bulgaria was scheduled to trade agricultural produce with Hungary for mining machinery, type unspecified. Whether this agreement has been fulfilled is not known. 230/ No postwar imports from the UK have been reported.

to only 91 percent of the planned figure. 231/ To rebuild and expand their mines after the war the Czechs purchased mining equipment from both the West and the USSR. From the US the Czechs obtained 30 coal cutters in 1947 for $157,000. In 1949 and 1950 they bought 46 coal loaders for $142,000. When conveyors, hoists, and rock drills are added to their orders, the total postwar purchases by the Czechs from the US add up to $617,000, not including spare parts. From 1946 to the end of 1948 they bought from the UK well over 100 coal cutters, valued at 158,000 pounds. Total Czechoslovak purchases of coal mining equipment from the UK from 1946 to the end of 1951 weighed more than 1,800 long tons and were valued at 771,000 pounds* (see Table 16).** Just how much the Czechs obtained in addition from the USSR is not known. The Czechs were said to have had, in 1948, 20 loaders of the S-153 type in the Ostrava Basin with which they were dissatisfied. 233/ As early as 1949, however, the USSR was scheduled to ship to Czechoslovakia 12 KMP-1 and 3 GTK-3 longwall cutters and 6 rock loaders of the Eimco type. 234/

Although the Czechs are serious about mechanizing their coal mines and have considerable industrial potential, they appear to be relying in part on the USSR to supply the more complicated types of coal mining equipment, such as the cutters, combines, and loaders. 235/ It was proposed under the 1952 Plan to increase Czechoslovakia's total of Donbas combines from 7 to 60 by 1 January 1953. Other inventories and increases are shown in Table 17.***

This same Plan called for the installation in 1952 of 60 coal loaders, as distinguished from the rock loaders; 252 locomotives; and much other equipment. Apart from the locomotives and conveyors, it is likely that most of this equipment will be imported from the USSR.

4. East Germany.

Although East Germany produces more coal than any other Satellite, most of the product is lignite, mined from open pits. The total output amounted to 153.1 million MT in 1951 and was expected to increase by 10 million MT during 1952. 236/ The 1951 Plan called for

* It has been reported that much of this equipment found its way to the uranium mines at Jachymov. 232/

** Table 16 follows on p. 107.

*** Table 17 follows on p. 108.

Table 16

US and UK Exports of Coal Mining Equipment to Czechoslovakia 237/
1946-51

A. US (Thousand $)

	1946		1947		1948		1949		1950		1951		Total	
	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$
Coal Cutters	0	0	30	157	0	0	0	0	0	0	0	0	30	157
Loaders a/							21	60	25	82	0	0	46	142
Conveyors	0	0	25	56	0	0	0	0	0	0	0	0	25	56
Hoists	0	0	176	128	1	10	0	0	0	0	0	0	177	138
Rock Drills	251	53	150	32	0	0	20	39	0	0	0	0	421	124
Total from US		53		373		10		99		82		0		$617

B. UK (Thousand £)

	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£
Coal Cutters	33	17	205	87	103	55		b/		b/		b/	341	159
Winding (Hoisting) Equipment	58	23	11	4	0	0		b/		b/		b/	69	27
Other Equipment	156	67	317	109	226	75		b/		b/		b/	699	251
Conveyors c/					141	20		b/		b/		b/	141	20
Total from UK	247	107	533	200	470	150	205	90	266	148	89	76	1,810	£771

a. Classification established in 1949.
b. Breakdown not yet available.
c. Classification established in 1948.

Table 17

Czechoslovak Inventory of Coal Mining Equipment, 1 January 1952 and Planned Inventory, 1 January 1953 238/

Units

Equipment	Inventory 1 Jan 1952	Inventory Planned, 1 Jan 1953	Planned Increase
Coal Cutters	181	213	32
Cutter-Loaders	18	55	37
Combines	7	60	53
Chain Conveyors	60	155	95
Rock Loaders	200	400	200

an increase in the production of brown coal to 205 million MT by 1955. Most of this increase will come from open-pit installations, which require types of equipment other than that dealt with in this report. The production of black coal was scheduled to be increased from 2.8 million MT in 1950 to 3.4 million MT in 1951, 239/ although most of the firms building equipment for deep mining are located in West rather than in East Germany. East Germany has, therefore, been hard put since the war to find sources of such mining equipment within the Soviet system. 240/ It is believed that very little in the way of underground mining equipment was shipped by the USSR to East Germany prior to 1952. A recent release indicated that shipments during the last half of 1952 would include 2 combines, 6 armored conveyors,* 16 scraper conveyors,** over 3,600 MT of pipe, 5,000 MT of rails, and 15 km of signal cable. 241/

5. Hungary.

In Hungary the Five Year Plan adopted in December 1950 provided for the increase of coal output from the 11.5 million MT mined in 1949 to a level of 18.5 million MT by the end of 1954, a gain

* Panzerfoerderer, a reinforced conveyor.
** Kratsbandfoerderer.

of 61 percent. A general revision of the Plan in 1951 resulted in the moving forward of the 1954 goal to 1952. The new goal for 1954 was established at 27.5 million MT, which is 239 percent of the 1949 figure. In order to accomplish these plans, it was intended to open new mines, employ large numbers of additional miners, and mechanize existing installations. 242/ The 1952 Plan called for the addition of 7,000 workers to the 1951 force, in addition to a wide variety and quantity of new machinery in the hitherto unmechanized Hungarian mines. 243/ Mechanical coal cutting, which accounted for only 1.1 percent of the total output in 1950, was to be raised to 60 percent by the end of 1954; mechanical loading of mine trucks was to be increased from 8 percent of total production to 60 percent; and mechanical loading of coal at the shaft was to be boosted from only 27 percent of total production to 90 percent. 244/

Hungary has purchased no coal cutters or loaders and only a minor quantity of other mining equipment from the US in the postwar period and made no reported purchases in the UK before 1949. Her total UK purchases of coal mining equipment in 1949 amounted to less than 16,000 pounds. 245/ Hungary has, therefore, been dependent for coal mining machinery on her own resources and those of the USSR. The Ganz Electric Factory in Hungary was building electric coal mine locomotives as early as 1948, 246/ and in 1949 was reported as planning the construction of a coal combine. 247/ Hungary is also capable of producing mine cars, conveyors, and subsidiary equipment, the most significant development being the Ajtay-Szilard coal combine, a heavy tank-like combine mounted on caterpillar tracks and operating entirely by means of a breaker bar instead of the traditional cutter chains. These machines are so heavy that it is difficult to introduce them into the mines. Once inside, moreover, they tend to churn up any but the firmest of mine floors. They raise a quantity of dust and must be dismantled when moved from place to place, and they require trained operators and skilled maintenance. Nevertheless, Hungary, partly as a matter of national pride, has insisted on building these machines, although it is developing lighter types. Hungary built a number of them in 1951 and, [redacted] planned to build as many as 200 in 1952* for use in preference to the Donbas combine. 249/ Presumably 50X1

* It is doubtful if Hungary could build so many of the heavy Ajtay machines in 1 year. If this figure is valid, it must indicate that Hungary has developed a lighter type of machine, which may be the F type, reference to which has been made in late 1951 and early 1952. 248/ The heavy type would appear to be limited in usefulness to the driving of preparatory passages. It is reported as being built at the Mining Machinery and Mechanical Transportation Equipment Factory (BAMERT) at Ujpest, recently renamed the Duclos Mining Machine Works.

this would result from Hungary's stated intention of doubling its output of mining machinery in 1952. 250/

To help meet its plans, Hungary has been buying coal mining equipment from the USSR since at least 1949. Shipments of drills, cutters, cars, and locomotives began to arrive in 1950. 251/ A Soviet loader was received in the first quarter of 1950. 252/ The first Donbas combine arrived in the late summer of 1951. 253/ During 1951 the USSR sent to Hungary 20 coal loaders, 7 coal cutters, and 20 chain and 20 rubber-belt conveyors, along with the aid, advice, and assistance of numbers of Soviet Stakhanovites. The 1952 shipments are expected to have exceeded those of 1951. 254/

Despite this aid, and despite the great need for coal because of the rapid expansion of its industrial system, Hungary was expected to fall about 1.5 million MT short of meeting its 1952 coal production goal of 18.5 million MT. 255/ This situation is having strong political repercussions inside of Hungary, where investigation has shown divisions of opinion concerning the merits of Soviet versus Hungarian combines and loaders, as well as a considerable reluctance on the part of many workers and mine managers to accept any form of mechanical equipment. 256/ Soviet pressure for coal mine mechanization is expected to prevail, however, so that Hungary must be included among the Satellites that required much coal mining equipment from the USSR during 1952.

6. Poland.

Of all the Satellite coal mines, those of Poland are of most value to the USSR both directly and because of their power in international trade. Poland produced 87 million MT of coal in 1951, of which only 5 million MT was lignite. Poland planned to mine 92 million MT in 1952 and has long-run plans to bring production above 100 million MT by the end of the current Six Year Plan in 1955. 257/ At the end of World War II, although Polish mines had purchased more mechanical equipment from the West than any other of the Satellites, Polish mines were not in good condition, equipment was run down and unstandardized, and mechanization was far from complete. About half of the coal output was mechanically undercut before the war, but very little was mechanically loaded. Somewhat less than half was mined by longwall methods. 258/

Poland set out to restore its mines, mechanize their working, and expand their capacity soon after the end of the war. Official figures show that Poland purchased about $1.3 million worth of coal cutters and rock drills from the US between 1946 and the end of 1948 (see Table 18).* Poland must also have purchased considerable quantities of coal mining equipment from the US that are not reported out as such in the published figures. From the UK the Poles have continued to purchase coal mining equipment long after US channels were closed. Total Polish purchases from the UK from 1946 to the end of 1951 weighed almost 6,000 long tons, valued at 1,817,000 pounds, and continued actively through 1952 (see Table 18). Judging from the 1947 purchases, Poland has been able to absorb as many as 250 coal cutters per year into its mining system. Indeed, it was Poland's plan to buy as many as 326 coal cutters, 57 rock loaders, 87 coal loaders, 2 cutter-loaders, and large quantities of drills, compressors, conveyors, and related equipment in 1948. 259/ Poland attempted without success to purchase $6 million worth of the latest model coal loaders from a British manufacturer. This order would have amounted to almost 250 machines. 260/ Poland has thus been hard pressed by the restriction of trade with the West, despite the bargaining power which it holds by virtue of its coal surpluses. It is to Poland's disadvantage that the countries which are negotiating for Polish coal do not build large quantities of specialized coal mining machinery such as coal cutters and loaders. It should also be noted that the Poles undoubtedly need replacement parts for their inventory of Western equipment.**261/

Poland's need for coal mining equipment has been too great for the USSR to supply. The Poles have, therefore, attempted to establish their own mining machinery industry since World War II. As early as 1948 the Polish coal mining industry set up a Union of Manufacturers of Mining Machinery and Tools to build their own equipment. This organization planned to build in 1948 some 24,000 tons of equipment, including 8,000 cars, 600 pumps, 210 coal cutters, 2,400 rock drills, and 2,200 pneumatic picks. 262/ To assist Polish factories in designing and testing mining machinery, the Ministry of Mining sponsored the erection, early in 1950, of a state corporation, to be called the Central Mining Machine Bureau. 263/ Under state directives, by 1951, Polish factories were building air tools, conveyors,

* Table 18 follows on p. 112.

** Poland is reported to have attempted to purchase $1.5 million worth of bearings and an equal amount of rubber conveyor belting for replacement purposes from the US in 1946-49.

Table 18

US and UK Exports of Coal Mining Equipment to Poland 264/
1946-51

A. US (Thousand $)

	1946		1947		1948		1949		1950		1951		Total	
	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$
Coal Cutters	65	159	175	885	102	185	0	0	0	0	0	0	342	1,229
Loaders a/							0	0	0	0	0	0	0	0
Conveyors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoists	0	0	0	0	0	0	1	3	0	0	0	0	1	3
Rock Drills	175	37	112	38	0	0	0	0	0	0	0	0	287	75
Total from US		196		923		185		3		0		0		$1,307

B. UK (Thousand £)

	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£
Coal Cutters	4	1	166	86	0	0		b/		b/		b/	170	87
Winding (Hoisting) Equipment	0	0	0	0	0	0		b/		b/		b/	0	0
Other Equipment	155	36	392	57	125	23		b/		b/		b/	672	116
Conveyors c/					54	9		b/		b/		b/	54	9
Total from UK	159	37	558	143	179	32	2,205	655	1,863	577	854	373	5,818	£1,817

a. Classification established in 1949. It is believed, however, that at least 25 rock loaders were sold in 1947 to Poland, valued at $4,282 each, or $107,050 for the group. The shipment date is not known. The order included $8,000 worth of spare parts. It is of course possible that these were classified as mining other than coal. 265/
b. Breakdown not yet available.
c. Classification established in 1948.

compressors, pumps, ventilators, coal cutters, and locomotives. 266/

After investigation of Polish mining conditions by two Soviet commissions, the USSR sent a coal combine, probably the Donbas combine, to a Polish mine near Katowice in 1949. 267/ From blueprints supplied by the USSR, in 1951 the Poles built a copy of the Donbas combine at the Mining Machinery Works at Piotrowice 268/ that was put into use at Zabrze on 28 August 1951. 269/ After tests it was deemed to be satisfactory for the soft coals of Silesia and was ordered to be placed into production on a regular basis. 270/ The Poles expected to use 60 coal combines during 1952. With their aid it is intended to increase the mechanical loading of coal by five times, to assist in opening new mines, and to help boost coal production by 4 million MT over the 1951 plan. 271/ If the Poles can build 60 combines in a year and operate them efficiently, they should be able to meet their planned coal production increases handily. It is more than likely, however, that they will achieve neither a high output of machines nor full efficiency with the new combines in so short a time. With the aid of Soviet designs and technicians the Poles should be able to build enough coal mining machinery to ease somewhat the demand on the USSR for this type of equipment, if not enough wholly to satisfy Polish needs.

7. Rumania.

So great is the demand for coal in the Soviet Bloc that even Rumania, smallest producer of coal next to little Albania, is seeking to expand its output, mechanize its mines, and learn how to manufacture the simpler types of coal mining equipment. Rumania mined only 2.6 million MT in 1948 and 3.6 million MT in 1951. The original 1955 goal of 138 percent over the 1950 production would amount to about 4.13 million MT and should be met early in 1953. 272/ Meeting the 1960 goal, which is said to have been set recently at from 20 million to 25 million MT, may be more difficult, and even the new goal of 8.5 million MT for 1955 may be a challenge. 273/ Rumanian imports of coal mining equipment from the US and the UK since World War II have been negligible. However, Rumania has in recent years received from the USSR such surprising items* as the rock-digging combine PPK-1, the ZAL-1 frontal combine, the O-5 coal loader, and the Karlik battery locomotive AK-1. 274/ The USSR is also supplying

* Surprising because most of them are still experimental in the USSR.

Rumania with conveyors, ventilators, drills, mine lamps, and other mining equipment. 275/

It is Rumania's plan to replace, during the present Five Year Plan, the mattock and hand drill with hydraulic and electric drills and then to seek to achieve more extensive use of coal-cutting machines. Rumania is already building, however, the less complicated types of equipment, such as drills, picks, compressors, and conveyors.* It hopes to receive from the USSR during the present Five Year Plan several hundred scraper conveyors and loading machines, dozens of extracting machines and locomotives, and hundreds of winches and coal cars. With this equipment Rumania hopes to bring its most modern mines, which belong to the Sovromcarbune (Soviet Rumanian Coal Combine), up to a high degree of mechanization. For the General Directorate of Coal, increases from 1950 to 1955 are expected to be as follows: mechanization of cutting, from 5 to 37 percent; transportation from the face, from 20 to 72 percent; transportation to the shafts, from 40 to 80 percent; and transportation to the surface, from 92 to 98 percent. 276/ These figures indicate how unmechanized the Rumanian mines were in 1950 and suggest that, to meet the 1955 and 1960 goals, Rumania will have to rely on the USSR for relatively large quantities of equipment.

8. China.

For all its vast size and population, China mined but 19.8 million MT of coal in 1948, a total that was increased to 40.3 million MT in 1951 and was expected to reach 44 million MT in 1952. 277/ China will no doubt join the European Satellites in seeking to expand coal output by drawing upon the USSR for mining equipment. China is known to have a few old US coal cutters, 278/ and it is probable that it has in recent years received a small number of Soviet coal cutters and other types of mining equipment as well. It was reported by the Peking radio on 28 September 1951 that the State-operated Taiyuan Machine Factory had succeeded in building a 65-hp coal cutter built entirely from native-made parts.** 279/ This report was echoed not long afterward by a claim that Chinese factories had been turning out 65-hp coal cutters during the past year, 280/ and the Soviet press soon spread the report further. 281/ In June 1952 it developed that the factory named had "formed a committee to promote progressive experiences" by carrying forward experimentation and theoretic studies

* Rumania acknowledges that it must import flashproof motors from abroad.

** Possibly built from Soviet blueprints of the MV-60.

at the same time. This factory, it was added, "has manufactured some rather complicated and huge machines never manufactured before, such as a coal cutting machine, and a drilling machine." 282/ Probably China is not yet in serial production in the building of coal cutters. Nevertheless, it claims to have doubled its mechanized output of coal in the past year 283/ and asserts that it has trained 385 miners in the use of mechanized cutters at the Tatung colliery, where machines were said to have been in use since the first of 1951. 284/ The likelihood is that China also has received a few Soviet coal cutters and that the USSR may seek to supply China with such amounts of mining machinery as can be spared, considering the demands of the more industrialized Satellites as well as labor conditions in China. Judging from the Polish experience, the USSR may even encourage the Chinese to build certain types of mining machinery from Soviet blueprints.

C. Summary of Soviet Requirements.

Although Soviet-built coal mining equipment has been shown at recent international fairs, it is believed that these displays were more for propaganda purposes than the result of any serious effort to invade the international market.* The evidence just presented is sufficient to indicate that Soviet and Satellite plans for the expansion of coal mining, their desire to save labor by the extension of mechanization, and their steady need for replacement will leave them little or no surpluses of mining equipment for export purposes outside of the Bloc.

This survey indicates also something of the nature of the planned expansion of the coal mining efforts of the Soviet Bloc. To Soviet plans of raising output by 20 million MT in 1952 must be added the European Satellite plans for another expansion of approximately 30 million MT, which would have brought the total increase of the Bloc up to 50 million MT or more in 1952. 286/ The subtraction of open-pit operations might reduce the planned expansion in underground mining to about 33 million MT.** If detailed studies of mining equipment performance in each of the Bloc countries were available, it would be a relatively simple matter to calculate equipment requirements for this

* For example, at Helsinki in June 1951 and at Bombay in 1952. 285/
** Plus or minus 15 percent.

increase of output. The projection of Soviet estimates for the Bloc, not counting Communist China, would show a demand for about 1,200 coal cutters or about 660 coal combines. Considering the probable lower efficiency of the Satellites as a whole, this might be recalculated on a 25-percent differential as about 1,350 coal cutters or 740 combines.* This total, it should be understood, would be the quantity of cutters or combines required in 1952, both to meet the plans for the expansion of coal mining and to achieve the increased output entirely by mechanical means. Even so generous an allotment of equipment would not reduce the actual amount of coal now being cut by less advanced methods. In one sense this figure may be thought of as the demand, but it is not necessarily the effective demand.

It must be remembered that these figures cover only the requirement for enough machinery to raise output to planned goals by mechanical methods of mining and that they do not take into account replacement needs. These needs cannot be figured closely until a basic study is made of the Satellite mines that will show their inventory of coal cutters and combines over a period of years. Even granted such information, it must also be kept in mind that this report deals with planned economies. It is therefore not certain on what basis capital is allocated for the expansion of mechanical facilities. In view of this considerable ignorance, it is possible to make only a series of estimates of what the effective demand for coal mining equipment will be in the Soviet Bloc.

These estimates have been made in terms of the preceding discussion and are shown in Table 19** -- for coal cutters, coal combines, coal loaders, coal conveyors, and coal mine locomotives, the items that fall within the scope of this report. It should be emphasized that this table attempts to arrive at the quantity of each type of equipment to be supplied in 1952 by the USSR for its own use and for allocation to the various Satellites. Where possible, the

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* Calculated for the USSR at the rate of 36 coal cutters or 20 combines per million MT of coal. Satellite requirements are figured on the basis of 25-percent lower efficiency.

At 110,000 rubles per Donbas combine this would cost 81.4 million rubles for combines. At an average price of 46,000 rubles for the heavier coal cutters, 1,350 coal cutters would cost about 62.1 million rubles. No comparable price exists in US dollars for Donbas combines. The 1,350 coal cutters would sell in the US for about $13.5 million at 1952 prices. 287/

** Table 19 follows on p. 117.

Table 19

Estimated Soviet Coal Mining Equipment Requirements a/
(Effective Demand) 1952

Units

Item	Total	Domestic	All Satellites	European Satellites	Albania	Bulgaria	Czecho-slovakia	East Germany	Hungary	Poland	Rumania	China
1. Coal Cutters	1,301 b/ 1,200-1,400	1,118 b/ 1,018-1,218	183 125-252	158 110-217	1 0-2	10 5-15	15 c/ 10-25	7 5-10	15 d/ 10-25	100 d/ 75-125	10 5-15	25 e/ 15-35
2. Coal Combines	400 b/ 325-475	312 b/ 275-350	88 53-135	83 51-125	0 0	6 3-10	45 c/ 30-60	2 0-5	10 d/ 5-15	15 d/ 10-25	5 3-10	5 2-10
3. Coal Loaders	904 700-1,100	700 600-800	204 143-270	199 143-260	0 0	2 d/ 0-5	130 c/ 100-160	2 0-5	30 d/ 20-40	30 d/ 20-40	5 3-10	5 0-10
4. Coal Conveyors e/	4,650 4,200-5,200	4,500 4,000-5,000	144 95-205	134 90-190	2 0-5	12 10-15	5 5-10	25 15-40	60 40-70	5 5-10	25 15-40	10 5-15
5. Coal Mine Locomotives f/	1,760 1,560-1,960	1,750 1,550-1,950									10 5-20	

a. These figures are estimates, based on the discussion in the preceding text. Satellite requirements are not those that mine owners would like to satisfy, although such estimates for the entire Soviet Bloc are given in the text, but are quantities provided for by economic planning, minus domestic production and purchases from one another. The upper figure in each entry indicates the best estimate; the lower figure, the estimated range.
b. Since coal cutters and combines perform similar functions, they were considered together in developing estimated requirements. The requirement for combines was made equal to estimated combine production. Mining requirements not satisfied by estimated combine production were allocated to cutters for the purpose of determining cutter requirements. See pp. 179-180, below.
c. It is estimated that Czechoslovakia is able to build about half of the planned items shown in Table 17, p. 108, above, and that eventually Czechoslovakia will attempt to become self-sufficient for coal mining equipment.
d. Building some but believed to be partially dependent on the USSR.
e. The USSR probably shipped prototypes but expected most of the Satellites to build their own.
f. It is believed that the Satellites are producing their own, trading with one another, and purchasing from Western Europe.

estimates are based on the respective national plans. It should also be stressed that the requirements as shown do not indicate total additions to inventory for the Satellites but only the equipment which they expect to receive from the USSR.

Wherever Satellite industrial potential has been sufficient, the USSR has encouraged local production from Soviet designs. The result of this policy is undoubtedly expected to be a smooth transition from partial reliance on the USSR to local autonomy and self-reliance for coal mining equipment. The export of Soviet designs is thus part of a plan to reduce the types and models in operation at any one time to a minimum in order to keep the maintenance problem under control. In general, the policy is being applied to simpler types of equipment initially, such as conveyors, coal cars, and mine locomotives, although the more industrialized Satellites are already building some cutters, combines, and loaders. Under this policy, even countries such as China and Bulgaria have built prototypes of cutters and loaders.

Combined Soviet Bloc requirements that may thus be regarded as operating on Soviet planning in 1952 for the production of coal mining equipment can be summarized as follows: about 1,300 coal cutters, about 400 coal combines, about 900 coal and rock loaders, about 4,650 conveyors, and about 1,760 coal mine locomotives. These figures include estimates for the expansion of production, the replacement of worn-out apparatus, and exports to the Satellites. It should be cautioned that a generous range of accuracy should be allowed, especially for the Satellite estimates.

V. Supply.

A. Location of Facilities.

For the purpose of this report, the coal mining equipment industry of the USSR is considered to be those plants which manufacture coal mining equipment and which are operated by the Ministry of the Coal Industry, together with certain other plants subordinate to other ministries that produce equipment for the coal mining industry.* From a product point of view the subject matter of this report has been limited to coal cutters, coal combines, coal loaders, coal conveyors, and coal mine locomotives. It is intended to follow the economics of these products from demand through supply to a consideration of inputs.**

From a few plants at the end of the First Five Year Plan (1928-32), the number of plants engaged in the building of equipment for the coal mines has increased to more than 40, most of them under the supervision of Glavuglemash.*** Included in the group are some of the heavy machine building complexes. In addition, the coal mining industry draws on plants in other industries for coal loaders, electric motors, and bearings. It also operates a number of equipment repair shops, some of which manufacture mine cars and repair parts, subsidiary equipment that escapes notice in a study of the major plants.

Oldest of the coal cutter plants is probably the Gorlovka Mining Equipment Plant imeni Kirov,**** which began to build coal

* For a map showing Soviet coal mining equipment plants by economic region, see Fig. 16, following p. 295.

** In order to determine what was being made at the various plants of the industry and to assess their potentiality, it was of course necessary to survey their entire product rather than merely the items just enumerated. This information will be reported in VI, below, though it is not proposed to make an analysis of the economics of the production of pneumatic picks, pumps, compressors, ventilators, hoists, coal-processing equipment, or other apparatus.

*** For the organization of the industry, see II, above.

**** See B, below.

cutters in the Ukraine about 1932, in a factory that dated back to before World War I. 288/ It is now the largest coal cutter and combine building works in the USSR. The Gorlovka plant was probably antedated by the Pnevmatika Mining Equipment Plant in Leningrad, which is the major builder of pneumatic picks in the USSR and which also supplies various other types of air-powered equipment, including pneumatic motors with which to operate coal mining machinery in gassy mines.* 289/

On the eve of World War II the industry was concentrated chiefly in the Ukraine, where most of the coal was mined. Before this area was overrun during the war, the Gorlovka plant was evacuated to Kopeysk in the Urals, where it was re-established as the Kopeysk Mining Equipment Plant imeni Kirov, No. 25. 290/ Likewise the Toretsk Mining Equipment Plant imeni Voroshilov, at Druzhkovka in the Ukraine, the leading prewar builder of mine cars and locomotives, was said to have been moved to Kopi in the Urals, where it was re-established in the plant of the Aleksandrovsk Steel Works as the Aleksandrovsk Mining Equipment Plant imeni Voroshilov. Two conveyor building plants were also moved from the Ukraine. One was the Voroshilovgrad Mining Equipment Plant imeni Parkhomenko, which was moved to the Kazakh, where it became the Karaganda Mining Equipment Plant imeni Parkhomenko and which has since built a wide variety of equipment, including combines, loaders, conveyors, cars, and processing machinery. 291/ Another old and well-established Ukrainian conveyor works, the Svet Shakhtera Mining Equipment Plant in Khar'kov, which, as its name indicates, also produced miners' lamps, was removed to Kemerovo in Western Siberia.** 292/ After the conclusion of the war, each of the war-damaged plants was reconstructed, newly equipped with captured German and other tools, and started on its way again at its original specialty. At the same time, the plants opened during the war continued in production. Thus the Ukraine again became the most important single mining equipment manufacturing region, but the disparity between it and the other regions was reduced.

* This plant claimed to be 50 years old in 1950 and also asserted that it was the first in Europe to build pneumatic tools.
** This plant was converted to agricultural machinery production in May 1946. It is possible that its mining machine building facilities were transferred to the Anzhero-Sudzhensk Mining Equipment Repair Plant, Svet Shakhtera, also in Kemerovo Oblast. This plant now builds mine conveyors.

The Soviet coal mining equipment building industry is fairly well decentralized both geographically and in terms of product specialties. Geographically the equipment manufacturing plants are located in several major industrial centers that are in turn located in the coal mining areas. Thus the major plants, as is shown by the map (Fig. 16; see also Table 20)* are in the Donbas, the Caucasus, the Urals, the Mosbas, the Kuzbas, the Karaganda, the Central Asia, and the Irkutsk mining regions, each of which, partly because of its coal deposits, has also been developed as an industrial center. From a product point of view, scarcely any one of the plants produces a full range of the equipment built by the industry. Instead, the plants tend to be grouped, with some overlapping, into cutter and combine plants, conveyor plants, locomotive plants, and plants that build pneumatic picks.**

Series production of coal cutters in 1951 is known to have occurred at only two plants: (1) the Gorlovka Mining Equipment Plant in the Ukraine, which builds the GTK-35 and the MV-60 longwall cutters, and (2) the Kopeysk Mining Equipment Plant in the Urals, which builds the KMP-1 longwall cutter. The manufacture of coal combines on a production basis occurred at these two plants, as well as at the Svet Shakhtera Mining Equipment Plant at Khar'kov, also in the Ukraine. The Gorlovka plant built chiefly the Donbas combine,*** the Kopeysk plant may have still been building the VPM-1 cutter-loader, and the Khar'kov plant had begun to produce the thin-seam combine UKT-1.

Proceeding down the line of products in terms of the dispersal of production, it is seen that coal mine locomotives were built at five different plants: (1) the Toretsk Mining Equipment Plant imeni Voroshilov at Druzhkovka in the Ukraine; (2) the Gornyak Mining Equipment Plant at Kutaisi in the Caucasus, which built lightweight storage-battery locomotives; (3) the Yerevan Mining Machine Eactory at Yerevan, also in the Caucasus; (4) the Laptevo Coal Mining Equipment Plant in the Moscow area; and (5) the Aleksandrovsk Mining Equipment Plant imeni Voroshilov in the Urals. This represents a fair

* Table 20 follows on p. 122.

** Mine cars are built at both locomotive and conveyor plants. The production of pumps, ventilators, and coal-processing equipment is widely distributed.

*** In 1951 the Gorlovka plant also built a few of the new UKMG thin-seam combines, together with some of the KKP-1 steep-seam combines.

Table 20

Soviet Production of Coal Mining Equipment by Plant, Economic Region, and Function*
1951

Units

Economic Region	Plants [a]**	Cutters	Combines	Loaders	Conveyors	Locomotives	Cars	Pumps or Ventilators	Picks, Drills, and Compressors	Processing	Miscellaneous
I	Leningrad [b]								X [c]		X
III	Barvenkovo						X		X		X
	Brianka				X	[b]	X	X			X
	Druzhkovka			145 EPM-1		400	X	X		X	X
	Gorlovka	600	200 (Donbas (VOM-1 (UKMG-1 (KKP-1					X			X
	Khar'kov		25 UKT	PML-5 [d]	X						X
	Konotop							X	X		X
	Kramatorsk										X
	Krivoi Rog			140 PML-5				X	X		X
	Rutchenkovo		1		X			X	X	X	X
	Sergo-Kadiyevka				X		X	X	X	X	X
	Stalino										X
	Voroshilovgrad	[e]			X	[b]	X	X		X	X

* Spaces left blank in this table indicate that data are not available or are not applicable.
** Footnotes for Table 20 follow on p. 125.

Table 20

Soviet Production of Coal Mining Equipment by Plant, Economic Region, and Function
1951
(Continued)

Units

Economic Region	Plants [a]	Cutters	Combines	Loaders	Conveyors	Locomotives	Cars	Pumps or Ventilators	Picks, Drills, and Compressors	Processing	Miscellaneous
IV	Novocherkassk				X		X	X			X
	Shakhty				X			X		X	X
V	Kutaisi				X	600		X		X	X
	Yerevan				X	180					
VII	Electrostal										X
	Laptevo				X	120	X	X		X	X
	Moscow					[e]					
	Rudovka					[b]	X				X
	Skopin				X		X	X			X
	Tula-Batishchev							X		X	X
	Tula Machine Building										X
	Uzlovaya				X		X			X	X
VIII	Karpinsk								X		X
	Kizel						X		X		X
	Kopeysk	500 KMP-1	113	[b]	X			X			X
	Kopi				X	400	X				X
	Nev'yansk										X
	Sverdlovsk			210 S-153							

Table 20

Soviet Production of Coal Mining Equipment by Plant, Economic Region, and Function
1951
(Continued)

Units

Economic Region	Plants [a]	Cutters	Combines	Loaders	Conveyors	Locomotives	Cars	Pumps or Ventilators	Picks, Drills, and Compressors	Processing	Miscellaneous
IX	Anzhero-Sudzhensk [b]				X						X
	Kiselevsk				X	[b]	X				X
	Omsk		[e]								X
	Prokop'yevsk				X		X	X	X	X	X
	Stalinsk			L-1; BCH-3	X		X		X		X
	Tomsk			255 UMP-1					X		X
X	Alma-Ata				X		X		X	X	X
	Karaganda		1	10 Yegorov	X		X	X		X	X
	Tashkent				X			X			X
XI	Cheremkovo				X		X	X	X		X
	Krasnoyarsk	[e]						X			X
XII	Vladivostok				X		X	X		X	X
	No. of Plants in Series Production	2	3	6	23	5	19	21	12	13	40
	Total Production	1,100 [f]	340 [g]	760 [h]	4,500 [i]	1,700 [j]	100,000	X	X	X	X

Table 20

Soviet Production of Coal Mining Equipment by Plant, Economic Region, and Function
1951
(Continued)

a. For complete plant names, see Appendix B.
b. Not confirmed.
c. X indicates this item to be in production at the plant named. The quantities produced, however, are not available, because these products are outside of the formal scope of this report.
d. Production scheduled to have begun in 1952.
e. Production believed to be terminated.
f. From Table 21, p. 138, below.
g. From Tables 22 and 23, pp. 142 and 149, below.
h. From Table 24, p. 153, below.
i. From Table 25, p. 160, below.
j. From Table 26, p. 162, below.

degree of dispersion, although it indicates that to date no indications of production east of the Urals have been confirmed.

Coal loaders were built in 1951 at six different plants, three of which were located in the Ukraine: (1) the Druzhkovka plant, previously mentioned, which built EPM-1 rock loaders; (2) the Khar'kov plant, also previously mentioned, which produced the PML-5 rock loader; (3) the Kommunist Mining Equipment Plant at Krivoi Rog, which also built the PML-5 machine; (4) the Sverdlovsk Transport Machinery Plant in the Urals, which produced S-153 coal loaders; (5) the Tomsk Electromechanical Plant imeni V.V. Vakhrushev in the Kuznets Basin, which built UMP-1 rock loaders; and (6) the Karaganda Mining Equipment Plant imeni Parkhomenko, which built a few Yegorov loaders.

By contrast, coal mining conveyors, the final piece of major equipment considered in this report, are produced in at least 23 different plants, distributed throughout most of the major coal producing regions. This dispersal is to be explained in terms of (1) the simplicity of this type of equipment, which is built more to sheet-metal-shop standards of precision than to machine-shop standards, and (2) to the greater weight of conveyor systems, which militates against their being shipped long distances.

Of the other items built in these plants but not included in the scope of this report, the 100,000-odd coal mine cars built every year are produced in more than 19 different plants, widely distributed throughout the USSR; the 20,000 to 30,000 pneumatic picks, together with the drills and compressors, are built in a dozen scattered plants; the large quantities of pumps and ventilators are produced at some 21 even more widely diffused establishments; the processing equipment is made in at least 13 spaced-out plants; and a great quantity of miscellaneous equipment is produced locally in 40 of the 43 plants studied. Dispersion of the manufacture of coal mining equipment throughout the USSR is therefore related in a fairly close manner to the complexity of the equipment, the precision with which it must be built, and the amount of special tooling-up that is required before series production can be achieved.

Insofar as production by plant is concerned, it may also be noted that, by and large, each of the major plants which builds coal mining equipment produces a special model that is built only in that one plant. Thus, although the USSR has made the designs of the

Donbas combine and the MV-60 coal cutter available to other countries within its orbit, both of these machines are built within the USSR only in the Gorlovka plant. With few exceptions, this situation also applies to the manufacture of the cutters, combines, loaders,* and mine locomotives. It should not be concluded that there has been complete standardization of equipment within the USSR for each special task to be performed by the mines. Instead, alternate designs of equipment to do the same or similar jobs have been developed. In 1951, for example, three types of thin-seam coal combines were being developed: the UKT, the UKMG, and the Shakhter, by the Khar'kov, Gorlovka,and Rutchenkovo plants, respectively. 293/ It is likely that the former two were already in production in 1952 at separate plants. Although it is a striking fact that in 1951 the USSR had in production only three models of coal cutters and equally few models of related equipment, this appears to be due both to the difficulty of producing successful coal mining machines and to a deliberate effort to standardize equipment. In fact, there is some reason to believe that the Soviet aim is to encourage development along parallel and even competing lines of design and technology.

B. Productive Capacity.

The production estimates that follow later in this section are based upon study of the mining equipment building plants, surveys of the Soviet technical literature in the field, and examination of Soviet press and radio reports of plans and plan accomplishments. Insofar as the study of the coal mining machine plants is concerned, certain special problems arise from the nature of the industry which make it hazardous to calculate production with any reasonable degree of accuracy from plant studies alone. Apart from the obvious handicap which arises from the untrained character of the observers, who were mostly prisoners of war, and their limited opportunities to observe, the character of the coal mining machine industry makes it difficult to calculate production from plant studies.

Although the Soviet coal industry needs large numbers of mining machines, it does not need so many as to make it economically feasible to build coal cutters, combines, loaders, and locomotives by conveyor-line methods on a mass production basis. These machines

* One exception appears to be the PML-5 loader, which, it is reported, has been built both at the Krivoi Rog and the Khar'kov plants. It is possible that production from the former plant may be going to metallic mines rather than to coal mines.

are usually built, instead, on a batch basis, in parallel fashion, so many at a time. A casual, untrained observer thus finds it difficult to estimate with any accuracy how many are produced in a given period, much less the time it takes to build a single machine or even the difference between series and batch production. To complicate matters further, although a given model of coal mining machine is generally built at a single plant, this item is not the only one that is built at that plant. Thus the Gorlovka plant not only builds several types of coal cutters and combines but also produces pumps, ventilators, and a wide variety of miscellaneous articles, like mine cages, head frames, mine cars, and coal crushers, not to mention pots and pans for people of the town. 294/ The heterogeneous nature of the product mix confuses observers and diffuses their attention so as to make it less likely that they will be able to report with a high degree of accuracy the output of any one item.

Because of the mixed nature of the output, it is also difficult, if not impossible, to tell [redacted] 50X1
[redacted] how much labor is required to build any one particular item. 50X1
This factor also confuses the entire input picture, since inputs of raw materials, [redacted] are ultimately divided 50X1
among the respective products. By the same token it becomes impossible to tell, from a study of plant size alone, what the output of any given product, such as coal cutters, is likely to be in a given period, when the capacity of the plant may be distributed over several dissimilar articles, such as cutters, pumps, and ventilators.

If there can be said to be an average type of coal mining equipment plant in the USSR, then to an outside observer this plant will first appear as a fenced or walled installation containing from half a dozen structures up to as many as two dozen buildings clustered and scattered throughout the grounds. The main entrance may stand out because of the presence of a statue of one of the Soviet heroes. Admission is by pass through a corps of security guards. Almost always the plant is on a railroad line or siding, although a number of trucks are at the disposition of the works. Frequently the plant has been in existence since before the Revolution and has been added to from time to time and perhaps converted from its original product to a different task. The construction of these older buildings varies considerably, though the tendency in the newer shops is toward steel or concrete framework with masonry fill.

The flow of materials within each plant is from raw-material stockpiles to the plant foundry, forge, stamping shop, or machine shop, as the case may be. Every plant of any size in the industry was found to have its own pattern shop and foundry.* In the larger plants, strides have been taken toward mechanization of the foundry by means of moulding machinery and conveyor lines for the cooling of the castings. Heat treatment has also been mechanized to some extent. Although the USSR has followed the US in shifting from cast to forged steel for parts that must withstand hard service, the USSR may lag behind the US in this trend.

In mining machinery the tolerances are adapted to the nature of the equipment. The manufacture of coal cutters requires fairly close machining, though not necessarily machining of the most precise character. Mine cars, and especially mine conveyors, on the other hand, are generally built to much wider tolerances. Conveyors must be constructed so that they can be knocked down easily and set up quickly. This demands loose-fitting parts which can withstand hard service. Soviet machine shops are set up with these factors in mind.

Although the output of coal cutters, combines, and loaders is not sufficiently great to justify the erection of an automatic plant or even to adopt assembly-line methods, mine cars are now assembled on continuous assembly lines in the Druzhkovka plant, which features a number of separate production lines for bodies, underframes, and wheel and axle assemblies. Each of the subassemblies joins the main conveyor line at the proper point. At the Gorlovka plant, cutter-chain bit blocks are forged and machined at points on a conveyor line which features the use of semiautomatic machinery. By the use of continuous automatic welding assembly methods the Svet Shakhtera Mining Equipment Plant at Khar'kov claims to have increased mine conveyor production by 3 to 3.5 times and to have cut work time for the upper trough from 2.78 to 0.8 man-hours per section and for the lower conveyor trough from 3.3 to 0.9 man-hours per section. At the Voroshilovgrad Mining Equipment Plant imeni Parkhomenko, drop-forged chains for scraper conveyors are machined and assembled by continuous methods. At the Gorlovka plant, just mentioned, another assembly line works on impellers for centrifugal pumps. In Leningrad at the Pnevmatika Mining Equipment Plant a continuous assembly line machines and puts together the parts for the OMI-1 pneumatic pick.

* None of the mining machine plants of the Ministry of the Coal Industry is large enough to have its own blast furnace or rolling mill.

The plants of the coal mining machinery industry have also taken steps to adopt advances in machining technique made elsewhere in the Soviet economy. The Pnevmatika plant has installed at least one unit for the anode mechanical sharpening of machine tools. The Khar'kov plant is said to have adopted the electric-spark method of hardening tools. High-frequency tempering is employed by the Krasnyy Metallist Electrical Plant at Konotop for gears and small shafts. The Gorlovka plant is said to use induction tempering on gears for the Donbas combine and also to harden coal-cutter bits. Dynamic balancing machines are said to be in operation at the Konotop plant to test mine ventilators. In fact, the Soviet mining machine industry is sufficiently proud of its advanced production methods to have permitted a book to be published in which they are described and illustrated. 295/

The 40-odd coal mining equipment building plants of the USSR are too numerous to describe individually. A fairly close look at the Gorlovka Mining Equipment Plant imeni Kirov will help to illustrate the characteristics of the Soviet plants of this industry.*

Gorlovka is an old plant that has been expanded from time to time. The accompanying sketch, drawn to scale from aerial photographs, reveals it to have an area of approximately 326,000 square meters. It has good access to nearby railroad facilities, and numerous sidings connect with its main buildings and storage facilities. Raw materials are processed either in the foundry at Point 4 or in the forge at Point 7. The foundry is centrally located and measures 226 by 60 m.** Most of the prisoner-of-war reports indicated that it was built of steel with brick fill. It contains a high central aisle covered by a gable roof with transverse skylights. The west aisle is lower and is divided in the center by a higher portion covered with a hipped roof. The eastern aisle is also lower than the center one and is roofed over by sawtoothed superstructures.

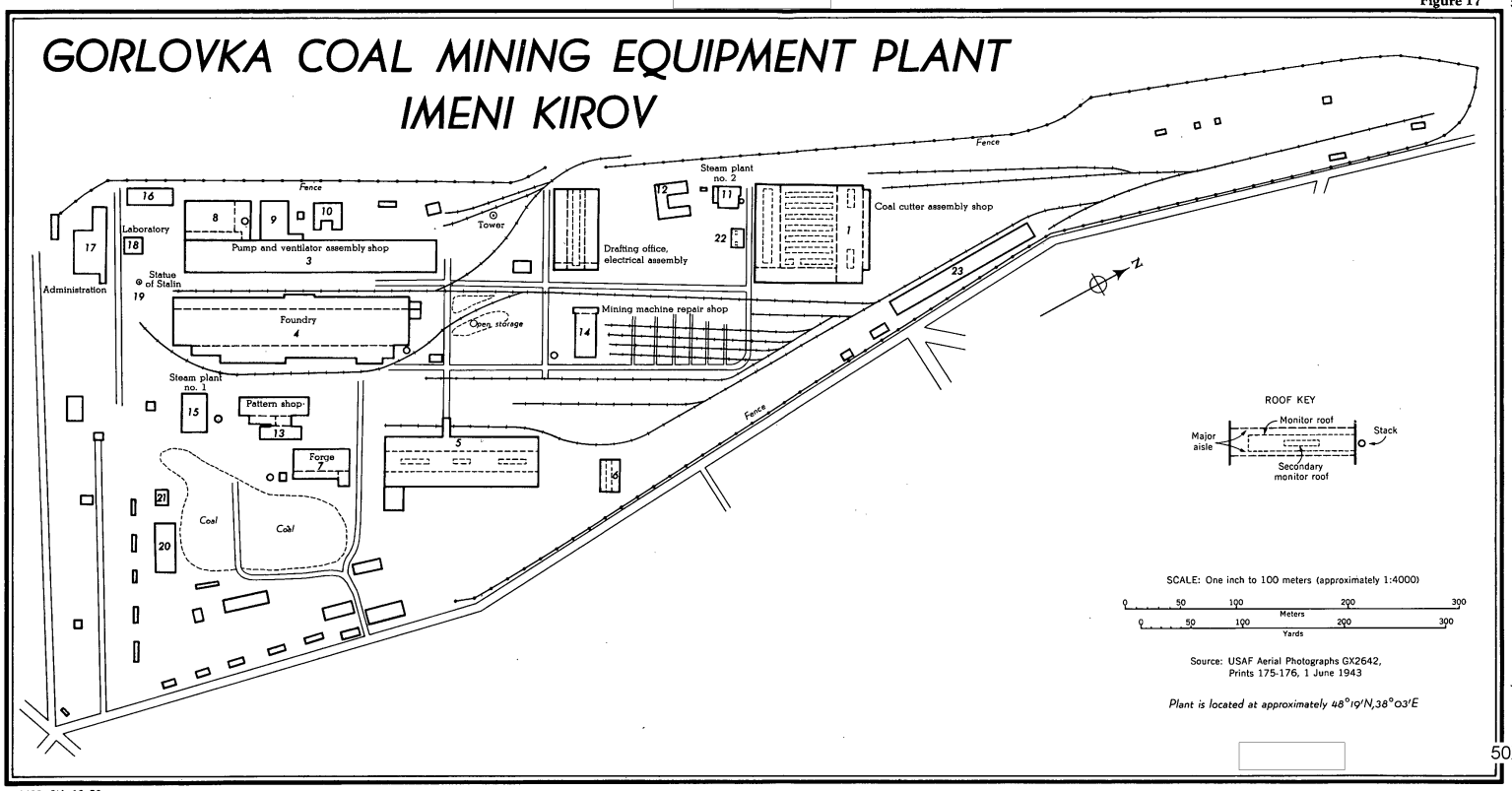
Reports on the equipment contained in this foundry varied widely. Prisoners of war better versed in technology than the

* For the layout of this plant, see Fig. 17, 296/ following p. 130.
** Prisoner-of-war reports of the dimensions of this structure varied considerably. Some sample dimensions as recollected by prisoners of war were 100 x 20 x 12 m high 297/; 150 x 50 x 5 m 298/; and 200 x 50 x 12 m. 299/

SECRET

Figure 17

50X1



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average reported that it contained four heavy-duty trolley cranes. The same source reported the casting facilities to consist of two German-made electric furnaces, two German-made Bessemer converters, one coke-fired cupola, and four German-made joggling machines.* 300/ Another report describes the foundry as containing a rotating casting installation. 301/ The foundry was served in turn by a patternshop at the conveniently located Point 13, of which the largest section, A, was 63 by 15 m, two stories in height, with a gable roof vented at the northern end. Connected with this main section at its mid-point, by D, a passage 14 by 10 m, was another two-storied shop, C, 37 by 12 m, topped by a gable roof.

The forge, a short distance to the east, consisted of a central section, A, two stories high, about 51 by 21 m, to which smaller, one-story wings were attached. It had been gutted during the war. Four large hammers were installed in 1946, but at first only two were placed in operation. 302/ [redacted] rated these hammers as follows: two, 3/4 MT capacity; one, 1-3/4 MT capacity; and one, 3 MT capacity. It was also said to contain 2 German air hammers, of 0.5 and 0.25 MT capacity, together with a German screw-upsetting machine, and 30 individual forges. 303/ The forge was also said to contain five or six Russian-built coal ovens, used to heat iron (?) blocks 50 cm by 30 cm by 20 cm high. 304/ 50X1

Steam for the forge and heat for the buildings were supplied by the boiler house at Point 15, 39 by 24 m, which had been unroofed in the war but which still possessed a tall stack in 1943. Prisoner-of-war accounts of its equipment ranged from two to four furnaces and boilers. Coal was stored in the open nearby. 305/ A second steam plant at Point 11 supplied additional heating steam. Electric power came from the town grid. 306/

Castings from the foundry and rough-forged pieces from the forge were diverted into two flow patterns. Those destined to become parts for coal cutters were moved by small electric cars to the machine shop and assembling works at Point 1, 105 by 90 m in size, bounded by a long north aisle roofed over by a flat, single, longitudinal monitor, interrupted by seven transverse, sawtooth skylights; by a flat-roofed east aisle without a monitor; and by a flat-roofed south aisle with a single monitor. Between these structures stood a central area covered by a low gable with seven transverse monitors.

* That is, molding machines?

This building was of single-story construction, with brick walls and steel trusses. Numerous prisoners of war agreed that a fire, of undetermined origin, destroyed this shop and its equipment in 1946. It was rapidly restored by a battalion of engineers. After its restoration it was divided into three working sections. A well-equipped machine shop with as many as 500 machines of all types, such as special lathes, boring mills, and presses, machined the rough parts received from the foundry and forge. In a separate section containing about 10 oil-fired ovens the machined pieces were heat-treated and hardened. This shop contained two or three traveling cranes of about 2 MT capacity each. From the heat-treating shop, parts were routed to the main assembly section, equipped with two traveling cranes of about 5 to 8 MT capacity and an unknown number of rivet hammers and work benches. Here the various parts were put together with coal-cutter subassemblies consisting of cable section, drive section, head section, cutter bar, and cutter chain and were finally assembled into finished coal cutters or combines. 307/

Parts for mine pumps and ventilators, the other major products of the Gorlovka plant, were shunted from the foundry and forge to the long single-story assembly shop at Point 3, 229 by 33 m, whose truss roof had been destroyed during the war. It was fitted with three overhead cranes of medium capacity and perhaps as many as 200 machine tools of various types; sandblasts; welding apparatus; and individual workbenches, fitted with anvils. Tacked onto this shop at its southwest end were smaller shops at Points 8 and 9 fitted with forges, annealing furnaces, and machine tools which produced small parts for pumps and ventilators as well as tools for the entire factory. 308/

At Point 14 there is said to have been located, in the smaller 23-by-48-m structure, a well-equipped one-story repair shop for the overhaul and repair of mining machines. When spare parts were not available, this shop was equipped to make them. 309/

Electrical assembly and repair work were stated to be carried on in the first story of the 41-by-75-m reinforced-concrete structure at Point 2. Drafting and engineers' offices were reputedly located on the second floor. 310/

The plant laboratory is reported to have been situated in the three-story structure at Point 18, about 17 by 16 m, with a hipped roof. Between this group and the main entrance stood the 30-by-71-m central office building, which also is reported to have contained the

headquarters of the sales staff. 311/ Adjacent to this group at Point 19 stood a statue of Lenin.

Operations at the mine locomotive and mine car works in Druzhkovka, the Toretsk Mining Equipment Plant imeni Voroshilov, are even better defined. At this large plant, not far from Kramatorsk, 5,000 to 10,000 workers, 40 to 50 percent of them women, were said to be engaged in the manufacture not only of mine cars and locomotives but also of mine rails and switches, steel mine props, cages, pit-head frames, ventilators, and miscellaneous mining equipment. 312/ This plant had two foundries: a large one, about 150 by 75 m, and a smaller one, 80 by 25 m, which was taken out of operation about 1947. In the main foundry, steel car wheels and buffers were poured by mass production from perhaps four or five cupolas into reusable molds. The molds were moved away while still hot on three conveyor lines installed in the summer of 1949, one for wheels and two for buffers. The molds were moved through a cooling chamber, after which they were broken out and chipped free of scale. Cracks were welded shut to keep rejections down to a minimum. 313/

Prisoners of war did not agree on the dimensions of the mine locomotive building section, which may have been 50 by 50 by 9 m higher, but they did agree that locomotives were built by batch rather than assembly-line methods. One prisoner of war saw 40 locomotives on the floor every day but was not sure that this was the daily production. Motors were brought in from outside the plant and were fitted to the locomotives in another shop. 314/ The locomotive shop, at which it was said some 250 Russians worked, was off limits to prisoners of war. 315/ The reported productivity varied widely. One observer stated that the norm was four per month but that the average was only about two. Another reported having seen a plaque in the office that claimed an output of 8,000 locomotives in 1948. Although this figure is extravagant, the same observer estimated the production of mine cars to be 36,000, as stated on the same plaque, 316/ which could be a fairly accurate estimate.

By contrast, the quantity of mine cars produced has for some time justified more continuous production than locomotives at this plant. When it was re-established after the war, separate assembly lines were set up for the body, frame, and wheel assemblies, which were put together by what the Soviets termed the brigade unit method. The wheels and buffers were cast in the plant foundry, and the undercarriage was constructed in a shop 80 by 12 by 4 to 5 m high, under a

prisoner-of-war foreman until 1949. According to this same foreman, the body was stamped and welded in a shop 150 by 100 by 15 m high, from plates 12 to 14 m long. This shop was equipped with presses, boring machines, and an electric welder. The cars were built in three sizes, ranging from 0.5 to 3 MT in capacity, of which the 1-MT size was most numerous. Only 140 persons, including 60 to 90 prisoners of war, were employed in these two shops. 317/ A welder in the car shop reported that his norm was 15 mine car frames per day and that the output was about 100 to 150 per day. 318/

[redacted] 50X1

at this time the body was built up from two sheets of steel, 4 mm thick, joined at the bottom and bent at the seams in such a way as to increase their rigidity. The parts were held by clamps and welded together by hand-held welding apparatus. Finally the bodies were bolted to the frames and then welded for good measure. After this step the wheel assemblies were attached. All of these operations consumed much labor, although the method was not considered as technologically retarded. Parts and units were moved by two overhead traveling cranes, which constituted a serious bottleneck to rapid and smooth production. 319/

In the machine shop, which prisoners of war reported operated on three 8-hour shifts for 6 days in the week, overhead conveyors fed locomotive and mine parts to the operators. A double line of turret lathes on either side of a conveyor belt produced locomotive and mine car accessories. Four lathes fed by overhead conveyors machined mine car axles in series. Another conveyor line bored the shaft housing in the wheels. Four engine lathes bored annular lubrication ways in the wheel bearing housings. Bearings were pressed onto the shafts, after which grease holes were drilled and tapped by semiautomatic drill presses. 320/

Sometime before 1950 the operations in the mine car assembly shop were thoroughly revised. The brigade unit method was replaced by continuous assembly-line techniques. To permit this change-over, the design of the car was revised to provide for a simple U-shaped body. The ends were cut and stamped with flanges, then sent off on a conveyor to meet the sides, which had been welded together automatically from two sheets of steel together with a reinforcing strip. Ends and body met in a specially constructed frame which bent the body into shape while the whole assembly was being rotated under the welding arc. [redacted] 50X1

labor consumed in assembling and welding the body was thereby reduced from 4.26 to 0.8 man-hours. Moreover, at the appropriate point the body met other subassemblies, such as the undercarriage, buffers, and wheels, all of them now produced by continuous methods. As an overall result, it was claimed that working time was cut from 12.6 to 6.3 man-hours per car. 321/

This large plant is said to have received daily 600 MT of coal, two to three cars of molding sand, two to three flat cars of logs, and two 60-MT carloads of iron ingots, together with an equal quantity of aluminum. 322/ One prisoner of war asserted from hearsay that the immense coal pile in the plant yard contained a million MT and was sufficient to last 6 months.* 323/ These facts are sufficient to indicate something of the methods employed at Druzhkovka as well as to suggest its more than ordinary size. From the somewhat contradictory prisoner-of-war reports, it is possible to piece out a production of 40,000 to 50,000 mine cars per year. Unfortunately the mine locomotive shop, in which primary interest centers, was off limits to the prisoners of war. Beyond indicating that mine locomotives of certain types are built there, a study of the plant alone, [redacted] discloses neither its production nor its capacity. 50X1

In general, this condition prevails for the coal mining equipment industry. Plant studies help to establish what is being produced in each geographic area and also indicate something about manufacturing methods. When supported by studies of the press and the technical literature, they can pinpoint production by model. Plant studies, unsupported by the press and the technical literature, fail to yield a reliable indication either of capacity or of actual production in the mining equipment field, (1) because the prisoners of war were not ordinarily competent to describe the specialized equipment; (2) because they were not admitted into shops producing locomotives, coal cutters, coal loaders, or other equipment more complicated than coal cars; and (3) because the nature of the product mix enables the plant to shift the proportion of major products and by-products without changing its capital facilities in any marked way.

For this reason, productive capacity should be derived not so much from plant size as in terms of production history. Clearly the

* Compare the above estimate of 600 MT per day, or about 100,000 MT in 6 months.

USSR could build more coal mining equipment than it does. It might be able to build as much as it deems necessary. In fact, such considerations are somewhat theoretical. In a planned economy such as that of the USSR, where coal mining equipment has been under production for some years and is already a well-established industry, the quantity built reflects a planning decision as to the quantity needed in terms of its priority in relation to the need for the entire range of capital goods produced by the economy. The average amount produced in recent years is a better guide to capacity to produce than any figure derived from prisoner-of-war tallies of the area of the plant or the number of workers that it employs or the quantity of machine tools that it contains.

C. Domestic Production.

Production within the USSR of coal cutters, combines, loaders, locomotives, and conveyors has been calculated from the beginning of production to the end of 1951, with emphasis upon the postwar years. Where available, production has been shown plant by plant, model by model, and year by year. Although the derivations have been explained in detail in the tabular annotations, it may be said of the method that, where possible, first reliance has been placed on plant studies. These have been checked in all instances against production statements in the press and in technical publications. Very few production figures, however, have been released for this industry since 1938. A little, but not a great deal more, has been stated publicly of intentions and of accomplishments in the form of inventory. In practice, therefore, production has been computed in connection with inventory, retirement, and exports. Although it has been necessary to estimate freely and to interpolate frequently, all figures have been checked one against the other for balance. In particular, production has been compared carefully with definite figures released in the press for inventory increases. However, although considerable confidence may be placed in production estimates for a period of years, such as 1945-51, it is recommended that less reliability be assigned to the figures of (1) total annual production, (2) annual plan production, and (3) production by model.*

* This caution should be applied to all of the production tables reproduced in this section. Relatively speaking, reliability is assigned in the following descending order: combines, cutters, loaders, locomotives, and conveyors.

1. Coal Cutters.

Total production of coal cutters by year since its inception in 1928-29 is shown in Table 1.* Postwar production is shown by plant, model, and year in Table 21.** These figures check with the Soviet statement that in 1951 the industry had 20 percent more coal cutters than in 1940. 324/ Prewar figures down to 1938, taken directly from published Soviet reports, indicate that prewar production of coal cutters reached a peak of 1,110 in 1938, a figure that was not again attained until 1947. The reliability of the 1938 figure is not beyond doubt, but if it is premature, 1940 output is still believed to have exceeded 1,000 units. It should be emphasized that prewar models, even of heavy coal cutters, were considerably lighter and less well-finished than currently built equipment. Moreover, prewar production included a sizable proportion of light cutters. Consequently,postwar production involves a much greater production accomplishment toward the mechanization of coal mining than is indicated by merely comparing the number of units produced with the prewar record. During the war, production was shifted from the Gorlovka Mining Equipment Plant imeni Kirov in the occupied Ukraine to the Kopeysk Mining Equipment Plant in the Urals. In the war years this plant built the KMP-44 longwall cutter but tooled up for the KMP-1*** in 1946. Production in that year amounted to only 30 units. The output of this mediumweight machine has been brought up to about 500 units per year. When the Gorlovka plant was rebuilt after the war, it resumed production of the prewar lightweight GTK-3, which in its modified form became known as the GKT-3M. Large numbers of this machine were built to meet the strong postwar requirements, and 1947 output may have reached almost 1,000 units. Production was cut back in 1948, partly because the plant was beginning to put out the heavyweight MV-60 machines and partly from a belief that the GTK-3M was rapidly becoming obsolete. By 1950 it is believed that the plant had begun to build the further modified GTK-35, which is now definitely recognized as a light-duty model. Production of the heavy MV-60 coal cutter had been scheduled to reach 300 units in 1947, but because of troubles with the field trials, production in that year probably did not exceed 9 machines sent out for testing in the mines. Production of the MV-60 increased slowly at first because

* P. 15, above.

** Table 21 follows on p. 138.

*** For further technical and historical data on the development of the machines discussed in this section, see III, above.

Table 21

Estimated Production of Soviet Coal Cutters
1945-52

Units

Year	Gorlovka imeni Kirov			Kopeysk imeni Kirov, No. 25				Krasnoyarsk Voroshilov Arms	Total All Plants
	GTK	MV-60	Total	KMP-44	KMP-1	ShVD-48	Total	VTU-1	
1945	600 a/	0	600 a/	50 b/	0	0	50	0	650
1946	800 a/	0 c/	800 a/	0 d/	30 e/	0	30	15 f/	845
1947	991 a/	9 g/	1,000 a/	0	200 h/	0	200	200 i/	1,400
1948	700 j/	150 k/	850 a/	0	275 l/	0	275	200 i/	1,325
1949	600 m/	300 n/	900	0	400 o/	5 p/	405	100 q/	1,405
1950	300 m/	350 n/	650	0	475 r/	0 s/	475	0	1,125 t/
1951	200 u/	400 n/	600	0	500 r/	v/	500	0	1,100
1952	300 w/	450 n/	750	0	500 r/	v/	500	0	1,250

a. Total production for the Gorlovka plant for 1945-48 is estimated as follows: (1) In August 1947, Gorlovka produced its 2,000th cutter since the war. 325/ (2) Late in January 1948 it completed its 9,405th machine since the start of production in 1933. 326/ (3) It shipped its 10,000th cutter in November 1948. 327/ All 2,000 cutters were reasoned to be the postwar GTK-3M, except 9 MV-60 machines known to have been built in 1947. 328/

b. Estimated. The improved KMP-44 was being produced in 1945. 329/ The plant had not yet fully reconverted from war production in 1945.

c. Fifteen were being built, 330/ but only 9 were in use in early 1948. 331/

d. Estimate: none. It is believed that the plant was tooling up for production of the KMP-1.

e. The plant was tooling up for the KMP-1. 332/

f. The plant was preparing to manufacture parts for 15 heavy coal cutters. 333/

g. Three hundred were planned for 1947. 334/ Only nine were built, early in 1947. After experimentation, mass production of revised models began in early 1948. 335/

Table 21

Estimated Production of Soviet Coal Cutters
1945-52
(Continued)

h. Estimated total production of 250 machines, including 50 VPM-1 cutter-loaders, which require a KMP-1 cutter as a base.
i. Although a rate of 30 per month was indicated by a Japanese prisoner of war, production for this and succeeding years is conservatively estimated at 200 per year. 336/
j. Estimated, based on note a. A cutback in the production of the GTK-3M was assumed as a result of the shift to the production of the modernized, heavy MV-60, which weighed 3,500 kg as against 2,000 kg for the GTK-3M.
k. Estimated. The first series shipment was not made until August 1948. It was then proposed to replace the GTK-3 machines. 337/
l. Estimated total production of 375 machines, including 100 VPM-1 cutter-loaders.
m. Estimated on the basis of a cutback in production of the outmoded GTK-3M. The 1950 estimate includes a small quantity of the new GTK-35 machines. 338/
n. Estimated. No official data are available on production. Demand is believed to be restricted by efforts to introduce the Donbas combine, which was built around the power unit of the MV-60. Since the 1947 plan called for 300 MV-60 machines, at a time when production was just getting started, it is probable that at least as many as 300 would be produced per year once the plant had achieved full production. Difficulties were experienced with the machine in 1948 and 1949, which necessitated changes in motors, starters, and ratchets.
o. Prisoner-of-war reports furnish estimates ranging from 30 to 80 cutters per month, which must have included quantities of cutter-loaders. Production is estimated at 500 machines, including 100 cutter-loaders.
p. Estimated from statement that in 1949 some experimental models of the ShVD-48 short-wall cutter were put out. 339/
q. Since this machine is too powerful for the work to be done, it is believed that it was discontinued in 1949 in the expectation that it would soon be replaced by the ShVD-48 or another model.

Table 21

Estimated Production of Soviet Coal Cutters
1945-52
(Continued)

r. Estimates, excluding units for VPM-1 cutter-loaders.
s. Still in the experimental stage; will probably undergo extensive modifications. 340/
t. According to the Soviet press, before World War II (that is, in 1940) the Soviet mining machinery plants put out over 1,000 cutting machines. The machine building plants of the Ministry of the Coal Industry alone are to produce 11,000 cutting machines during the post-war Five Year Plan. 341/
u. Estimated from statement that the Gorlovka plant was producing a large number of the new GTK-35 machines. 342/ Forty new GTK-35 cutter machines were to be ready for Miners' Day, late in August. 343/
v. Few, if any. No definite information.
w. Estimated. This machine, although light in weight for regular work, is useful in thin seams.

quantities of the drive section were in demand for use as the power unit of the Donbas combine. Output had been raised to an estimated total of 400 by 1951 and is subject to further increase.*

Although the Kopeysk plant continued to produce coal cutters during the war, its output could not have been great, owing to its involvement in munitions production. Reconstruction of the Gorlovka plant began soon after the evacuation of the Ukraine in 1944. By 1945, total output of coal cutters reached 650 as compared with the estimated 1940 output of 1,050. The postwar peak of 1,400 was reached in 1947. Subsequent declines are to be explained in terms of conversion to coal combine construction and adjustments and changes in models. Production in 1951 is estimated at about 1,100 and may have risen to 1,250 during 1952 under pressure of demand from the Satellites, unless a conversion away from coal mining equipment manufacture has set in.

2. Coal Combines, Cutter-Loaders, and Coal Planers.

Continuous mining equipment was employed experimentally in the USSR prior to World War II, but production was too small and intermittent for serious consideration. The production table that follows (Table 22)** shows output by model, plant, and year. Experimental production has generally been detected from press reports and is reported as such. The USSR does not publish annual inventory or production figures on coal combines. Therefore, production has been traced model by model in the respective manufacturing plants, in the press, and in technical publications. Although it has been necessary to make numerous estimates, it has been possible to check these fairly closely from occasional references to increases in inventory which

* Of the other postwar cutters, the ShVD-48, a shortwall machine primarily intended for work in preparatory passages, was tested in 1949 but never seems to have gone into series production. Finally the heavy VTU-1 universal-type, tractor-mounted cutter, which is also a shortwall and development combine, was built in quantity as a by-product of the Voroshilov Arms Plant in Krasnoyarsk from about 1946 to 1949. Because this machine was too overpowered for the job to be done, it is believed to have been taken out of production about 1949, pending the development of a successful combine for use in mining coal and rock in preparatory passages.

** Table 22 follows on p. 142.

Table 22

Estimated Production of Soviet Coal Combines
Exclusive of Cutter-Loaders and Coal Planers
1945-51 a/*

Units

	Gorlovka imeni Kirov						Kopeysk imeni Kirov, No. 25			Karaganda imeni Parkhomenko Makarov d/	Omsk imeni Voroshilov Makarov d/	Khar'kov Svet Shakhtera UKT-1	Miscellaneous	Total All Plants
Year	Donbas b/	VOM c/	UKMG-1	KKP-1	Other	Total	Makarov d/	Other	Total					
1945	0	1 e/	0	0	2 f/	3	0	0	0	1 g/	0	0	0	4
1946	0	1 h/	0	0	6 i/	7	0	0	0 j/	10 k/	0	0	0	17
1947	0	0 l/	0	0	2 m/	2	0	4 n/	4	15 o/	12 p/	0	0	33
1948	52 q/	1 r/	0	0	5 s/	58	3 t/	0 u/	3	10 v/	2 w/	0	0	73 x/
1949	100 y/	15 z/	0	0 aa/	0 bb/	115 cc/	dd/	dd/	dd/	dd/	dd/	0	1 ee/	116 ff/
1950	150 gg/	5 hh/	0	0	3 ii/	158	jj/	22 kk/	22	ll/	mm/	5 nn/	0	185 oo/
1951	175 pp/	10 qq/	2 rr/	10 ss/	3 tt/	200	uu/	13 vv/	13 vv/	1 ww/	xx/	25 yy/	1 zz/	240
Total	477	33	2	10	21	543	3	39	42	37	14	30	2	668

* Footnotes for Table 22 follow on p. 143.

Table 22

Estimated Production of Soviet Coal Combines
Exclusive of Cutter-Loaders and Coal Planers
1945-51
(Continued)

a. Excluding cutter-loaders and coal planers described in Table 23, p. 149, below.
b. Originally known as GUK-1: currently termed Donbas 1.
c. Models VOM-1, VOM-2, and VOM-2M.
d. Models KM-4M, KM-5M, and KM-6M, which are, respectively, 2,200 mm, 1,379 mm, and 1,720 mm high.
e. An experimental model. 344/
f. Consists of one Abakumov, AMV-1, and one machine of unknown type, built by the engineers who later received credit for designing the Donbas combine. 345/
g. A mining machine designed by S.S. Makarov was placed in operation in Mine No. 31 of the Karaganda Basin in 1945. 346/
h. A second machine built. 347/
i. One VNAT 348/ and five Abakumovs. 349/
j. Plant retooling to build the Makarov combine and the VPM cutter-loader. 350/
k. Total number built in USSR in 1946. 351/ Believed to have been built at Karaganda, where they are designed.
l. Estimated. Experimenting with VOM-1 and still did not have heavy cutting machine MV-60 as base for combine. Subsequently built VOM-2.
m. Estimated production of VNAT. The five Abakumov, AMV-1, machines produced in 1946 were experimental and were never put into serial production. They laid the basis for the MBK-1, trial models of which were built in 1948. 352/
n. Estimated two VNATI and two UKA-1. These VNATI machines were built in 1947 and tested in the Andreyevugol' Trust in the Kizel Basin of the Urals. 353/ The first models of the UKA-1 were built and passed tests at the Anzherugol' Trust of the Kuznets Basin in 1947. 354/
o. This is a maximum figure. Many of them may have never been installed in mines and may instead have been cannibalized for parts with which to repair other machines in the Karaganda mines.
p. These were assembled and tested in April. 355/ They went into serial production. 356/ The plan called for 100 more by the end of 1947, but it is believed that they were never built, owing to operational difficulties at the mines.
q. Two were completed by September 1948. 357/ Fifty more were completed in December as per plan. 358/ This combine was first introduced at the end of 1948 at Mine No. 3-bis of the Chistyakovantratsit Trust in the Donets Basin. 359/
r. The new VOM-2 was under trial in the Moscow Basin. 360/
s. Estimated. All were experimental. These included two S-29 models, 361/ two MBK, and one ZAL-1. 362/
t. Estimated. Production began in the summer of 1948. 363/
u. No information. Believed to be none.
v. Estimated.
w. Estimated. Modernized Makarov combines completed tests. 364/ These models were believed to be experimental.

Table 22

Estimated Production of Soviet Coal Combines
Exclusive of Cutter-Loaders and Coal Planers
1945-51
(Continued)

x. In the middle of 1948, according to the Soviet press, 20 combines were in use in the USSR. 365/ The number of coal combines increased 2.2 times in 1948. 366/ The estimate is believed to be in accord with the number in use, considering that the earlier Makarov machines were giving trouble and the production of these as well as of other models would be limited.
y. Estimated. Gorlovka was to deliver the second batch of Donbas combines on 1 April 1949. 367/ The Donets Basin was to get 100 combines in 1949. 368/ It is believed that probably two batches of 50 machines each were made in 1949. Series production did not begin until early 1950.
z. One hundred faces were to be equipped with VOM-1 combines in 1949. 369/ It is believed that all of these machines were intended for use in the Moscow Basin, but subsequent information leads to the conclusion that so large a number was never produced. Evidently there was a change-over to the VOM-2 which did not prove successful. This was followed by the modified VOM-2M. Development of the VOM-2 and the VOM-2M depended on development of the new MV-60 heavy-duty coal cutter. (See also Table 21, notes k and n, p.139, above). A batch of VOM-2 machines was produced for the Moscow Basin, probably in 1949. 370/
aa. An experimental model of this machine was produced in 1949 at the Malakhovskiy plant. 371/ It is believed that Gorlovka did not begin production until later.
bb. No evidence of production.
cc. The Donbas was stated in the Soviet press to have had three times as many combines in 1949 as in 1948. 372/
dd. Minor production, if any.
ee. An experimental model of the KKP-1 was built at the Malakhovskiy plant. 373/
ff. In the last 2 years the number of combines in the USSR increased elevenfold. 374/ This statement was made by Minister Zasyad'ko in February 1950 and is assumed to mean that the number of combines in use at the end of 1949 was 11 times greater than that at the end of 1947. Many of the early machines were out of use by the end of 1949 and may have been scrapped.
gg. Estimates based on the over-all increase of about 75 percent in inventory of all types during 1950.
hh. Estimated. The Gorlovka plant completed the first batch of the VOM-2M combines, the third and recent modification of the VOM combine, in 1950. 375/
ii. Two trial models of the S-40 were to be manufactured in the near future. 376/ An experimental model of the MBK-1 was built at Gorlovka. 377/
jj. Few, if any. The plant was probably developing the KMP-1 two-bar combine and the PK-2 entry driver.
kk. The first PK-2 was tried at the Kopeyskugol' Trust in February 1950. 378/ The PK-2M was first used in the Moscow Basin in June 1950. 379/ The Kopeysk plant was ordered to build 10 KMP-1 two-bar combines in March and 10 in April 1950. 380/ It is estimated that 20 of these machines and 2 PK-2M combines were built in 1950.
ll. Probably none.
mm. Probably none.
nn. The new UKT-1 was used effectively in Mine No. 19 of the Rutchenkovugol' Trust. 381/ Several were in operation in the Donbas mines in the early part of 1951. The first machines were experimental models. Therefore, it is estimated that only five were built in 1950.

Table 22

Estimated Production of Soviet Coal Combines
Exclusive of Cutter-Loaders and Coal Planers
1945-51
(Continued)

oo. At the end of 1950, 300 combines were stated to be in use. 382/ At the end of 6 months, 1950, the number of combines increased 38 percent. 383/ At the end of 8 months, 1950, the number of combines increased 50 percent. 384/

pp. It was planned to construct 48 combines in the entire USSR during the last 4 months of 1951. 385/ Work was being started on a lighter and simpler Donbas 1. 386/

qq. Estimated.

rr. An experimental model of the UKMG-1 was working in a mine of the Budennovugol' Trust. 387/ Tests of the UKMG-1 were completed by the Gorlovka plant and the Donets Coal Institute, and machines were to be shipped to the mines of the Stalin coal combine on 5 December 1951. 388/ It is probable that only one or two machines were shipped in 1951, since [redacted] the first group of five machines was completed. 50X1

ss. Estimated. The KKP-1 combine was being tested at the mines of the Artemugol' Combine in the Donets Basin. 389/ At the end of 1951, this machine was reported as being in use in many mines of the central Donbas. 390/

tt. Estimated. Experimental models of the Gornyak machine, a combine for the mining of slanting seams, 0.6 to 0.8 m thick. 391/

uu. Probably none.

vv. In late 1950 the Kopeysk works received an order to build 10 more KMP-1 two-bar combines with culm remover. The plan for 1951 was to build enough of these machines to meet the demand of the Chelyabinskugol' Combine. 392/

Another new machine, made at Kopeysk, comprises an earthloosener, culm remover, and side controls to ensure straight running of the machine along the coal face. 393/

It is estimated that probably two of the complex PK-2M combines and one of the unnamed machines, as well as at least 10 KMP-1 two-bar cutters, were made. The plant prefers to concentrate on the KMP-1 longwall cutter and was forced to build the two-bar machine.

ww. The Soviet press stated in March 1951 that a caterpillar hewing and loading machine, nicknamed by the miners, the "underground tankette," capable of producing 13,000 MT of coal per month, had been invented by S.S. Makarov. 394/

xx. Probably none.

yy. Estimated. The experimental plant of Giprouglemash put out the first models of the new UKT combine, designed to extract coal from seams 0.4 to 0.7 m thick. These machines were said to have worked well in mines of the Rostovugol', Stalinugol', and Voroshilovgradugol' combines, where extraction of coal from thin seams increased on an average of 30 percent. In 1951 the plant was to send dozens of the UKT-1 to mines. 395/

zz. Estimated. One experimental, heavy-duty combine, possibly produced at the Kuznetsk Mining Machine Plant at Stalinsk in the Kuznets Basin. [redacted] a new combine, designed by the Stazhevskiy brothers, cuts coal from the face and delivers it to a car. A heavy-duty model passed its tests in the Kuznetsugol' Trust. 396/ 50X1

50X1

appear from time to time in the press, such as at the beginning of the year and on Miners' Day, at the end of August.

Beginning in 1945, the Soviet press gave much publicity to the Makarov combine, a combine for the mining of thick seams, for which there was a good market in Karaganda, the Kuzbas, and elsewhere. About 10 were built at the Karaganda Mining Equipment Plant imeni Parkhomenko in 1946. In 1947, perhaps 15 more may have been built there, together with about a dozen at the Voroshilov Tank and Locomotive Combine in Omsk. Another total of 15 may have been built in 1948 at these two plants, together with the Kopeysk Mining Equipment Plant in the Urals. By 1948 these heavy, cumbersome machines, which by that time had been denoted the KMP-4M, KMP-5M, and KMP-6M, were proving too unwieldy for satisfactory service. It is doubtful if any were produced after 1949, although it took several years for the press to dispose of them gracefully.*

At about the same time, experiments with the VOM-1 thick-seam combine, which may have been under development since before the war, were resumed. Improved and redesignated the VOM-2, this ring-type combine, which now employed the power unit of the MV-60 longwall cutter, was brought out again in 1949 by the Gorlovka plant. This machine was further modified in 1950, at which time another batch was produced under the model number VOM-2M. It is doubtful that more than 5 were built in 1950 and 10 in 1951, judging from the lack of comment on this machine in the Soviet press. 398/ This failure and partial success still leave the USSR without a combine of proved merit for its numerous thick coal seams.

In medium- and thin-seam coal mining the USSR has had better results in its effort to build coal combines. The Donbas combine, introduced by the Gorlovka plant in 1948, proved to be an almost immediate success for medium-seam coal mines. Production has been estimated at 52 in 1948, 100 in 1949, 150 in 1950, and 175 in 1951. As compared with the Makarov combine, this machine uses for its power unit the power section of the heavy MV-60 coal cutter, which is relatively simple to build. Its success in the Donbas area

* As note the recent press release that in the 2.5-m-thick seam of the Kirov mine in the Karaganda region, two medium-seam Donbas combines had been linked together and made to operate as one unit. This would scarcely happen were the Makarov combine still in production. 397/

has been so great that efforts have even been made to use it in thick seams by mounting two units in tandem. Production in 1952 may possibly have increased further, though the Gorlovka plant is devoting part of its capacity to the production of steep-seam combines and to experimentation with thin-seam combines.

Encouraged by the success of the Donbas combine, Soviet designers have brought out at least three subsequent combines directed at solving the problem of mechanizing the mining of thin seams of coal, which in the past have imposed laborious work on the miners and in which the yield per worker has necessarily been low. For this marginal type of mining the Svet Shakhtera Mining Equipment Plant in Khar'kov introduced its thin-seam UKT-1 combine in 1950. It is estimated that approximately 5 were built in 1950 and perhaps 25 in 1951. The Gorlovka plant, which has also been experimenting with thin-seam combines, may have built two units of its UKMG-1 model in 1951. In 1952 it was testing its Gornyak model, which resembles a cut-down Donbas combine.

Gorlovka also placed its steeply sloping-seam combine, the KKP-1, on the market in 1951, amid much publicity, centering about the fact that it was to be made available with both electric and air drive. Since it is meant to be used in areas which until now have been cut either by hand or with pneumatic picks, it should, if successful, increase productivity in those seams which pitch at too great an angle to permit the use of regular coal cutters or combines. It is estimated that about 10 units of the KKP-1 may have been built in 1951.*

According to this analysis, some 668 coal combines have been built by the USSR from 1945 to the end of 1951. Of these, the 71 built before the advent of the Donbas combine can be written off to experimentation. About 477 Donbas combines, according to these estimates, were built from 1947 to the end of 1951. Even if the UKT-1 and the KKP-1 machines are beyond the experimental stage, it would appear that from 100 to 125 of the combines built since the

* At the demand of certain local mining organizations in the Urals, the Kopeysk plant was ordered to build 20 two-bar KMP-1 cutters in 1950. It is not known whether these were true combines, in the sense of being equipped with loading devices and breaker bars, although the latter could be omitted in thin coal. If they were true combines, they may have resembled the UKMG-1 combine. 399/

war should be written off as experimental efforts from which little sustained output was secured. Despite this deterrent, the USSR has increased its output of combines during every year since the end of World War II. Moreover, the increment of increase has been slowly rising until it is now somewhere in the neighborhood of 50 to 60 machines per year. In terms of current production this would be a production gain of about 20 to 25 percent per year. If the group of new thin-seam combines yields at least one successful machine, as is likely because several of the new models are scaled-down versions of the Donbas combine, then considerable increases in combine production may be predicted for the near future.

In the postwar years the USSR also experimented with coal planers and cutter-loaders (Table 23).* The coal planer, which the Soviets may have borrowed from the Germans, who employ it extensively in the Ruhr, received much favorable publicity from 1946 through 1948, but mention of it has almost disappeared from the Soviet press, and it is no longer believed to be in production, though there is some possibility of an improved model being in the offing. Judging principally from press statements, it appears that cutter-loaders, of the VPM-1 type, have been built with some regularity since 1946 at the Kopeysk Mining Equipment Plant imeni Kirov. Production may have reached a peak of 125 in 1950.** Not a great deal is now seen in the Soviet press concerning cutter-loaders. It is probable that eventually they will be displaced by coal combines.***

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* Table 23 follows on p. 149.

** Cutter-loaders, as indicated in III, above, are merely modified longwall cutters. First the coal is undercut with a regular cutter. Then it is drilled and blasted or broken down with picks. What coal does not fall onto the conveyor is loaded by the so-called cutter-loader, which is a regular coal cutter that has been equipped with a loading plow. This function could be performed as well, at less expense, by an independent loading plow, designed to be drawn along the edge of the face conveyor by a winch.

*** Should the estimated production of cutter-loaders be too high, the machines could be reclassified as coal cutters, in which classification they may properly fall from an input point of view.

Table 23

Estimated Production of Soviet Coal Combines, Cutter-Loaders, and Coal Planers* a/**
1945-52

Units

Year	Cutter-Loaders: Kopeysk imeni Kirov, No. 25 VPM-1 a/	Coal Planers: Voroshilovgrad imeni Parkhomenko US-2	US-3	US-4	Total	Coal Combines (Exclusive of Cutter-Loaders and Planers) b/	Total All Plants
1945	0	0	0	0	0	4	4
1946	1 c/	1 d/	1 d/	0	2	17	20
1947	51 e/	0	1 f/	0	1	33	85
1948	100 g/	0	35 h/	5 h/	40	73	213
1949	100 i/	0			0 j/	116	216
1950	125 k/	0			0 j/	185	310
1951	100 l/	0			0 j/	240	340
1952	100 m/	0			0 j/		

* Spaces left blank in this table indicate that data are not available.
** Footnotes for Table 23 follow on p. 150.

Table 23

Estimated Production of Soviet Coal Combines, Cutter-Loaders, and Coal Planers
1945-52
(Continued)

a. Cutter-loaders may be thought of as two-cycle or multi-cycle continuous miners. The VPM-1 undercuts the coal in the first cycle. Next the coal is drilled and blasted. Some of the coal falls on the armored face conveyor and need not be loaded. The remaining coal is loaded by means of a plow, attached to the cutter, which thus must make a second pass across the face.

The VPM-1 is the only cutter-loader known to have been built in this period with the exception of the BNU. The BNU was a modification of the GTK-3M coal cutters, whereas the VPM-1 is probably an adaptation of the KMP-1.

b. Totals from Table 22 (p. 142, above).

c. One VPM-1 was built at Kopeysk; regular production was to begin at the end of 1946. 400/ The machine delivered in 1946 was probably an experimental model.

d. The US-2 and US-3 were developed in 1946 by the Voroshilovgrad Construction Office of Giprouglemash. Coal planers consist of a heavy plow, designed to shear a small amount of the coal from the coal face when the plane is drawn across the length of the face by means of a winch. The coal broken loose is moved by the planer onto the regular face conveyor. The US-2 plow was of welded construction, whereas the US-3 was a steel casting. 401/ Estimated production is for an experimental model of each machine. However, production may have been delayed until 1947.

e. This estimate included one BNU, which was being tested in 1948. Changes being made in the GTK-3M in 1948 probably indicate that this BNU was built in 1947. Tests of the BNU were canceled when it proved inferior to the VPM-1. 402/

f. Two complex installations of the US-3 were exploited in 1947-48 in Mine No. 5 of the Voroshilovgradugol' Trust and Mine No. 47 of the Bryanskugol' Trust, both of which are located in the Donbas. 403/ In March 1948, it was reported that trials were begun a few months past in the Voroshilovgradugol' Trust of the coal planers. 404/ It is believed that no more than three coal planers had been produced prior to 1948.

g. Estimated.

Table 23

Estimated Production of Soviet Coal Combines, Cutter-Loaders, and Coal Planers
1945-52
(Continued)

h. The 1948 Plan called for 60 machines. Because of shortages of parts and trouble with heat treatment, actual production was two in the first quarter and two more by May 20 instead of six planned. 405/ Although a total of 60 were planned for 1948, 406/ only 40 were built, and then no more according to one PW report. 407/ Some US-4 models were built later in 1948. 408/ At the end of 1948, 13 were in use in the Donbas. 409/ It is estimated that production amounted to 40, consisting of 35 US-3 and 5 US-4 planers.
i. Estimated. Thirty-seven were probably in operation in the Donbas early in 1949. 410/
j. No reference to production has been seen subsequent to 1948. It is probable that a few additional experimental models may have been built. Stalin prize-winner I.I. Bazhenov reported in 1950 that coal planers were being tested in the Donbas and had proved successful in getting weak coal and in seams of average strength where the thickness was up to 2 m and the gradient was slight. 411/ One such unit, designed by L.V. Yegorov, was reported as being in experimental operation at this date in the Karaganda coal fields. 412/
k. Estimated.
l. Estimated.
m. Estimated. Although little evidence was available as a basis for these estimates, it was believed that the character of the machine makes an estimate possible. These machines, as previously explained, are standard coal cutters to which loading plows have been added. Since their production has been deducted from that of the coal cutters built at the Kopeysk plant, an excess of cutter-loaders does not alter the total output figure nor the total input requirements, except for the matter of the loading plows.

3. Coal and Rock Loaders.

Production of coal and rock loaders in the USSR before World War II is believed to have been inconsiderable.* Modern construction of these devices dates from about 1947. Strictly speaking two types of equipment are involved: the rock loader, known in the US as the rocker shovel, and the coal loader, as the term is used in the US. Both machines are employed in the USSR chiefly in preparatory passages, where it is often necessary to load rock as well as coal. Although both can perform these duties, the coal loader is more complex to build and is somewhat overpowered for the task. Therefore, the rock loader is preferred for this service in the USSR and is the more commonly built of the two machines. From the Soviet technical press it was learned that as of the first quarter of 1952 the proportion of rock loaders to coal loaders was 66 to 34. The former were said to have increased in quantity in the last 4 years by 21 times, the latter by 8 times, and the total by 14 times. 413/ [redacted] 50X1
[redacted] the total inventory comprised about 1,600 units at the end of 50X1
1951. 414/ From these proportions, inventory at the end of 1951 was calculated at 1,053 rock loaders, 543 coal loaders, and 1,596 total; and, from the rates of increase, inventory at the end of 1947 was figured at only 48 rock loaders and 66 coal loaders, or a total of 114. Plant studies did not indicate the extent of production of each type, but they did reveal when production of each of the three types of rock loaders, the UMP-1, the EPM-1, and the PML-3, PML-4, and PML-5, was initiated. [redacted] 50X1
[redacted] 50X1
[redacted] a composite production, inventory, retirement, 50X1
and export table was constructed, with breakdowns by plant, model, and year (see Table 24).**

* Before the war most of the Soviet coal conveyors were of the shaker type. For use with these conveyors, so-called duckbill loading heads were built which were called loaders but which do not compare with the present loaders in input requirements. The duckbill is simply a reciprocating pan that attaches to the end of a shaker conveyor and is fed into the coal by means of a rachet or similar device.

** Table 24 follows on p. 153.

Table 24

Estimated Inventory, Production, Exports, and Retirement of Soviet Coal and Rock Loaders*
1940-41, 1946-51

Units

	Totals				Rock Loaders																Coal Loaders S-153 and O-5			
					EPM-1				PML-3-4-5				UMP-1 [a]				Totals							
					I	P	E	R	I	P	E	R	I	P	E	R					I	P	E	R
Year	Inventory (I)	Production (P)	Exports (E)	Retirement (R)	Druzhkovka imeni Voroshilov				Krivoi Rog and Kher'kov				Tomsk imeni V.V. Vakhrushev				I	P	E	R	Sverdlovsk			
1940	23 [b]	[c]							[d]															
1941																								
1946					0	0	0	0					0	0	0	0					0	0	0	0
1947	114 [e]	91	0		0	0	0	0	48 [e]	25	0		0	0	0	0	48 [e]	25	0		66 [e]	66 [f]	0	
1948	551 [g]	476	0	39 [h]	1 [i]	1 [i]	0	0	110 [j]	75 [j]	0	13	215 [i]	225 [i]	0	10	326	301	0	23	225 [j]	175 [b]	0	16
1949	1,000 [k]	525	0	76 [h]	65 [i]	75 [i]	0	11	140 [j]	50 [j]	0	20	420 [m]	225 [m]	0	20	625	350	0	51	375 [j]	175 [j]	0	25
1950	1,200 [n]	505	190 [o]	115 [h]	145 [j]	105 [j]	5 [o]	20	165 [p]	100 [j]	50 [o]	25	465 [m]	175 [m]	95 [o]	35	775	380	150 [o]	80	425 [j]	125 [j]	40 [o]	35
1951	1,596 [q]	750	222 [o]	132 [h]	253 [q]	145 [j]	10 [o]	27	221 [q]	140 [j]	59 [o]	25	579 [q]	255 [m]	101 [o]	40	1,053 [q]	540	170 [o]	92	543 [q]	210 [j]	52 [o]	40

a. Also known as the OM-510 rock loader at the V.V. Vakhrushev plant in Tomsk, where it is built. [415]
b. Estimated. In 1951 the available park of loading machines for development work increased 70 times over 1950. [416]
c. The 1951 plan called for the production of 400 loaders and 145 rock-removing machines. [417]
d. PML-3 rock loaders were built in unknown numbers at the Krivoi Rog plant in 1940. [418]
e. Based on 1951 estimates. See note q.
f. Series production of the S-153 began in 1947. It is believed that most of the coal loaders built were of the S-153 type, though a few O-5 machines may have been built. [419]
g. Estimated. Assumed to be less than 600 at end of year. According to the Soviet press, there were over 600 coal and rock loaders in operation in preparatory drifts. [420]
h. Estimated from production, export, retirement, and inventory data. Production was initiated at times indicated by press data and plant studies. Output was computed so as to balance with known inventories after retirement and export estimates were deducted.
i. The EPM-1 and the UMP-1 were both developed between 1948 and 1952 according to press statements. [421] Thus all 1947 production of rock loaders must have been of the PML type. Production of the EPM-1 is not believed to have begun until 1949, although a trial model was built in 1948 (see note 1). Therefore it is necessary to estimate 1948 production of the new UMP-1 type as high as 225 units in order to maintain a balance with total inventories of all loaders as documented under the total inventory column and the distribution of the various types of loaders as documented in note q for the end of 1951.
j. Interpolated.

* Spaces left blank in this table indicate that data are not available or are not applicable.

Table 24

Estimated Inventory, Production, Exports, and Retirement of Soviet Coal and Rock Loaders
1940-41, 1946-51
(Continued)

k. According to the statement of A.F. Zasyad'ko, the Minister of the Coal Industry, on 10 February 1950, the number of rock and coal loaders increased 10 times in the past 2 years.
l. Production began of the new model coal loader, EPM-GT, according to a press statement. It was stated that the first model worked perfectly in the Proletarka mine of the Rostovugol' Combine. Several hundred were to be built at the Druzhkovka plant in 1949. 422/
m. Interpolated. Production of the UMP-1, which began so auspiciously, must have been cut back in 1950, judging from 1951 inventory as shown in note q.
n. Interpolated. Over 1,000 coal and rock loaders were said to be in use at the end of 1950. 423/
o. Estimated. It will be noted that the Czech plan for mechanizing its coal mines calls for the installation of 200 shovel (that is, rock?) loaders and 60 coal loaders in 1952. 424/ Hungary imported 20 loaders from the USSR in 1951. 425/ See also IV, above.
p. The same plant was building the PML-4 in 1950 and may have shifted to the PML-5 in this year. 426/
q. Estimated. Coal was said to have been mechanically loaded at almost 1,600 development faces at the end of 1951. 427/ It was stated authoritatively in a Soviet technical periodical early in 1952 428/ that, beginning with 1947, the widespread introduction of loading machines was undertaken. The park of working loading machines was said to have increased 14 times in the last 4 years. Most widespread were the rock loaders, the number of which grew 21 times in the last 4 years; the number of coal loaders increased 8 times; and the combined total of both types increased 14 times. At present, it was said, in the general park of machines, the rock loaders constitute 66 percent, and the coal loaders 34 percent, of the total. From these ratios the total was computed at 1,596, the number of rock loaders at 1,054, and the number of coal loaders at 543. [redacted] a percentage distribution of inventory as between the three types of rock loaders in production, which permitted breaking them out as follows: 50X1

Estimated Soviet Rock Loading Machines by Types
End of 1951

Types	Units	Percent
UMP-1	579	55
EPM-1	253	24
PML-5	221	21
	1,053	100

Total loader production according to these estimates has increased from only 91 machines in 1947 to about 750 in 1951. Increases have not been especially regular, but this should not be expected, since this total is a composite of four different models of machinery, production of which was initiated at different times during the period.* Oldest and lightest of the types was the pneumatically driven PML,** which was being built as the PML-3 in 1940. Postwar models were designated the PML-4 until about 1950, but the PML-5, which is rated at 20 cu m per hour, may have gone into production as early as 1948. Principal production of this model has been at the Kommunist Mining Equipment Plant at Krivoi Rog. The Svet Shakhtera Mining Equipment Plant in Khar'kov was scheduled to begin batch production of the PML-5 early in 1952. 429/ Annual production has increased from an estimated 25 in 1947 to about 140 in 1951, in fairly regular increments except for 1949, which probably was the year of a model change. If the Krivoi Rog plant continues to produce for the coal mining industry, the result should be a considerable increase in output.

The electrically driven UMP-1, rated at 30 to 40 cu m per hour, has been under production since 1948 at the Tomsk Electromechanical Plant imeni V.V. Vakhrushev. No prisoner-of-war reports are available for this plant, which is located in Western Siberia. Production, which has been calculated by interpolation from inventory, began somewhat abruptly and ambitiously, with 225 units in 1948. Although it has not shown any great change since then, except for a temporary drop in 1950, this could possibly be explained by the fact that the production accounted for in this report is that which was shipped to the coal mines. It is quite likely that this plant is producing additional units for metal mining which do not appear in inventories of coal mining machinery. Production in 1951 was estimated to be 255 units.

* By the method of calculating that was employed, account was taken of production for the Soviet coal mines, of retirements, and of exports. It was not possible to account for such machines as may have been produced for use in metal mining in the USSR. It is believed that most of these were built by other plants than those associated with the Ministry of the Coal Industry, but a certain number of the machines built by this Ministry may have been disposed of to other ministries. This could account for the apparent decline in production in 1950.

** For technical details, see II, especially Tables 10 and 11, pp. 69 and 74, above.

The third of the rock loaders, the EPM-1, also electrically driven, which has a capacity of about 30 to 45 cu m per hour, is built at the Toretsk Mining Equipment Plant imeni Voroshilov at Druzhkovka, which also builds mine locomotives. A prototype was built in 1948. Production began in 1949 with about 75 machines and has increased to about 105 in 1950 and 145 in 1951.

Between these three types of rock loaders, Soviet production reached a figure of about 540 units per year in 1951. Production of this equipment has been increased steadily, and since it is relatively simple to build as compared with the coal loaders and is in demand in both the USSR and the Satellites, its production may be expected to increase further before it is leveled off.

In contrast the USSR builds only one type of coal loader, the S-153, in quantity, although it includes the O-5 loader in its complement of this kind of equipment. The S-153, the Soviet equivalent of the Joy 12BU, is rated at only 50 MT per hour and is a relatively lightweight piece of equipment as this type of machinery goes (Table 11*). Nevertheless, it has a rating adequate for service in development work under Soviet conditions. This machine is built, insofar as is known, only at the Sverdlovsk Transport Machinery Plant in the Urals. Estimated production began with about 66 units in 1947 and rose to 175 in 1948. The failure to show an increase in 1949 and the decrease to 125 in 1950 in all probability represent the diversion of output from this plant, which is not under the control of the coal industry, to other purposes for which the apparatus is well adapted. Production in 1951 is estimated at 210 units. Although the need of the Soviet coal industry for this machine is high, reluctance to overstock pending the development of a combine for the preparatory passages may have induced the USSR to release considerable fractions of the 1950 and 1951 output to the Satellites.

4. Coal Mine Conveyors.

Very little is known about the production of USSR coal mine conveyors by comparison with what is known about coal cutters, combines, and loaders. It is known that the Soviets planned to build 33,000 mine conveyors of all types during the postwar Five Year Plan (1946-50). It is doubtful that so many were built, although

* P. 74, above.

the increase since 1940 is said to have been such that the industry had 140 percent more conveyors in 1951.* 430/ At the beginning of 1950 there were said to be over 10,000 scraper conveyors and over 4,000 belt conveyors. 431/ To complicate the situation, before World War II the USSR relied chiefly upon shaker conveyors, whereas since the war it has converted its system chiefly to scraper conveyors, with some assistance from belt conveyors.** The number of scraper conveyors is reported to have increased nine times from 1940 to the end of 1951. 432/ Plant studies have been of little assistance in estimating conveyor production, because conveyors are built in sections and observers find it difficult to tell how many sections that it takes to make a complete conveyor. Interrogation in this respect could have been far more effective had this fact been borne in mind. No statement of annual production has been found in the postwar period.

Nevertheless, if the total inventory for 1940 were known, then 1950 production could be estimated from the above data. Estimates of inventories in the Donbas for 1940 range from 5,500 to 6,200. 433/ If the latter figure be accepted, then it can be estimated that there may have been a total of 8,000 to 9,000 conveyors in the whole USSR before the war. On this basis, using a figure of 8,500 for 1940, it may be calculated that there were about 20,000 conveyors at the end of 1951, or about 14,000 scraper conveyors and 6,000 belt conveyors. By the same token, production since 1949 may be calculated at about 3,000 scraper conveyors and 1,500 belt conveyors per year. This assumes that the prewar inventory of shaker conveyors has been completely retired. Such is not impossible.*** From the foregoing, conveyor inventory and production may be calculated with some reservations,**** as in Table 25.*****

* It is quite possible that this figure really refers to an increase of only 40 percent rather than one of 140 percent.

** For technical description of current models, see Tables 12, 13, and 14, pp. 78, 81, and 82, above.

*** In this connection it may be noted that duckbill loader heads, which were extensively used in connection with shaker conveyors before the war, are not listed in the mining machine price list published by the industry at the end of 1949.

**** Because scraper conveyors have a high mortality, those built shortly after the end of the war are now wearing out. It may require an output of 3,000 per year to make gains of only 2,000. Output in terms of units has not been increased, because units are growing longer and heavier. Nevertheless, this table is only an approximation and is no better than the limited quantity of available data.

***** Table 25 follows on p. 160.

Table 25

Estimated Soviet Production and Inventory of Coal Mine Conveyors
1949-51

Units

	Scraper Conveyors		Belt Conveyors	
Year	Inventory	Production	Inventory	Production
1949	10,000	3,000	4,000	1,200
1950	12,000	3,000	5,000	1,500
1951	14,000	3,000	6,000	1,500

5. Coal Mine Locomotives.

The USSR began to build electric coal mine locomotives as early as 1932 and continued to build them even through the war years. Prewar production fluctuated considerably as the result of experimentation with battery and trolley construction. Just before the war, mass production was established at Druzhkovka in the Ukraine at the Toretsk Mining Equipment Plant imeni Voroshilov. Although this plant is said to have been evacuated to Kopi, where production may have been resumed during the war, the only positive figure for wartime production is a claim that 1,000 units for the coal mines were produced at the Moscow Dynamo Electric Plant in the 3 years between 1942 and 1945. Following the war the Druzhkovka plant was re-established. The Kopi plant expanded its output, and several other plants were gradually brought into production, the Moscow plant eventually giving up production in this field to concentrate on advisory and design work. Plant studies failed to disclose reliable production figures by model in the larger establishments, although they gave some indication of the trend of operations.

Instead, it was necessary to calculate production from changes in inventory. Apparently reliable figures showed 1,855 units in the park in 1940 and 1,748 in 1945 (see Table 26).* [redacted] 50X1
[redacted] 1949 inventory was 2.5 times that of 1940, and 1951 inventory was 4 times that of 1940. Inventory for intervening years 50X1

* Table 26 follows on p. 162.

was derived by interpolation. Output was calculated in turn from these inventory figures and tempered by press statements and information from the technical journals indicating when model changes occurred or new models were placed into production. For these reasons, although considerable confidence may be placed in the total production estimates for the periods 1945-49 and 1949-51, somewhat less reliability should be assigned to figures for any given plant or model for a single year.

Because production did not cease entirely during the war, it was possible to produce as many as 600 units in 1945 and to bring output, by increments of a few hundred per year, up to about 1,200 annually by the end of 1949. The augmentation of production in the 3 new plants led to an increase in output of 500 locomotives in 1950. Total production for 1951 is not believed to have exceeded by any sizable quantity the 1,700 produced in 1950, unless shipments to the Satellites have been greater than estimated.*

Of the heavy trolley-type locomotives, the 10-MT size (Yu-10-600 and Yu-10-900) (see Table 15**) is probably being built at the Kopi plant, and the 14-MT type (IV-TR-4),*** which may not have gone into production until 1950, is very likely being constructed at both the Kopi and Druzhkovka works. The Druzhkovka plant formerly built the mediumweight 6.5- and 7-MT trolley types (II-TR-2 and II-TR-3) and now builds the new AC locomotives termed by the Soviets the condenser type (KE-1). At Kopi are built the lightweight 3.2-MT trolley-type gathering locomotive and car spotter, known as the "Karlik" (AK-2).**** Plants building the mediumweight 8- and 8.5-MT battery-type locomotives have not been identified with certainty.

Of the total production of 1,700 locomotives estimated for 1951, it is believed that about 400 were built at the Druzhkovka plant. This output would include principally 14-MT DC trolley locomotives with some output of mediumweight AC and battery types. By

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* It is believed, however, that although the USSR has supplied quantities of coal cutters, combines, and loaders to the Satellites, it expects more self-reliance of them in building mine locomotives.

** P. 87, above.

*** T refers to trolley; R, to mine; 4, to fourth model.

**** A refers to battery.

Table 26

Estimated Production, Retirement, and Inventory of Soviet Electric Coal Mine Locomotives* a/**
1927-28 - 1951

Units

Year	Total Production	Retirement	Inventory (End of Year)	Druzhkovka imeni Voroshilov				Kutaisi Gornyak AK-2	Yerevan AK-2
				Trolley					
				DC	AC (KE-1)	Battery	Total		
1927-28			59 b/ 434/						
1928-29									
1929-30									
1931			150 b/ 435/						
1932	87 c/		283 437/						
1933	245 c/								
1934	161 c/		429 d/ 438/						
1935	220 c/								
1936	169 c/								
1937									
1938									
1939									
1940			1,855 439/						
1941	e/			e/					
1942									

* Spaces left blank in this table indicate that data are not available or are not applicable.
** Footnotes for Table 26 follow on p. 165.

Table 26

Estimated Production, Retirement, and Inventory of Soviet Electric Coal Mine Locomotives a/
1927-28 - 1951
(Continued)

Units

Year	Total Production	Retirement	Inventory (End of Year)	Druzhkovka imeni Voroshilov				Kutaisi Gornyak AK-2	Yerevan AK-2
				Trolley					
				DC	AC (KE-1)	Battery	Total		
1943									
1944									
1945	600		1,748 441/	f/	g/	f/	100 h/	0	0
1946	700	100	2,348 i/				200 i/	0 j/	0
1947	900	200	3,048 k/				300 k/	0	0
1948	901	199	3,750 l/		0	m/	300 l/	1 n/	0
1949	1,190 o/	300 o/	4,640 p/		7 m/ q/	m/	400 o/	340 o/ r/	90 o/ s/
1950	1,700 t/	300 u/	6,040 u/				400 u/	600 u/	180 u/
1951	1,700 v/	340 v/	7,400 w/				400 v/	600 v/	180 v/

Table 26

Estimated Production, Retirement, and Inventory of Soviet Electric Coal Mine Locomotives a/
1927-28 - 1951
(Continued)

Units

Year	Moscow imeni Kirov			Kopi (Aleksandrovsk) imeni Voroshilov				Miscellaneous
	2-TR-2 II-TR-3 IV-TR-4	Total	Laptevo	YU-10	1-TL-1m	Battery	Total	
1927-28								
1928-29								
1929-30								
1931								
1932								
1933								
1934								
1935								
1936								
1937								
1938								
1939								
1940								
1941								
1942		(						
1943		(1,000 x/						
1944		(						
1945		300 h/					200 h/	y/
1946	z/ aa/	300 i/ bb/					200 i/	
1947	z/	300 k/			cc/		300 k/	
1948	z/	300 l/	0				300 l/	
1949		0 o/	60 dd/				300 o/	
1950			120 u/ ee/				400 u/	
1951			120 u/				400 v/	

Table 26

Estimated Production, Retirement, and Inventory of Soviet Electric Coal Mine Locomotives a/
1927-28 - 1951
(Continued)

a. Plant studies indicate the types of equipment built at each factory but do not show the amount produced of each type. It has, therefore, been necessary to estimate production from inventory figures published in the Soviet press, aided by knowledge of the trend of design as obtained from Soviet technical literature. For these reasons, while considerable confidence may be placed in production figures for a period of years, such as 1945-51, it is not recommended that high reliability be assigned to the figures of total annual production, yearly plant production, or production by model.

b. That is, imported equipment.

c. Compiled from official figures. 436/

d. 1934 inventory is as of 15 September.

e. Planned production, 200. 440/ This may be taken as the prewar capacity of the Druzhkovka plant.

f. Was said by the Soviet press in 1945 to be building 10-MT electric mine locomotives. 442/

g. In 1946 were to build a "trolley accumulator" electric mine locomotive. 443/

h. Estimated. Assumes partial production by Druzhkovka and full production at Moscow and Kopi. The Druzhkovka Works imeni Voroshilov moved here during the war and began series production of the Yu-10-600 and 900 series of 10-MT trolley locomotives. 444/

i. Estimated. Asumes retirement of 100 and production of 700, divided as shown.

j. The AK-2 2-MT battery locomotive was designed by Giprouglemash in 1946. 445/

k. Estimated. Assumes retirement of 200 and production of 900.

l. Estimated. Assumes retirement of 199 and production of 901.

m. Giprouglemash designed a combination battery-trolley locomotive, and the Voroshilov plant in Druzhkovka built the first experimental model. After tests and modifications it was built serially as the II-TAR-1m and 2m, but production was halted temporarily in 1949 in order to devise a way to charge the batteries from the trolley line. 446/

Table 26

Estimated Production, Retirement, and Inventory of Soviet Electric Coal Mine Locomotives
1927-28 - 1951
(Continued)

n. It was planned to build AK-2 mine locomotives for the Georgian mines after tests were completed. 447/

o. Estimated. Assumes retirement of 300 and production of 1,190, as shown. Also based on conclusion that the Moscow Dynamo Plant had ceased to build mine locomotives serially although it still lends its engineering force for purposes of design and may construct prototypes in its plant.

p. In 1949 the coal mines had 2.5 times as many underground locomotives as in 1940. 448/

q. The first batch of KE-1 condenser locomotives was in use since the summer of 1949 at seven mines. 449/

r. Its new AK-2, 2-MT electric trolley car was in series production. 450/ Locomotive No. 1000 left the works on 1 May 1949. 451/ This may have been the first one built. The Gornyak works sent its first batch to the Donbas. 452/ Output was estimated at from 20 to 30 per week to 40 to 50 per month. 453/ It was planned that 600 2-MT battery locomotives were to be in use by the end of 1949. 454/

s. Production of electric coal mine locomotives began in the summer of 1949 after completion of the foundry. Estimated production of 8 to 12 per day may refer to the number being worked on simultaneously. 455/

t. In September 1950 the Soviet press reported that compared to 1946, production of electric mine locomotives was increasing 2.1 times. 456/

u. Estimated by interpolation. Assumes retirement of 300 and production of 1,700. Retirement figure may include some exports.

v. Estimated as in 1950, with retirement of 340.

Table 26

Estimated Production, Retirement, and Inventory of Soviet Electric Coal Mine Locomotives
1927-28 - 1951
(Continued)

w. At the end of 1951 the Soviet press claimed that the coal mining industry had almost 4 times as many electric locomotives as in 1940 and that 10- and 14-MT locomotives now comprised 25 percent of all operating electric locomotives. 457/ Retirement figure may include some exports.

x. The Moscow Dynamo Plant added an electric mine locomotive shop to its plant in 1942 (?). It was said to have built over 1,000 electric 7-MT coal mine locomotives, Type II-TR-2, by the beginning of 1945. 458/

y. Production of one electric mine locomotive per month was reported at the UMZ Coal Mining Machinery Plant at Kizelevsk. 459/ Since no report has been received to confirm this statement, it is possible that the reference is to the repair of mine locomotives.

z. The Moscow Dynamo Plant was reported to have built about 1,300 mine and industrial locomotives, most of the 7-MT weight, in 1946-47 and part of 1948. From 1946, they were denoted the II-TR-2. 460/

aa. Assembly of 14-MT mine locomotives was begun according to a press report. 461/ Another report indicates that the shop had completed a 14-MT trolley and would soon start production. 462/ These statements probably refer to Type IV-TR-4.

bb. The KE-1 condenser-type, two-phase AC electric mine locomotive was designed in 1946 by the Moscow Dynamo Plant, which built the prototype and turned it over to the Voroshilov plant in Druzhkovka for production. 463/

cc. In 1947 the Kopi plant began production of the modernized lightweight 1-TL-1m, 3.2-MT trolley locomotive. 464/

dd. Estimated. Production of 2-MT battery locomotives began in the summer of 1949 at the rate of 10 per month. [redacted] it would be expanded greatly. 465/ 50X1

ee. The Karlik locomotive was being built at this plant according to a press report. 466/

these calculations, production of this plant increased from 100 units per year in 1945 to 400 by 1949. That no increase in output has occurred since 1949 may be accounted for by the fact that this plant has also undertaken to build rock loaders. It has not been possible to reconcile any further increase in production for this plant with known over-all inventories of equipment, unless this projected increase is being exported to the Satellites or diverted to mining uses other than coal mining.

Output of the other major locomotive plant at Kopi consists of the 10- and 14-MT trolley types, the 3.2-MT trolley type, and perhaps a certain number of mediumweight battery locomotives. Production of this plant has been estimated at 400 units per year since 1950 and has increased no further, by the same logic as was used in the case of the Druzhkovka plant.

The 2-MT battery locomotive was designed in 1946 by Giprouglemash, but building and testing of a trial model seems to have been delayed until 1948. By the end of 1949, 600 units were to be in use -- by which may have been meant production of 600 units per year. Although it was not met in 1949, it probably was achieved in 1950. Production was also scheduled to begin at the Yerevan Mining Equipment Factory in the Transcaucasian region on the completion of a foundry in 1949. This plant may also be building as many as 180 units per year, probably of the lighter weights. Finally, there is good evidence to believe that the Laptevo Mining Equipment Plant in the Central Industrial Area, primarily a mine pump works, has added, from about the summer of 1949, a line of lightweight battery locomotives to its output. This plant may be contributing another 120 units per year to total production.

The opening of these new plants may in the future permit them to specialize in the construction of the lightweight locomotives needed by the USSR to complete the elimination of hand pushing and the use of animal haulage underground, as well as to replace the use of continuous cable lines as a source of mine motive power. These plants would then free the major works at Druzhkovka and Kopi to concentrate on the heavier types which are needed by the plan to overhaul main-line underground haulage and shift from lighter to heavier cars, in order to keep up with the increasing productivity of the new coal combines.

6. Coal Mine Cars.

The subject of mine cars was excluded from this report by definition. However, in the course of examining other aspects of the industry, incidental information was gathered concerning the production of mine cars which it is proposed to summarize briefly, since the very number of these cars required by Soviet coal mines makes them of intelligence significance. The western regions of the USSR are reported to have had 112,000 underground mine cars in 1941. 467/ It was planned to build 125,000 cars in 1941. 468/ The 1946-50 Plan called for the manufacture of 565,000 additional cars. 469/ Between 1941 and September 1950 the number of cars of from 1- to 1.2-MT capacity increased 40 percent, those under 1 MT in size decreased 10 percent, and those larger than 1 MT increased 20 percent. 470/ The capacity of the Toretsk Mining Equipment Plant imeni Voroshilov at Druzhkovka, which builds mine cars by continuous production methods, is said to be 50,000 cars a year.* No totals have been published since the war showing either inventory or production of coal mine cars for the whole USSR. Mine cars are believed, from plant studies, to be in production in no less than 19 plants, widely scattered throughout the USSR (see Table 20**). On the basis of the above data, but without a close plant-by-plant tabulation, it is estimated that production in 1951 was approximately 100,000 cars.

7. Pneumatic Picks.

Pneumatic picks are also outside of the defined scope of this report. As in the case of mine cars (see Table 1***), a brief summary will be made of available data. The 1940 inventory is estimated at about 18,000 units.**** In 1941 the western regions of the USSR were said to have over 11,000 pneumatic picks. 471/ The 1941 Plan called

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* See discussion above in this section.

** P. 122, above.

*** P. 15, above.

**** In 1940 it is estimated that about 31 million MT of coal were produced with pneumatic picks in the entire USSR (see Table 2, p. 17, above). In 1941, 14.1 million MT of coal were mined outside of the Donets Basin. It is assumed that 19 million MT were produced with pneumatic picks in the Donbas in 1940 and 12 million MT elsewhere in the USSR. On this basis, production per pick averaged 1,730 MT in the Donbas (19 million MT divided by 11,000 picks). Assumption of a like rate for the rest of the USSR gives a total of about 18,000 picks in 1940.

for the production of 33,000 pneumatic picks of various kinds. 472/ In 1940 the Pnevmatika plant at Leningrad, the largest manufacturer of this equipment in the USSR, built its 100,000th pneumatic pick since 1929. 473/ Production in 1940 of the entire USSR is believed to have been 30,000 units. 474/ The Pnevmatika plant completed its 173,000th pneumatic pick in August 1950. 475/ The 1951 inventory was stated to have been 80 percent above that of 1940, 476/ bringing the inventory up to about 32,000 units at the end of 1951. Production in 1951, based on the fact that pneumatic picks and electric mine drills were being built in almost a dozen plants (see Table 20*), is estimated to have been about 25,000 pneumatic picks per year.

D. External Sources.

1. From the Satellites.

It is not believed that the Satellites have been in a position to supply the USSR with any considerable quantity of specialized coal mining equipment, such as coal cutters, combines, loaders, conveyors, or locomotives, of the type being reviewed in this report. After the end of World War II the USSR may have requisitioned coal mining equipment in occupied territory, but the extent of mine mechanization in Eastern Europe was too meager to have yielded much of a supply in the form of war booty. For the last several years, moreover, it has been the object of the USSR to develop the coal mining industries of its Satellite countries. Instead of regarding them as sources of coal mining equipment, the USSR has taken it upon itself to supply the Satellites with coal mining equipment of Soviet manufacture. At the same time, the USSR has encouraged the Satellites to build coal mining equipment from Soviet designs. In no instance, however, has the industrial potential of the Satellites been sufficient to produce a surplus of the more complex types of mining equipment sufficiently large to permit them to meet their own needs and contribute significantly to the supply of the USSR. Although the USSR no doubt has it in its power to commandeer equipment produced by the Satellites, it is believed that the Satellites are being permitted, instead, to apply such equipment as they can build to the mechanization of their own mines, in order to serve Soviet plans for building up the industrial potential of the Bloc as a whole. As a result, the USSR has been dependent for coal mining equipment of the type being discussed in this report either on its own domestic resources or on sources outside of the Soviet system.

* P. 122, above.

2. Outside the Soviet Bloc.

Outside the Soviet Bloc, the chief prewar manufacturers of coal cutters, loaders, conveyors, and locomotives were the US, the UK, and Germany. Destruction of German industry during the war left the US and the UK as the principal builders of this kind of equipment except for the USSR itself. During the war the USSR requested large quantities of coal mining machinery from the US in the form of Lend-Lease shipments. The USSR, in fact, requested more equipment for the year 1945 than the entire capacity of the US mining machinery industry could have produced (see Table 27).* Even when scaled down, Soviet allotments for 1945 amounted to 394 coal cutters, 157 loaders, 365 conveyors, and 120 locomotives. In fact, the USSR received only the locomotives and 10 shortwall coal cutters in 1945. The balance of the coal cutters, however, and, according to the published trade statistics, large quantities of the other items were shipped to the USSR in 1946. Examination of Table 28** together with prewar trade statistics indicate that except during the war years the USSR has been independent of both the US and the UK for coal mining equipment. Of about $16 million worth of coal mining equipment exported from the US to the USSR from 1932 to 1951, all but $100,000 or so were shipped between 1941 and 1948. Between 1942 and 1947 the USSR received from the US 447 coal cutters, 11,147 rock drills, 589 conveyors, 508 hoists, and at least 129 mine locomotives.*** The bulk of these imports occurred as a result of arrangements made during the war years. Few purchases of coal mining equipment have been made by the USSR in the US since the end of 1947.

If the USSR has not been dependent upon the US for coal mining equipment, it has been even less dependent upon the UK. No shipments of coal cutters from the UK to the USSR have been reported since 1939. The principal shipments of this kind of equipment from the UK to the USSR have consisted of 367 long tons of

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* Table 27 follows on p. 172.

** Table 28 follows on p. 173.

*** It cannot be determined from trade statistics what proportion of the conveyors, hoists, or rock drills were for use in coal mines. The trade figures fail to report mine locomotives separately from road and industrial locomotives. Coal loaders were not separately reported until 1948.

Table 27

Soviet Requests for US Coal Mining Equipment for Shipment in 1945 477/

Units

Type of Equipment	Soviet Request	Estimated US Productive Capacity a/	Schedule of US Production For USSR	Schedule of US Production Total
Locomotives	400	450	120	454
Shuttle Cars	0	300	C	322
Mine Cars	0	28,000	0	18,100
Shortwall Cutters	54	525	54	435
Longwall Cutters	920	275	320	330
Universal & Arcwall Cutters	50	204	20	231
Crawler Trucks	0	225	0	160
Chain & Elevating Conveyors	85	1,000	85	763
Belt Conveyors	60	150	60	146
Shaker Conveyors	520	700	220	578
Duckbills	80	150	40	145
Crawler Loaders	210	360	125	429
Track Loaders including Conways	90 b/	155	32 b/	151
Electric Drills	2,200	2,400	940	2,453

a. Maximum productive capacity expected to be available during 1945 without subcontracting, or best assumptions as to availability of materials, components, and manpower with existing priority position of the industry.
b. Conway loaders only: that is, rock loaders.

miscellaneous items not separately reported but valued at 97,000 pounds, shipped between 1946 and 1948. Total known shipments of coal mining equipment from the UK to the USSR from 1941 to June 1952 amounted to 111,000 pounds.*

* Again a note of caution should be sounded, since certain types of mining equipment are not separately reported in the trade statistics.

Table 28

US and UK Exports of Coal Mining Equipment to the USSR 478/
1941-51

A. US (Thousand $)

	1941		1942		1943		1944		1945		1946		1947		1948		1949		1950		1951		Total	
	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$	No.	$
Coal Cutters	0	00	0	0	8	69	4	8	10	47	320	1,638	105	640	0	0	0	0	0	0	0	0	447	2,402
Loaders a/																	0	0	0	0	0	0		
Conveyors	8	10	3	7	216	320	207	294	76	232	63	127	15	45	0	0	0	0	1	3	0	0	589	1,038
Hoists	0	0	0	0	36	127	69	972	203	5,575	152	1,060	48	559	0	0	0	0	0	0	0	0	508	8,293
Rock Drills	21	175	3,087	587	906	560	4,329	1,464	1,297	443	1,459	550	38	264	10	98	0	0	0	0	0	0	11,147	4,141
Total from US		185		594		1,076		2,738		6,297		3,375		1,508		98		0		3		0		$15,874

B. UK (Thousand £)

	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£	Long Tons	£
Coal Cutters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Winding (Hoisting) Equipment	0	0	0	0	0	0	0	0	0	0	0	0	20	14	0	0	0	0	0	0	0	0	20	14
Other Equipment	0	0	0	0	0	0	0	0	0	0	303	54	24	10	40	33	0	0	0	0	0	0	367	97
Conveyors b/															0	0	0	0	0	0	0	0		
Total from UK	0	0	0	0	0	0	0	0	0	0	303	54	44	24	40	33	0	0	0	0	0	0	387	£111

a. No data before 1949.
b. Classification established in 1948.

In the historical and technical sections of this report it was shown that the USSR has established a domestic coal mining equipment industry (see I and III, above). The trade statistics just reviewed indicate that in consequence of this domestic production the USSR has in fact become independent of the West for the types of coal mining equipment that are the subject of this report.

Although the USSR has during the last 20 years established its own coal mining equipment industry, it has relied, especially in the prewar period, upon Western experience in the design of this equipment. Soviet designers have carefully followed the course of Western technology. Prototypes from the US, UK, and Germany have been used in the design of Soviet coal cutters,* conveyors, loaders, and other specialized coal mining apparatus. 480/ As late as 1949, Amtorg representatives in the US were reported to have made strenuous efforts to obtain details of the latest publicized coal mining machine of a leading US manufacturer so that it might be duplicated for use in the Vorkuta area of the USSR.** 481/ From Soviet technical publications it is evident that Soviet engineers follow closely the mining equipment developments in the West,*** although they have adapted and modified foreign designs to suit their own needs and, when necessary, have explored new technological frontiers.****

* The Soviet longwall cutter KMP-1 is reported to have been copied from the CLE-5 longwall cutter built by the Joy Manufacturing Company in the US, and the Soviet MV-60 is likewise said to have been patterned after the E-60 built by the British affiliate of the Joy Company. In copying this foreign equipment the USSR increased the power of the motors but replaced certain worm gears with straight-cut gears to adapt them to Soviet manufacturing capabilities. 479/

** Probably the continuous mining machine built for shortwall work by the Joy Manufacturing Company. Such a machine would be useful as a combine in preparatory passages. Presumably shortwall methods are to be used in the Vorkuta region.

*** Recently it was found that the Washington office of a US mining equipment manufacturer was unable to supply a photograph of a machine built by its foreign affiliate. Shortly thereafter the desired photograph was found in a Soviet technical publication in an illustrated article dealing with the history of coal combines. 482/

**** For example, intensive Soviet efforts to build coal combines for the mining of longwall faces.

It is obvious, therefore, that the USSR now has a fairly mature coal mining machine building industry and that, except under the duress of invasion, has been meeting its own needs for coal mining machinery domestically. Western export controls have therefore had little effect on the ability of the USSR to keep its coal mines supplied with coal mining machinery. Western export controls, as applied against the Satellite nations, however, add to the overall requirements being levied upon the Soviet coal mining equipment industry and may seriously overtax the productive capacity of the USSR* in this specialized area of manufacturing.

E. Substitutes.

At current rates of production the USSR has been able to meet the demands for coal mining equipment sufficiently well to make steady headway in its program to expand coal output and mechanize its coal mines. This program might be upset by further conversion to a war economy. If for any reason current production rates in the mining machine industry were drastically reduced, a number of alternatives are available.

1. Alternative Machines.

In the first instance, it is possible for the USSR to substitute simpler or lighter equipment for some of the machines now in production. From a short-run point of view the output of machines might be partially sustained by reducing or halting production of the MV-60 and even cutting back the KMP-1 heavy longwall cutters in order to concentrate on production of the lighter GTK-35 machine. This would achieve approximately a 50-percent savings in the weight of material inputs. The labor saved in producing the lighter machines would not be so high. Undoubtedly such machines would be less productive and less durable than the heavy models. Although they would partially alleviate a shortage in the short run, ultimately they would require more maintenance and earlier replacement than the heavy equipment.

Similarly, a decision would have to be made as to whether it paid to shift the balance of production from coal combines to coal cutters or vice versa. From a production point of view it might be tempting, and advisable under certain circumstances, to build more

* See IV, above, for an estimate of these requirements.

coal cutters and fewer or no coal combines. If combines are as productive as the USSR claims they are, however, much is to be said for building combines rather than cutters. Assuming that one combine takes about twice the inputs of a cutter and can produce almost twice as much coal, the combine, it must be remembered, also mechanizes the loading of coal at the face. Granted that a crisis in coal mining machine production would be part of a wider national emergency, in which labor as well as materials would be under high priority, then it might be reasoned that the labor saved in the use of combines as against cutters, other factors being equal, would weigh in favor of the production of more combines than cutters.

On the other hand, in the field of loading machines, which, as has been explained, are used principally in preparatory work in the USSR, it might be advantageous to reduce drastically the use of the heavier and more complex coal loaders in favor of the lighter though less productive rock loaders.

2. Alternative Materials.

Another approach to a production crisis is to substitute alternative materials for those in use at present. Certain alloys can be substituted for others, carbon steel can be used in certain machine parts for alloy steels, nonprecision bearings can sometimes be specified in lieu of precision bearings, and lighter-gauge metals may often be employed instead of standard and heavy gauges now in use. Changes in gauge could effect the greatest savings in conveyors and mine cars, which use large quantities of metal. The object of such changes in construction would theoretically be to make substitutions that would reduce inputs at once without at the same time resulting in simultaneous reductions in productive capacity of the equipment. In this manner a temporary crisis could be withstood, although the equipment might in the long run require more maintenance and have a shorter working life.

3. Alternatives to Machines.

During World War II, when the demand for coal continued to be high, although many of the mining equipment building plants were destroyed or partially diverted to war production, the USSR contrived to maintain coal output by reverting back to the use of pneumatic picks and to the even more rudimentary method of blasting

the coal from the face without undercutting. This is to be regarded as somewhat of a desperate, last-resort measure, for the reason that smaller increments of inputs in a mining machine building establishment can save larger quantities of labor in the coal mines.

4. Intensive Maintenance.

In view of the fact that Soviet coal mining equipment has been short-lived, production problems in a crisis could be greatly alleviated by a more intensive maintenance policy. This plan apparently exists on paper. If carried out in practice and coupled to a program of worker education in better machine care, such a policy could result in a reduction of breakdowns as well as in the prolongation of the life of existing equipment. In the USSR, improved maintenance also has other possibilities. The use factor for coal cutters and combines, as has been seen, may be as low as 75 percent or even lower. A scheduled maintenance program designed to keep a greater percentage of the inventory at work would of course reduce the pressure for new equipment.

5. Cannibalization.

When spare parts become difficult to secure, cannibalization, or the borrowing of parts from one machine that is out of service to repair another, becomes an important feature in the supply situation. Because design has been standardized in the USSR and only three types of coal cutters are believed to be in production, this practice is quite feasible. It is an equally important factor in connection with combines, loaders, and the other types of mining equipment. There is little doubt that cannibalization in a production crisis will be one of the remedies applied to alleviate the pressure.

6. More Intensive Use of Machines.

The coal mines of the USSR are already working on a two-shift basis, 6 days a week. Equipment in use is therefore being pressed so hard that it is not believed likely that it could be used for a longer part of the day or many more days per year. It is possible that by improved scheduling of operations, as is envisaged by the single-cycle movement already mentioned, the output per machine can be increased to some extent.

VI. Balance of Supply and Requirements.

In this section the estimated requirements of the USSR for coal mining equipment during 1952, as developed in IV, above, will be compared with its estimated production as derived from V, above. Requirements, as detailed in Table 19,* consist, insofar as the USSR is concerned, of needed equipment to (1) expand coal output as per plan, (2) replace worn-out equipment, and (3) make exports to the Satellites. Estimated output is computed from production capabilities as ascertained from plant studies and from study of over-all production figures, plant by plant and model by model, from 1945 to 1951.

The object of this comparison is to judge the extent to which the USSR will be able to meet these requirements. Where it appears that the requirements cannot be met, an effort will be made to ascertain the consequences of such failures, if any, and to evaluate their effects. These computations will be checked against estimated supply and requirements data for 1951, or earlier, as is appropriate in each case.

A. Coal Cutters and Combines.

Coal cutters and combines should be taken together in computing a balance, because of their similarity of function. In IV, above, it was estimated that to mine 20 additional million MT of coal per year the USSR would require either 400 coal combines or 725 coal cutters. Each combine produced would thus relieve the USSR of the need of building 1.8 coal cutters. Coal combine production has not been established long enough to provide a reliable series for the prediction of future production trends. Production of combines, however, is believed to have increased from 185 in 1950 to 240 in 1951 (Tables 22,** 23,*** and 31).**** If the production of combines was increased to 300 in 1952 and if cutter-loader output remained constant at about 100, then total production of combines and cutter-loaders may have reached approximately 400 machines in 1952, of which about 75 may have been set aside for retirement of old equipment. The remaining 325 would then have been available to the mines of the USSR

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* P. 117, above.
** P. 142, above.
*** P. 149, above.
**** Table 31 follows on p. 184.

and the Satellites. It is estimated that about 88 were allotted to the Satellites (see Table 19*), leaving only 237 additional machines for the USSR. In consequence the inventory at the end of 1952 would have totaled 1,109, resulting in a gain of 237 units in 1952 as compared with a gain of 247 in 1951.**

Based on the above figures, by which only 237 combines were supplied to do a job that requires 400 combines, there remained work to be performed equal to that which could be done by 163 combines. By the 1.8 ratio, 293 cutters would be required. Recollecting from IV, above, that 825 cutters were to be retired and that 183 were to be supplied to the Satellites, it is seen that the demand for cutters totaled 1,301 (Tables 19 and 30).*** Production in 1951, by contrast, was estimated at only 1,100. It is believed, however, that advanced knowledge of the need of allocating almost 200 coal cutters to the Satellites in 1952 would have permitted the 2 coal-cutter plants to raise their production sufficiently to reach 1,250 without undue difficulty and perhaps even 1,301 with considerable effort as required. A deficit of 50 machines**** could have been met from exports, retirements, or the quantity needed for plan fulfillment.

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* P. 117, above.

** This computation is subject to several criticisms. It should be made clear that no planned figure is available either for production of combines by the USSR in 1952 or for the intended increase in inventory. The independent variables in the above estimate are the estimated allotments to the Satellites and the Soviet inventory at the end of 1950. Production estimates for 1951 are partially dependent on inventory figures, and production estimates for 1952 are extrapolations from previous increases in production. However, since the present ratio between combine and cutter productivity is 1.8 and their input relationship may be somewhere from 1.5 to 2.5, errors in the estimate of the one are almost compensated for in the related estimate of the other.

It should also be noted that in the above computations, cutter-loaders have been assumed to have a productivity equal to that of the standard types of combines. It is possible that cutter-loader productivity is somewhat below that of combines, though well above that of cutters. In comparing the productivity of combines and other loaders to that of cutters, no account is taken of the decreased labor used in loading.

*** Table 30 follows on p. 184.

**** That is, enough machines to mine 1.39 million MT of coal per year.

This presumes that domestic inventory was increased by 242 cutters in 1952 as compared with only 150 in 1951, indicating a reversal of trend in inventory increases, which were very large in the immediate postwar years but which were reduced successively in 1949 and 1950 and through 1951, in a period when gains were being made in the efficiency with which equipment was being used (see Table 29).* Essentially, this reversal in inventory trend for coal cutters indicates that cutters will continue to be important until more versatile combines can be built, capable of operating where the Donbas combine is not satisfactory.

Although there may be discrepancies in the ratio established by the above method of reasoning, as between combine and cutter production, the totals suggest that the USSR should have been able without too much difficulty to meet the demands for coal cutters and combines for 1952, despite the fact that it was undertaking heavy responsibilities in assisting the Satellites to mechanize their coal mines. Although the USSR may be able to achieve increases in output by mechanical mining and at the same time to replace worn-out equipment, it does not appear that sufficient new coal cutters or combines will be available to enable the Russians to make any appreciable progress in substituting machine mining for coal now blasted from the solid without undercutting or mined by means of pneumatic picks.

B. Coal and Rock Loaders.

The 1952 demand for coal and rock loaders, principally for use in preparatory passages, is estimated at 904 machines (Table 19**), distributed as follows: 550 to inventory for the expansion of output in new faces, 150 to replacement, and 204 to the Satellites.*** Production in 1951, however, totaled only 750 loaders of all types. It would have required an increase in output of 150 machines in 1952 to meet estimated requirements for the year. Production in 1951 increased 245 units over that of 1950. Another increase of 150 units, which would in fact be scattered between several plants, is not implausible. It is perhaps more within the range of probability to estimate an increase of about 100 machines during the year, with a range of 50 to 150. In this event, if there was a shortage of about 50 machines

* Table 29 follows on p. 182.
** P. 117, above.
*** The derivation of these figures is detailed in IV, above.

Table 29

Estimated Inventory of Soviet Coal Cutters
End of Year, 1927-28 - 1951

Units

Year	Heavy Cutting Machines	Light Cutting Machines	Total
1927-28 483/	549	268	807
1928-29 484/	761	393	1,154
1929-30 485/	1,007	409	1,416
1931 486/	1,278	322	1,600
1932 487/	1,473	339	1,812
1933 488/	1,679	294	1,973
1934 489/	1,754	327	2,081
1938	2,509 a/	341 b/	2,850
1939	2,925 c/	600 b/	3,525
1940	3,442 d/	608 b/	4,050
1941	850 e/	300 f/	1,150
1945	1,450 g/	300 g/	1,750 g/
1946	2,400 h/	300 i/	2,700
1947	3,425 h/	275 i/	3,700
1948	3,950 h/	250 i/	4,200
1949	4,350 h/	150 i/	4,500
1950	4,600 h/	100 i/	4,700
1951	4,800 h/	50 i/	4,850 j/

a. Plan figure. 490/

b. Estimates. According to calculations based on Table 3 (p. 19, above), light cutting machines accounted for the following coal output (in MT): 1932, 579,000; 1937, 628,000; 1940, 1,437,000; 1941, 537,000; 1945, 527,000; 1946, 587,000 (included with heavy cutting machines in later years). The number of machines must have increased considerably in 1939 on the basis of production and declined sharply with loss of the Donets Basin in 1941. The output of these machines was only about 1,700 MT annually in 1932. It is probable that some increase in productivity occurred from new models. This factor has been taken into account in the estimates for 1939 and 1940. It is believed that the park of machines in 1939 did not increase proportionately with production in that year as compared with 1938 but was actually much less. The 1941 Plan called for production of 500 light cutting machines, but probably less than half that number were produced because of the war.

Table 29

Estimated Inventory of Soviet Coal Cutters
End of Year, 1927-28 - 1951
(Continued)

c. Estimated. At the beginning of 1940 there were 2,150 heavy cutting machines in mines of the western regions. 491/
d. This figure is probably based on Soviet data. 492/
e. Estimate. Before World War II the Donbas mines were using over 2,600 heavy cutting machines. 493/ A leading Soviet authority claimed that 2,700 machines were lost because of the war. There were over 3,000 cutting machines in the Donbas in 1941. 494/ It is assumed that 2,600 were lost in the Donets Basin and 42 in the Moscow Basin and that the eastern regions had a net gain of 50 as compared with 1940.
f. Assumed that 300 were lost in the Donets and Moscow basins.
g. The postwar Five Year Plan called for rebuilding 1,100. 495/ Twelve months after liberation the Donbas mines had at their disposal 442 coal cutters. 496/ It is believed that there were around 1,100 old machines in addition to production of 650 (estimated) new machines in the park at the end of 1945.
h. Residual figures after deducting estimated quantities of light cutting machines.
i. Zvorykin combines the production of coal from light cutting machines with that from heavy cutters following 1946. It is the opinion that no light cutting machines have been built since the war, and it is possible that all were retired in 1952, if not before.
j. The industry had 20 percent more cutters than in 1940. 497/

Table 30

Estimated Inventory, Production, Imports, Exports, and Retirement of Soviet Coal Cutters*
1945-52

Units

Year	Previous Inventory a/	Production b/	Imports c/	Exports d/	Total	Retired d/	Balance: End-of-Year Inventory
1945	1,100	650					1,750
1946	1,750	845	320		2,915	215	2,700
1947	2,700	1,400	105		4,205	505	3,700
1948	3,700	1,325			5,025	825	4,200
1949	4,200	1,405			5,605	1,105	4,500
1950	4,500	1,125		50	5,575	875	4,700
1951	4,700	1,100		100	5,700	850	4,850
1952	4,850	1,250		183	5,917	825	5,092

a. From Table 1, p. 15, above.
b. From Table 21, p. 138, above.
c. From Table 28, p. 173, above.
d. Estimated.

* Spaces left blank in this table indicate that data are not available.

Table 31

Estimated Inventory of Soviet Coal Combines, Coal Planers, and Cutter-Loaders a/*
End of Year, 1945-52

Units

Year	Coal Combines	Coal Planers b/	Cutter-Loaders b/	Total
1945	5 c/	0	0	5
1946	9 d/	2	1	12
1947	16 e/	3	35	54
1948	75	20	120	215
1949	175 f/	25	200	400
1950	300 f/	15	310	625
1951	460 g/	12	400	872
1952				1,109

* Footnotes for Table 31 follow on p. 185.

Table 31

Estimated Inventory of Soviet Coal Combines, Coal Planers, and Cutter-Loaders a/
End of Year, 1945-52
(Continued)

a. The inventories of machines are based mainly on estimated production of machines and on output of coal from these machines with discretionary allowances for heavy retirement, supplemented by available Soviet statistics. The figures in the table necessarily include numerous machines that are idle or not installed (see Tables 22 and 23, pp. 142 and 149, above).
b. Estimated from production tables.
c. Includes one Makarov built in 1944 and four of various types built in 1945. It is possible that there were a few prewar models in the mines, but it is doubtful if any of these were in operation.
d. Estimate based on report that 1950 inventory increased 32 times in 5 years since the war. 498/
e. Estimate based on report that the number of combines increased elevenfold in 2 years preceding 1950. 499/
f. At the end of 1950 there were 300 combines in use in the USSR. 500/ During first 6 months of 1950 the number of combines increased 38 percent. 501/ In 8 months of 1950 the number of combines increased 50 percent. 502/ The increase during 1950 was interpolated as 72 percent.
g. The production of combines is estimated at 240. About 50 of these were exported, and 30 old machines are assumed to have been retired.

in 1952, it is possible that replacements were deferred on old equipment or that deliveries to the Satellites were delayed. It is also conceivable that one of the assumptions on which the above estimates are based -- namely, that an effort will be made to mechanize all of the new preparatory passages required for expansion under the Fifth Five Year Plan (1951-55) -- will not be achieved. Although no figures were stated in the Plan, the mechanization of this particular operation was mentioned as having a high priority (see I, above). It is believed, therefore, that some effort will eventually be made not only to keep up with the expansion of output but also to extend mechanization to older operations. Expansion of existing facilities

to build present types of loaders may be undertaken with some caution, however, since the USSR has been experimenting with a special combine for use in development passages, which, if successful, would cut, break, and load both the coal and the rock in a continuous operation.*

C. Coal Mine Conveyors.

Combined requirements for scraper and belt conveyors for 1952 for the USSR have been estimated at about 4,650 conveyors, with a range of 4,200 to 5,200. As stated previously, in IV, above, this is a gross approximation, based upon little more than the knowledge that 10,000 scraper conveyors and 4,000 belt conveyors were in operation at the end of 1949 and that because of the shift away from shaker conveyors, most of this equipment was built in the postwar years. Although reasonable estimates might be made of the requirements for face conveyors, very little is known concerning the number or length of the gathering conveyors needed to move the coal from the face to the shaft. Since the technical information needed to calculate the relationship between planned coal output and needs for conveyors under Soviet mining techniques is lacking, no firm foundation can be laid for estimates of requirements. Production data on the subject of conveyors are likewise based on shaky evidence and assumptions, for reasons detailed in V, above. In fact, production data, instead of being derived from independent data, are deduced from inventories. It is not surprising, therefore, that if total 1952 production were estimated at 4,200 to 5,200 conveyors, weighted two to one in favor of scraper conveyors against belt conveyors, estimated production would turn out to be identical to estimated Soviet needs during 1952 for its own mines, including expansion and replacements, as well as for export to the Satellites. Comparisons with earlier years would corroborate these figures but would not constitute an independent verification. This number of conveyors is considerable but is not excessive when compared with the 33,000 called for by the Fourth Five Year Plan (1946-50). Moreover, conveyor construction is not in itself difficult, though it is not easy to build conveyors that are trouble-free and long-lived. Should the USSR succeed in improving the quality of its conveyors, it could reduce its annual requirements by as much as 15 to 20 percent and thereby save considerable amounts of steel and labor. In the meantime, although the Russians are probably meeting their needs, they are doing this at the cost of high expenditures in labor and materials.

* See III, above, with reference to the PK-2M and PPK-1 combines for development work.

D. Coal Mine Locomotives.

It was estimated in IV, above, that the USSR required about 1,760 coal mine locomotives in 1952, of which about 800 medium and heavy types were needed for the expansion of output, about 600 light types for mechanization of car shunting, about 350 for replacements, and only about 10 for exports (Table 19*). It would appear that if 1952 production had been increased to only 1,800, a gain of but 100 locomotives, there would have been ample on hand to retire 350, export the few going out of the USSR, and have a balance of 1,450. This increase would have brought the inventory at the end of 1952 up to 8,850 coal mine locomotives, most of them of postwar construction. Since the body of a mine locomotive is generally long-lived and since the motors and other wearing parts are renewable, this equipment, if maintained, should last for some time.

Closer inspection, however, of the distribution of production by type of equipment indicates the presence of a serious unbalance. Although the press has reiterated news of a drive to equip the Soviet mines with heavier equipment of the 10- and 14-MT types, by far the greater production is occurring in the field of the 2- and 3.2-MT car spotters and gathering locomotives. Production of these two types may have totaled 1,000 units in 1951, leaving as a balance an output of only about 375 to 450 of the heavy types and 250 to 300 of the mediumweight models. Unless production of the heavyweight machines was increased considerably in 1952, it will still be necessary for the USSR to use light-duty equipment where heavy-duty equipment is prescribed. In view of the fact that even the heavy Soviet types are medium by present US standards, the USSR may experience bottlenecks and breakdowns in its underground coal transportation system until this condition can be remedied.** An increase of production of 100 heavy locomotives in 1952 would have helped greatly to overcome the condition but would still have left the locomotive park underpowered.

E. Coal Mine Cars.

Although coal mine cars were excluded from this report by definition, incidental information pertaining to them has been presented in earlier sections. Soviet requirements have been estimated

* P. 117, above.

** This shortage may tend to verify reports that the USSR had ordered 60 mine locomotives from Italy for 1952 delivery, although it is not established that these were for underground coal mines. 503/

at about 75,000 to 125,000 cars per year for 1951. Increased coal production may require as many as 10,000 to 15,000 new cars per year. Since 1951 production has been estimated at about 100,000 cars, the USSR should have been able to meet its 1952 needs. It is believed, however, that these cars are so short-lived as to constitute a sizable and continuous drain in steel inputs.

F. Pneumatic Picks.

Pneumatic picks are also outside of the scope of this report. Like coal mine cars, they have been treated only in passing. Inventory is judged to have amounted to about 32,000 units in 1951. Mechanization of other operations tends to hold down the demand for pneumatic picks, though it has not been diminishing to any noticeable extent. Annual production to maintain the inventory is judged to have been 20,000 to 25,000 units. Productive capacity is estimated to have been about 25,000 a year, or sufficient to provide for known needs.*

G. Conclusions.

As a result of the high priority given in Soviet planning to the expansion of coal output, coupled with a desire to release labor from coal mining for other purposes, the USSR has experienced strong demands for coal mining equipment. Although the USSR has a fairly mature coal mining equipment industry to which it has given high priorities in capital goods, designing engineers, labor, and raw materials, it has not been easy to keep production up to the level required by domestic needs. The effort of the USSR to assist the Satellites to expand their coal output and mechanize their mines, an effort which has become intensified since 1950, has increased the burden on the Soviet coal mining equipment industry (Table 32).** A plant-by-plant and product-by-product survey of requirements and production of coal cutters, combines, loaders, conveyors, and locomotives indicates that while there is no surplus of production, output is keeping up with requirements. Moreover, the industry is essentially self-sufficient from imports. Indeed, the industry would be able to meet the demands upon it with little difficulty if the

* These estimates for mine cars and pneumatic picks, not having been founded on detailed research, should be taken as rough indications rather than as thoroughly documented judgments.

** Table 32 follows on p. 189.

quality of the equipment produced and the maintenance of this equipment in the mines could be improved to a level comparable to that of the US. Under present conditions it is believed that it is the somewhat mediocre quality of the product and the poor treatment which it receives underground that exercises more pressure on the Soviet coal mining equipment industry than the need to meet the expansion of coal mining or the recently imposed export requirements.

In addition, it should be noted that although it is an object of the Soviet coal mining equipment industry to extend mechanization to all phases of coal mining, it would appear that, because of high replacement and export needs, mechanization may be doing little more than keeping up with the expansion in coal output. In the long run this will result in considerable gains, but, as a result, progress in the replacement of operations now performed by hand is relatively slow and may require a considerable length of time.

Table 32

Estimated Supply and Demand of Soviet Coal Mining Equipment a/
1952

Units

Item	Estimated Requirements b/	Estimated Supply c/	Balance d/
Coal Cutters	1,301 e/ 1,200-1,400	1,250 1,150-1,350	- 51
Coal Combines including Cutter-Loaders	400 e/ 325-475	400 350-450	0
Coal and Rock Loaders	904 700-1,100	850 800-900	- 54
Coal Conveyors	4,650 4,200-5,200	4,650 4,200-5,200	0
Coal Mine Locomotives	1,760 1,560-1,960	1,800 1,700-1,875	+ 40

a. The upper figure in each entry indicates the best estimate; the lower figure, the estimated range.
b. From Table 19, p. 117, above.
c. Based on discussion in V, above, and VI.

Table 32

Estimated Supply and Demand of Soviet Coal Mining Equipment
1952
(Continued)

d. These balances should be used with caution in the context of the discussion in the text. In particular, balances as shown do not indicate the balance of types of equipment falling within each category.

e. Since coal cutters and combines perform similar functions, they were considered together in developing estimated requirements and balances. The requirement for combines was made equal to estimated combine production. Mining requirements not satisfied by estimated combine production were alloted to cutters for the purpose of determining cutter requirements. See pp. 179-180, above.

VII. Inputs.

A. Methodology.

Inputs into Soviet coal mining equipment may be estimated in a number of ways. Other things being equal, it would be desirable to make this calculation chiefly from Soviet sources, but unfortunately no Soviet breakdown of these inputs is available. Prisoner-of-war reports have been too inaccurate to be used as the basis of this computation. Moreover, since the activities of the Soviet coal mining equipment factories are dispersed in every instance over several products, it is not possible from even the best of plant reports to calculate inputs to a particular kind of machine, such as a coal cutter, apart from those into other kinds of equipment. In order, therefore, to calculate inputs accurately, it is necessary to build them up machine by machine.

For such an inquiry there is available from Soviet sources analyses, in varying detail, of the characteristics of each of the major types of machines, ranging from weight and dimensions to capacity and descriptions of the component parts. Were enough of this information available, it might be possible, with some effort, to estimate inputs into this equipment by applying US production techniques with suitable conversions. From this method a number of variations are possible. Each is based upon the transfer, by analogy, of US production methods, adapted whenever possible to Soviet conditions by appropriate correction factors.

The idea of reasoning from analogy from the US coal mining equipment industry to that of the USSR offers interesting possibilities, though it is at the same time fraught with dangers, owing to differences in manufacturing methods and mining technology. The comparative method, if it may be so called, can be applied (1) to the US coal mining machine building industry en masse, (2) to the individual plants, or (3) to individual products.

Looking at the situation as a whole, it is possible to examine US input requirements for the entire coal mining equipment industry during a single year, such as the year 1945, at the end of World War II. Initial plans for 1945 called for the production of items as listed in Table 33.*

* Table 33 follows on p. 192.

Table 33

US Proposed Underground Coal Mining Equipment Program
1945 504/

Units

Items	Destination of Output				Total Program 1945 (Proposed)
	US and Canada	UK	Other British Empire	USSR	
Locomotives	300	26	23	120	469
Shuttle Cars	220	83	8	0	311
Mine Cars	18,000	100	0	0	18,100
Shortwall Cutters	300	110	47	54	511
Longwall Cutters	10	0	0	320	330
Universal and Arcwall Cutters	184	0	28	20	232
Crawler Trucks	137	29	0	0	166
Chain and Elevating Conveyors	554	140	0	85	779
Belt Conveyors	80	6	0	60	146
Shaker Conveyors	346	12	0	220	578
Duckbills	100	5	0	40	145
Crawler Loaders	270	29	20	125	444
Track Loaders including Conways	110	0	9	32	151
Electric Drills	1,400	12	124	940	2,476

To make the above program possible, it was proposed to allocate to the US coal mining equipment industry controlled materials during 1945, as indicated in Table 34.* Here in brief is stated the amount of steel needed by the coal mining equipment industry in operation for 1 year under wartime conditions. Unfortunately, the value of this information is lessened by the fact that the US industry planned in 1945 not only to keep the US mines in operation but also to lend support to the mines of the British Empire and the USSR as well. Were it not for

* Table 34 follows on p. 193.

Table 34

US Proposed Controlled Materials Allotments to the Underground Coal Mining Equipment Industry 1945 505/

Controlled Materials	Total 1945	Unit
Carbon Steel	60,186	short tons
Alloy Steel	6,393	short tons
Copper Base Alloys		
Sheet, Strip, and Plate	51,540	lbs
Rods, Bars, and Wires	78,150	lbs
Tubing and Pipe	8,415	lbs
Brass Mill Copper Products	302,921	lbs
Wire Mill Products	633,845	lbs
Foundry Products	966,780	lbs
Aluminum	6,000	lbs

this disrupting factor, it could be said that under wartime conditions an allotment of 66,500 short tons of steel together with other needed items would be needed to keep in operation coal mines with a capacity of more than 620 million short tons. Even though the data are thrown out of focus by the export situation, this kind of a view helps to give a picture of the upper limits of the requirements of the coal mining machinery industry for raw materials in time of war. Were the data limited to US needs, it might even be possible to reason from them that, given an economy of a certain size requiring a given amount of coal and securing that coal by a stipulated technology, it would take an allotment of x tons of steel, and so on down the input list, to the coal mining equipment manufacturers to meet the national need for coal. The raw material inputs to the mining machine building industry could even be stated as x^a tons of steel per ton of coal to be mined. Could such a figure be devised for the US, by appropriate adjustment of requirements for equipment, in terms of output, it could with some computation be transposed to the USSR.

In contrast to this approach, which seeks to match the needs of an entire supplying industry with that of its consuming industry in the context of the whole economy, attention should also be called to the

possibility of ascertaining the inputs needed by a whole industry to build all machines performing a certain function, such as coal cutters, without regard to lesser variations in equipment within the general category. Such data are also to be had from the files of the War Production Board (WPB) from World War II. As shown in Table 35,* the coal mining equipment industry was allotted in 1944 7,491 tons of steel and 801,000 pounds of copper base alloys with which to build 1,067 coal cutters of all types, or about 7 short tons of steel and 750 pounds of copper per coal cutter. Similar input data can be derived from Table 35 for loaders, conveyors, mine cars, and locomotives. Unfortunately, however, the categories employed by the WPB were very comprehensive. The term "coal cutters" includes not only the shortwalls of all weights but also the heavy-mounted universal cutters, as well as self-propelled trucks used to move shortwall cutters from place to place in the mines. The loader figures also include equipment of various weights. Under conveyors are grouped all underground types -- chain, belt, and shaker -- regardless of length. Similarly, locomotives, shuttle cars, and even mine cars were grouped together for purposes of classification. So numerous were the mine cars, for example, that they establish an average of but 1.73 short tons of steel per item in the class of mine cars and locomotives, which would obviously be insufficient steel with which to build a coal mine locomotive. The cutter, loader, and even the conveyor averages, however, are not beyond the field of reason and would be useful in extrapolating to a country whose mine technology was close to that of the US.

From the point of view of method, this approach has its uses. Moreover, with some effort it might be possible to apportion the inputs derived from Table 35 for classes of equipment to particular types or even models. This could be done if the trouble were taken to devise conversion factors weighted according to the respective weights and frequency of the kinds of equipment being considered. The possibility of relating input weights to selling price should also be given some thought. If it be assumed that shipments did not lag too much and that there is a reliable relationship between the value of equipment shipped in 1944 and the weight of the inputs, then ratios could be established from which it would be possible to extract inputs by weight of steel and copper base alloys per each item of equipment either by weight or by value.

* Table 35 follows on p. 195.

Table 35

US WPB Production and Allotments Program of Underground Coal Mining Equipment
1944

Code	Item [a]	1944 Program 506/ US	1944 Program 506/ Total	Allotments 507/ Steel (Short Tons)	Allotments 507/ Copper Base Alloys (Thousand Lbs)	1944 Shipments 508/ Thousand $	Allotment Per Unit Steel (Short Tons)	Allotment Per Unit Copper Base Alloys (Thousand Lbs)
301	Coal Cutters	856	1,067	7,491	801	5,750	7.02	0.75
	Shortwall	520	671					
	Universal	184	184					
	Crawler Trucks	152	212					
304	Underground Coal Loaders	380	450	6,407	641	4,757	14.24	1.42
	Crawler	300	370					
	Track	80	80					
302	Underground Coal Conveyors	1,072	1,246	8,995	330	4,703	7.22	0.26
	Chain	616	722					
	Belt	72	85					
	Shaker	384	439					
300	Coal Mine Cars and Locomotives	29,332	29,462	51,056	481	12,167	1.73	0.02
	Locomotives	392	414					
	Shuttle Cars	244	352					
	Mine Cars	28,696	28,696					

a. Listed in order of treatment throughout this report.

It is also possible, employing a technique similar to the above, to analyze inputs, not by industry, but by company. This method has the advantage of permitting the focusing of attention upon companies which specialize in certain products, thereby overcoming some of the obstacles erected by the overgeneral categories used by the WPB. To employ this technique, it would be necessary to check allotments of materials to particular companies for a period long enough to overcome errors due to lag in output. Average monthly allotments could then be compared with scheduled monthly shipments. From the average price per unit of machinery in any given category, such as coal cutters, it would then be possible to reduce inputs to tons per machine scheduled to be shipped.

Two other approaches to the problem were considered and tried in greater detail. Both were based on the comparison of US and Soviet types of equipment. The first involved an examination of the equipment building industry as a whole, based not on the WPB records, but on the 1947 Census of Manufactures. The second approach that was attempted in detail consisted of working from the inputs to individual items of US equipment to inputs for equivalent pieces of Soviet machinery.

The limitations of the former method became apparent almost at once. In the first place, the coal mining equipment industry is grouped in the census with the construction equipment industry. Although production and sales for the former industry are reported separately by the census, raw materials consumed by the industry are reported together with those consumed by the construction equipment manufacturers. Furthermore, even production and sales were not available for all items. Moreover, in the census, items are grouped more by function than by producing or consuming industry. Thus coal mine locomotives are not included in the reports for coal mining equipment but together with transportation equipment. The breakdowns, even when by types of equipment, tend to be comprehensive. Thus the category for coal cutters includes all types, mounted and unmounted, heavy and light.

Although it was feared that the heavy items included in the construction equipment industry would throw out of balance the lighter pieces built for the underground coal mining industry, it was decided to proceed with an analysis of the census data, if only as a check on their validity and an independent test for more intensive analysis of individual models of machines that it was also planned to make subsequently.

The 1947 Census of Manufactures reported inputs to the mining and construction industry (3531) as $456,580,000. Separate inputs for the coal mining equipment industry were not given by the 1947 census. Shipments of the entire mining and construction industry totaled $932,430,000, and shipments of coal cutters were valued at $11,844,000. Assuming that the ratio of inputs to outputs is the same for the manufacture of coal cutters as for the entire mining and construction industry, it was reasoned as follows:

$$\frac{\text{\$ Coal Cutter Shipments FOB}}{\text{\$ All Mining and Construction Shipments FOB}} = \frac{\text{\$ Inputs to Coal Cutters}}{\text{\$ Inputs to Mining and Construction}}$$

Therefore,

$$\text{Inputs to Coal Cutters} = \frac{\text{\$ Coal Cutter Shipments x \$ Inputs to Mining and Construction}}{\text{\$ Mining and Construction Shipments}}$$

$$= \frac{\$\ 11{,}844{,}000 \times \$456{,}800{,}000}{\$932{,}430{,}000}$$

$$= \$5{,}800{,}000$$

Or

$$\frac{\text{\$ Inputs to Coal Cutters}}{\text{\$ Inputs to All Mining and Construction}} = \frac{\text{\$ Input Any Coal Cutter Component}}{\text{\$ Input Same Component to All Mining and Construction}}$$

$$= 0.0127$$

By applying this factor to the respective inputs to the entire mining and construction industry as shown in Column 2 of Table 36,* dollar inputs to coal cutter manufacture were computed in Column 3. This figure was then divided by 1,533, the number of coal cutters built in 1947, to ascertain the dollar input per average coal cutter (Column 4). By methods explained in the notes to Table 36, inputs were derived directly from the census reports or else converted from dollar values per coal cutter to material inputs. By appropriate conversion factors, steel inputs were reduced to raw steel and fuel inputs to standard Soviet fuel. These computations led to a series of inputs per coal cutter, as

* Table 36 follows on p. 201.

shown in Column 10. When inspected, these values appeared to be higher than experience warranted, thus confirming the prior doubts about the validity of the assumption that inputs to coal cutters were of an order similar to those to construction equipment. To overcome the overweighting resulting from the inclusion of the heavy construction equipment in this census category, recourse was had to WPB data for allotments to the coal mining equipment industry for 1944. On the basis of these allotments it appeared that only 8.2 MT of raw steel had been allotted to the coal cutter industry by the WPB in 1944, as compared with the 13.4 MT derived from the census of 1947. Using these steel ratios as an index, a correction factor of 0.614 was computed,* and all inputs were reduced by this quantity, as shown in Column 11. This may be taken as the inputs per average US coal cutter in 1947. By a further adjustment, on a weight-per-weight ratio, it could be applied to Soviet coal cutters.** By the same procedure, inputs to US coal loaders were computed from census data, as shown in Table 37.***

Although these computations are reported here, partly as a study in the methodology for the estimation of inputs to Soviet equipment, it is now believed that this method is appropriate only where the census categories embrace the confines of homogeneous industries. Inspection of the results, even when scaled down by the WPB correction factor, leads to the suspicion that the inputs computed in this fashion are high. It must be remembered, of course, that the coal cutters considered range from 3 to over 5 MT. Even so, an average input of 8.18 MT of steel would seem to be about 50 percent too much. It may be reasoned, then, that while the census study led to a gross approximation of inputs, it was, if only for the difficulty of separating coal mining

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* For the derivation of this correction factor, see the notes to Table 36.

** Computations in Table 36 were carried one step further by estimating in Column 12 the inputs to both new equipment and to maintenance, in conformity with US practice, with the exception of bearings, for which maintenance according to recommended Soviet practice was available.

*** Table 37 follows on p. 209.

from construction equipment, too crude a measuring device. This hypothesis was confirmed by subsequent study of inputs as reported by US manufacturers on a model-by-model basis.*

B. Input Requirements.

Inputs were next computed for each type of Soviet coal mining equipment from data supplied by US manufacturers of similar machinery. These inputs were worked back to raw materials, motors, bearings, labor, and other components, at so much per machine, as described in the notes to Table 38.** These inputs were then converted into inputs to equivalent Soviet equipment on a proportional basis. Certain inputs were obtained directly [redacted] This process was carried out on a model-by-model basis for coal cutters (see Table 38). Data for coal combines are limited, since these have been developed only recently. The combines were all assumed to have the same average inputs as the Donbas combine, which is a mediumweight type and the most frequently built model. Inputs to it were allocated on a weight-by-weight basis as compared with the MV-60 heavy coal cutter (see Table 39).*** This procedure appeared to be especially justified in view of the fact that the power unit of the MV-60 is used to drive many of the combines. Cutter-loaders were calculated as KMP-1 cutters to which loading plows had been attached. The S-153 coal loader inputs were figured from its prototype US machine with appropriate weight adjustments (see Table 40).**** No data were available directly from manufacturers for the three types of rock loaders. A weighted average was therefore computed for them, which was converted into inputs in the same manner as in the case of the S-153 coal loader. Conveyor inputs were calculated from US equipment, with adjustments to standard Soviet length (see Table 41, 42, 43, and 44).***** Locomotives were grouped into classes by weight. The 14- and 8-MT types were figured directly from US equipment, and the light models were figured in part from components and in part by proportion from the heavier weights (see Tables 45, 46, 47, and 48).****** In

50X1

* WPB records provide a good correction factor to the census reports. To the extent that the inputs are too high after the application of the WPB correction factor, it may be reasoned that the WPB requests for allotments were in themselves too high.

** Table 38 follows on p. 212.

*** Table 39 follows on p. 214.

**** Table 40 follows on p. 215.

***** Table 41 follows on p. 219; Table 42, on p. 220; Table 43, on p. 223; Table 44, on p. 224.

****** Table 45 follows on p. 225; Table 46, on p. 227; Table 47, on p. 229; Table 48, on p. 230.

most cases, inputs were calculated on a machine-per-machine basis. Then, total inputs required for estimated 1951 production were computed on a model-by-model basis. These inputs were combined in Table 49* to show total inputs to (1) cutters, combines, and cutter-loaders, (2) coal and rock loaders, (3) scraper and belt conveyors, and (4) mine locomotives. Table 49 thus shows the total inputs to that part of the coal mining equipment industry that has been examined in this report.

Table 49 indicates that the Soviet coal mining equipment industry may have consumed in 1951 as much as 77,000 MT of steel in the construction of new equipment and as much as 115,000 MT of steel if the manufacture of repair parts be included.** If these estimates are correct, the industry required almost 2.4 million antifriction bearings, more than 500 MT of copper base alloys, more than 5,000 MT of rubber conveyor belting, and almost 15,000 motors, ranging in size from about 2 to 75 kw.

If all of this equipment had been built in only five plants, one for each major kind of machine, as shown in Table 51,*** the industry would have needed about 1,200 machine tools, 153 welders, about 40 overhead cranes, over 450 jib cranes, and 7 cupolas, together with other related manufacturing equipment. These items alone would have needed a floor space of almost 90,000 square meters.

With the inputs shown here, the industry is estimated to have produced in 1951 new equipment of the types considered in this report totaling about 55,000 MT. Counting repair parts, the industry may have turned out a product whose net weight amounted to over 80,000 MT, as shown in Table 50.**** At only $1 per pound this product would have been worth in the neighborhood of $200 million, a sum that suggests the priority being given to the construction of coal mining equipment in the USSR.

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* Table 49 follows on p. 231.

** It should be emphasized again at this point that these are not the total steel requirements of either the coal mining equipment industry or the coal mines. The industry builds a great quantity of other items besides those considered in this report. Its steel requirements for mine cars alone may well total 50,000 MT more per year. This report does not necessarily seek to cover the heaviest or most numerous items being built for the Soviet coal mines. The focus of the analysis in this report has been, instead, the more difficult items, such as the cutters and loaders, which are a test of an economy's ability to build complex, heavy capital goods.

*** Table 51 follows on p. 235.

**** Table 50 follows on p. 233.

Table 36

Estimated Inputs to US Coal Cutters*
1947

Item	S.I.C.	2 Input to All Mining and Construction Machinery (Thousand $)	3 To Coal Cutters (Col. 2 x 0.0127) ($)	4 Per Each Cutter (Col. 3 ÷ 1,533) ($)	5 Cost per Unit (MT Unless Otherwise Indicated) ($)	6 Total Units to Mining and Construction	7 Units to Cutters (Col. 6 x 0.0127)	8 Units per Cutter (Col. 7 ÷ 1,533)	9 Input per Cutter Amount	9 Input per Cutter Unit	10 Corrected Totals	11 WPB Correction (Col. 10 x 0.6)	12 Plus Spare Parts (Col. 11 x 2)
Totals a/**		456,580	5,800,000	3,783.43							$2,945.86	$1,800	
Labor b/						84,694 man-yrs	1,080 man-yrs	0.7 man-yrs	1.05	Soviet man-yrs		0.64 Soviet man-yrs	1.3 Soviet man-yrs
Total Steel c/											To raw steel (MT) 13.402	8.18 MT	16.4 MT
Blast Furnaces	3311	1,085	13,783	8.99	40				0.23	MT	0.23		
Steel Works	3312					779,391 short tons	10,887 short tons	6.45 short tons	5.82	MT	8.06 a		
Iron Foundries	3321	21,933	278,615	181.74					0.76	MT	0.82 b		
Steel Foundries	3323					178,029 short tons	2,261 short tons	1.47 short tons	1.3	MT	1.40 b		
Iron and Steel Forgings	3391	13,232	168,090	109.65	311				0.35	MT	0.61 c		
Metal Stampings	3463	3,085	39,189	25.56	508				0.05	MT	0.88 c		
Wireworks	3489	2,641	33,549	21.88	460				0.05	MT	0.09 c		
Steel Springs	3493	325	4,128	2.69	209				0.01	MT	0.02 c		
Bolts, Nuts, and Washers	3494	7,959	101,106	65.95	440				0.15	MT	0.26 c		
Screw Machine Products	3495	5,000	63,516	41.43	451				0.09	MT	0.16 c		
Fabricated Metal Products	3499	15	191	0.12	105				0.001	MT	0.002 c		
Cutting Tools	3543	4,155	52,781	34.43	257				0.13	MT	0.23 c		
Special Industrial Machinery	3559	772	9,807	6.40	121				0.05	MT	0.09 c		
Machine Shops	3599	5,938	75,429	49.20	158				0.31	MT	0.55 c		
Aluminum		236				321 short tons	3.7 short tons		0.002	MT		0.001 MT	0.002 MT

* Spaces left blank in this table indicate that data are not applicable.
** Footnotes for Table 36 follow on p. 207.

Table 36

Estimated Inputs to US Coal Cutters
1947
(Continued)

Item	1 S.I.C.	2 Input to All Mining and Construction Machinery (Thousand $)	3 To Coal Cutters (Col. 2 x 0.0127) ($)	4 Per Each Cutter (Col. 3 ÷ 1,533) ($)	5 Cost per Unit (MT Unless Otherwise Indicated) ($)	6 Total Units to Mining and Construction	7 Units to Cutters (Col. 6 x 0.0127)	8 Units per Cutter (Col. 7 ÷ 1,533)	9 Input per Cutter Amount	 Unit	10 Corrected Totals	11 WFB Correction (Col. 10 x 0.6)	12 Plus Spare Parts (Col. 11 x 2)
Total Copper									0.04	MT		0.02 MT	0.04 MT
Rolled and Drawn	3351					1,491 short tons	17.0 short tons	0.012 short tons	0.01	MT			
Castings						2,473 short tons	28.27 short tons		0.02	MT			
Insulated Wire and Cable	3631	924	11,737	7.66	0.32 per lb				0.01	MT			
Total Coal (Bituminous Coal Equivalent) d/											To bituminous coal (MT) 3.99	2.4 MT	4.8 MT
Anthracite	1110				8.89	11,791 MT	149.74 MT		0.0976	MT	0.1		
Bituminous	1210				6.93	282,000 MT	3,582 MT		2.4	MT	2.4		
Coke	2932				16.89	29,931 MT	380.1 MT		0.25	MT	0.28		
Natural Gas	4922					1,800 mil cu ft	23.0 mil cu ft	15,000 cu ft			0.54		
Manufactured Gas	4925					426 mil cu ft	5.4 mil cu ft	3,530 cu ft			0.67		
Total Electric Power						445 mil kwh	5.65 mil kwh	3,686 kwh					
Purchased	4911					426 mil kwh						2,248 kwh	4,496 kwh
Generated in Plants						19 mil kwh							

Table 36

Estimated Inputs to US Coal Cutters
1947
(Continued)

Item	1 S.I.C.	2 Input to All Mining and Construction Machinery (Thousand $)	3 To Coal Cutters (Col. 2 x 0.0127) ($)	4 Per Each Cutter (Col. 3 ÷ 1,533) ($)	5 Cost per Unit (MT Unless Otherwise Indicated) ($)	6 Total Units to Mining and Construction	7 Units to Cutters (Col. 6 x 0.0127)	8 Units per Cutter (Col. 7 ÷ 1,533)	9 Input per Cutter Amount	 Unit	10 Corrected Totals	11 WPB Correction (Col. 10 x 0.6)	12 Plus Spare Parts (Co. 11 x 2)
POL	2911												
Avgas, Jet Fuel		0										0	0
Motor and Diesel Fuel		1,232	15,649	10.20	3.25 bbls				0.52	MT		0.32 MT	0.6 MT
Lubricants		632	8,030	5.25	20.00 bbls				0.44	MT		0.27 MT	0.5 MT
Industries Not Elsewhere Considered													
Lumber	2421	3,380	42,936	28.01	63 per thous ft		450 bd ft					275 bd ft	550 bd ft
Paints and Varnish	2851	2,322	29,496	19.24								$11.75	$23.50
Structural Metal Products e/	3441	2,820	35,823	23.37								$14.26	$28.52
Rubber Tires	3011											2 per truck per yr	2 per truck per yr
Motors and Generators f/	3614											1-47 kw	1-47 kw
Bearings g/	3593											21 units	59 units
Electric Control Apparatus h/	3616	3,143	39,926	26.04								$15.85	$31.70
Undistributed i/		72,000	915,414	597.14								$365.00	
Total Items under 0.5 Percent j/				135.80								$83.00	

a. When the census gives inputs for components of the industry by weight or other units than dollars, these units are shown in Column 8. In other instances, weights per dollar were taken from the census, as shown in Column 5, and reduced to weight per coal cutter in Column 9.
b. Soviet labor was calculated at 66.7 percent of the efficiency of US labor (US input x 1.5).
c. Corrections for raw steel are made in Column 10 as per WGC-D-3 (EIC), 20 December 1951. Small a indicates correction factor of 1.39; small b indicates divided by correction factor 0.925 (or multiplied by 1.08); small c indicates correction factor of 1.76.

Table 36

Estimated Inputs to US Coal Cutters
1947
(Continued)

d. Fuels listed herein were converted to bituminous coal of 13,000 Btu at the following ratio: anthracite, 12,700; coke, 13,000; natural gas, 1,150 Btu per cu ft; manufactured gas, 600 Btu per cu ft.
e. This item, composed of miscellaneous structural metal products, comprising about 1 percent per cutter in value of material inputs, could not be broken down into type of metal. It is therefore reported in dollars.
f. Coal cutters require one motor per machine. These range in size from the KMP-1, which uses a 47-kw motor, to the MV-60, which is equipped with a 57-kw motor.
g. The KMP-1 requires 21 antifriction bearings per machine.
h. This item consists chiefly of motor starters.
i. "Undistributed" refers to items not distributed by the 1947 census.
j. Consists of items totaling less than 0.5 percent in value per cutter. Other items, totaling $811 per cutter, showed up in the census but were deducted from the coal cutter items as being properly applicable to other types of mining equipment. These inputs consisted of items such as boiler shop products, pipe, valves and fittings, etc.

It has been indicated that the inputs per cutter shown in Columns 9 and 10 were based on the assumption that weights and values would be distributed in a valid manner throughout the segments of the mining and construction industry. Inspection of the resultant steel weights indicated that this assumption was not correct. It appeared that the heavier weights per unit of certain items of construction equipment had overweighted the more compact coal mining machinery items. Accordingly, in Column 11, all allocations per cutter have been corrected according to data derived from WPB allotments to the coal mining equipment industry for 1944 on the following basis:

$$\frac{\text{\$ Value of Coal Cutters Shipped in 1944 x Price Correction}}{\text{Weight of Steel Allocated to Coal Cutters, 1944}} =$$

$$\frac{\text{\$ Value of Cutters Shipped in 1947}}{\text{Weight of Steel Inputs to Coal Cutters, 1947}}$$

Therefore, Weight of Steel Input to Coal Cutters, 1947 =

$$\frac{6{,}742 \text{ MT} \times \$11{,}844{,}000}{\$5{,}750{,}000 \times 1.1} = 12{,}625 \text{ MT of Steel}$$

$$= 8.235 \text{ MT of Steel per Coal Cutter}$$

From this adjusted steel input figure a correction factor was calculated.

$$\frac{\text{WPB Steel Weight, 1944}}{\text{Census Steel Weight, 1947}} = \frac{8.235 \text{ MT}}{13.402 \text{ MT}} = 61.4 \text{ Percent}$$

All calculations were reduced by this amount in Column 11 which thus becomes an indicator of inputs per coal cutter built. Maintenance in this industry is a heavy item. Spare parts shipments equaled shipments of new equipment according to WPB records. While this may not be valid in peacetime years, it is assumed that Soviet maintenance in cold war conditions will equal US maintenance under hot war conditions of World War II. For antifriction bearings [redacted] a yearly need of 38 replacement bearings per machine of 21 bearings. In Column 12, therefore, figures are adjusted upward by 100 percent to include inputs to the spare parts sector of the industry. 50X1

Table 37

Estimated Inputs to US Coal Loaders a/*
1947

Item	Unit	1 Inputs per Coal Cutter (Derived from 1947 Census)	2 Inputs per Coal Loader (Col. 1 x 1.74)	3 WPB Correction (Col. 2 x 0.64)	4 Plus Spare Parts (Col. 3 x 1.5)
Labor	Soviet man-yrs	1.05	1.8	1.2	1.8
Steel	MT	13.4	23.3	14.9	22.4
Aluminum	MT	0.002	0.003	0.002	0.003
Copper	MT	0.04	0.07	0.05	0.075
Coal	MT	3.99	6.94	4.44	6.66 b/
Electric Power	kwh	3,686	6,414	4,105	6,158
POL					
Motor and Diesel	MT	0.52	0.90	0.58	0.87
Lubricants	MT	0.44	0.77	0.49	0.74
Industries Not Elsewhere Considered					
Lumber	bd ft	450	783	501	752
Paints and Varnish	$	19.24	33.48	21.43	32.15
Structural Metal Products	$	23.37	40.66	26.02	39.03
Motors and Generators	17-kw units		1		1.5
Electronic Control Apparatus	$	26.04	45.31	29.00	43.50
Undistributed	$	597.14	1,039.02	664.37	997.46
Total Items under 0.5 percent	$	135.80	236.29	151.23	226.85

* Footnotes for Table 37 follow on p. 210.

Table 37

Estimated Inputs to US Coal Loaders a/
1947
(Continued)

a. Inputs to US coal loaders were derived from the coal cutter inputs shown in Table 36 by the following line of reasoning:

$$\frac{\$ \text{ Inputs to US Coal Cutters, 1947}}{\$ \text{ Shipments to US Coal Cutters, 1947}} = \frac{\$ \text{ Inputs to US Coal Loaders, 1947}}{\$ \text{ Shipments to US Coal Loaders, 1947}}$$

or

$$\frac{\$ \ 5,800,000}{\$ \ 11,844,000} = \frac{\$ \text{ Inputs to US Coal Loaders, 1947}}{\$8,579,000}$$

Thus

$ Inputs to US Coal Loaders, 1947 = $4,201,131 per 637 Loaders, or $6,595 per Loader.

The ratio of loader to cutter inputs was therefore $\frac{\$6,595}{\$3,783} = 1.74$.

By means of this conversion factor, Table 37 was constructed. Census inputs per coal cutter are shown in Column 1. These are then converted into census inputs per coal loader by application of the multiplier 1.74. As in the instance of the coal cutters, it was found that the census inputs per coal loader, being weighted by the association with heavy construction equipment, proved to be excessive, as indicated by the high figures for steel inputs. Corrections were therefore devised based on WPB allotments for the construction of coal loaders, as follows:

$$\frac{\$ \text{ Value of Coal Loaders Shipped in 1944 x Price Correction}}{\text{Weight of Steel Allocated to Coal Loaders, 1944}} = \frac{\$ \text{ Value of Coal Loaders Shipped in 1947}}{\text{Weight of Steel Inputs to Coal Loaders, 1947}}$$

Therefore, Weight of Steel Input to Coal Loaders, 1947 =

$$\frac{5,766 \text{ x } \$8,759,000}{\$ \ 4,757,000 \text{ x } 1.1} = 9,453 \text{ MT of Steel Input to Coal Loaders, 1947.}$$

$$\frac{9,453}{637} = 14.84 \text{ MT Steel Input per Coal Loader, 1947.}$$

Table 37

Estimated Inputs to US Coal Loaders a/
1947
(Continued)

From this adjusted steel input figure a correction factor was calculated:

$$\frac{\text{WPB Steel Weight, 1944}}{\text{Census Steel Weight, 1947}} = \frac{14.84}{23.32} = 0.64$$

This correction factor was applied in Column 3. The resultant figures indicate the 1947 inputs per coal loader built in the US in 1947. Finally, in Column 4 an addition was made to allow for the production of spare parts. Considering that coal loaders are a relatively new Soviet product and that the park is therefore of fairly recent origin, the spare part factor was calculated at 50 percent. As in other calculations of mining machinery inputs, Soviet factory labor was reckoned as being 67 percent as efficient as US labor. Steel was converted back to raw steel as per directions received. Fuel was converted to Soviet standard fuel of 12,600 Btu.

b. 6.86 at Soviet standard fuel of 12,600 Btu.

Table 38

Estimated Inputs to Soviet Coal Cutters*
1951

	1	2	3	4	5	6	7	8	9
	50-Hp US Shortwall Cutter								
	Finished Components a/**		Stock b/		Inputs per Cutter c/		Soviet Longwall Cutters d/		
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units	(Col. 4 by Factor)	Units	GTK-35 (Units)	KMP-1 (Units)	MV-60 (Units)
Steel Castings	2,150 lbs	0.98 MT	÷ 0.88	1.11 MT	x 1.08	1.20 MT			
Rolled Steel	2,985 lbs	1.35 MT	÷ 0.84	1.61 MT	x 1.39	2.24 MT			
Total Ferrous	5,135 lbs	2.33 MT				3.44 MT	2.32 MT	2.91 MT	3.19 MT
Copper Cable e/	200 lbs								
Copper Base Alloys	90 lbs	0.04 MT				0.04 MT	0.1 MT	0.05 MT	0.05 MT
Tin	10 lbs	0.005 MT				0.005 MT			
Motor and Controller	2,700 lbs	1 50-hp unit				1 50-hp unit	1 35-kw unit	1 47-kw unit	1 57-kw unit
Bearings	18 units					18 units	22 units	21 units	21 units
Labor	803 man-hrs				x 1.5	1,205 Soviet man-hrs	816 Soviet man-hrs	1,024 Soviet man-hrs	1,120 Soviet man-hrs
Finished Weight	8,300 lbs	3.76 MT				3.76 MT	2.55 MT	3.2 MT	3.5 MT

* Spaces left blank in this table indicate that data are not applicable.
** Footnotes for Table 38 follow on p. 213.

Table 38

Estimated Inputs to Soviet Coal Cutters
1951
(Continued)

a. These figures were obtained from a US manufacturer and consist of the finished weights of the machine components. When totaled, they add up to the finished weight of the machine. Weights and other items are entered in Column 1. Weights are converted to metric units in Column 2.

b. The weights of finished components are converted by means of factors based on European practice in Column 3 to manufacturer's stock in Column 4. Factors used consist of division by 0.88 for the machining of castings and division by 0.84 for the fabrication and machining of steel shapes and sheets. 509/

c. Stock is converted back to raw steel according to procedures established for ORR Project 110-51: loss in the foundry is compensated for by multiplying by 1.08. Losses in rolling mills are taken into account by multiplying by 1.39. Totals in Column 6 thus represent weights of raw steel and weights of nonferrous alloys. Motor, controls, and bearings are reported in units. US man-hours are converted to Soviet man-hours by application of the factor 1.5.

d. In Columns 6-9, inputs are derived for the three Soviet coal cutters believed to be in current production, according to the following equation:

$$\text{Steel Input to Soviet Cutter in MT} = \frac{\text{Steel Input to US Cutter in MT}}{\text{Total Weight of US Cutter in MT}} \times \text{Total Weight of Soviet Cutter}$$

Soviet man-hours to produce each of the three coal cutters were computed from the same basic equation, substituting man-hours for steel inputs.

Data for motors were obtained directly [redacted] as shown in Table 9, p. 50, above. Requirements for bearings and copper base alloys [redacted] showed inputs to wearing parts of the KMP-1 and also of the GTK-3M, the predecessor of the GTK-35. Values for the MV-60 were assumed to be the same as for the KMP-1. 510/ 50X1 50X1

e. Inputs are figured to the connector plug and do not include the copper connecting cable.

Table 39

Estimated Total Inputs to Soviet Coal Cutters, Combines, and Cutter-Loaders
1951

		1	2	3	4	5	6	7	8	9	10	11
		Cutters a/						Combines b/		Cutter-Loaders c/		
		GTK-35		KMP-1		MV-60						
Item	Unit	Inputs per Machine x 200		Inputs per Machine x 500		Inputs per Machine x 400		Inputs per Machine x 240		Inputs per Machine x 100		Total
Raw Steel	MT	2.32	464.0	2.91	1,455.0	3.19	1,276.0	6.38	1,531.20	3.41	341	5,067.2
Copper Base Alloys	MT	0.1	20.0	0.05	25.0	0.05	20.0	0.1	24.00	0.05	5	94
Motors and Controllers	Units	1	200	1	500	1	400	2	480	1	100	1,680
Bearings	Units	22	4,400	21	10,500	21	8,400	42	10,080	21	2,100	35,480
Labor	Soviet man-hrs	816	163,200	1,024	512,000	1,120	448,000	2,240	537,600	1,040	104,000	1,764,800

a. Inputs from Table 38; production from Table 21, p. 138, above.
b. Inputs from Table 38; assumes average weight to be that of Donbas combine and to be twice that of MV-60 heavy cutter; production from Table 22, p. 142, above.
c. Inputs from Table 38; consists of addition of 100-kg plow to the KMP cutter-loader; production from Table 23, p. 149, above.

Table 40

Estimated Inputs to Soviet Coal and Rock Loaders*
1951

	1	2	3	4	5	6	7	8	9	10	11
	US Crawler-Mounted Coal Loader a/**										
	Finished Components		Stock		Inputs per Loader		Soviet S-153 Coal Loader c/ (Col. 6 x 4.24 ÷ 10.58 = 0.4)	Average Soviet Rock Loader d/ (Col. 6 x 6.08 ÷ 10.58 = 0.57)	Combined Inputs to Soviet Coal and Rock Loaders b/		
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units	(Col. 4 by Factor)	Units			Coal Loaders (Col. 7 x 210)	Rock Loaders (Col. 8 x 540)	Total (Sum of Cols. 9 and 10)
Steel Castings	8,900 lbs	4.04 MT									
Cast Iron	300 lbs	0.14 MT									
Total Castings		4.18 MT	÷ 0.88	4.75 MT	x 1.08	5.13 MT					
Rolled Steel	10,350 lbs	4.69 MT	÷ 0.84	5.58 MT	x 1.39	7.76 MT					
Forgings	500 lbs	0.23 MT	÷ 0.84	0.27 MT	x 1.39	0.38 MT					
Total Ferrous		9.10 MT				13.27 MT	5.31 MT	7.56 MT	1,115.10 MT	4,082.40 MT	5,197.50 MT
Nonferrous	600 lbs	0.27 MT				0.27 MT	0.11 MT	0.15 MT	23.10 MT	81.0 MT	104.10 MT
Bearings	73 units					73 units	73 units	42 units	15,330 units	22,680 units	38,010 units
Rubber	550 lbs	0.25 MT				0.25 MT	0.1 MT	0.14 MT	21.00 MT	75.60 MT	96.60 MT
Labor	2,900 man-hrs				x 1.5	4,350 Soviet man-hrs	1,740 Soviet man-hrs	2,480 Soviet man-hrs	365,400 Soviet man-hrs	1,339,200 Soviet man-hrs	1,704,600 Soviet man-hrs
Motors and Controllers	1 75-hp 1 4-hp						1 23.5-kw	e/	210 units	825 units	1,035 units
Finished Weight		10.58 MT					4.24 MT				

* Spaces left blank in this table indicate that data are not applicable.
** Footnotes for Table 40 follow on p. 217.

Table 40

Estimated Inputs to Soviet Coal and Rock Loaders
1951
(Continued)

a. These figures, which were supplied by a US manufacturer of coal loaders, consist of the finished weights of the machine components. They were, therefore, processed in the same manner as were the data for coal cutters considered in Table 38 in order to obtain the weight of the manufacturer's stock and to convert that back to raw steel and other components.
b. Production from Table 24, p. 153, above.
c. Total inputs to the US coal loader were then converted into inputs to the Soviet S-153 coal loader in Column 7 by the following equation:

$$\text{Input to Soviet Machine} = \frac{\text{Finished Weight of Soviet Machine}}{\text{Finished Weight of US Machine}} \times \text{Input Weight to US Machine}$$

It was reasoned that the Soviet machine, though lighter than the US prototype, would require the same number of bearings, albeit of smaller size.
d. Because it has not yet been possible to secure from US manufacturers the inputs to their rock loaders, it was necessary to compute value for these machines on a proportionate weight basis from the coal loader data. For this reason, a weighted average for the Soviet rock loaders was computed as follows:

50X1

Type	Finished Weight (MT)	Number Built 1951	Total Weight of Those Built 1951 (MT)	Motor Type	Motor Number
EPM-1	5.03	145	729.35	2 10.5-kw	290
PML-5	2.75	140	385.00	2 10-hp air	280
UMP-1	8.5	255	2,167.50	1 20.5-kw	255
			3,282		825

Dividing the total weight of those built in 1951 by the number built gave an average weight of 6.08 MT per rock loader. By the formula stated in note c, these were reduced to their relative input weights as compared with a US coal loader by the same technique that was applied to the S-153 coal loader.
e. Soviet motors for the rock loaders are shown in the table in note d, above. See also Table 10, p. 69, above.

Table 41

Estimated Inputs to the Average Soviet Longwall Scraper Conveyor*
91 M (300 Ft), 50 MT per Hr a/
1951

	1	2	3	4	5	6	7
	Finished Components		Stock		Inputs per Scraper Conveyor		
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units	(Col. 4 by Factor)	Units	Total Inputs b/ (Col. 6 x 3,000)
Castings	3,280 lbs	1.49 MT	÷ 0.88	1.69 MT	x 1.08	1.83 MT	
Rolled Steel	8,900 lbs	4.04 MT	÷ 0.84	4.81 MT	x 1.39	6.69 MT	
Total Ferrous	12,180 lbs	5.53 MT		6.50 MT		8.52 MT	25,560 MT
Nonferrous	0					0	0
Motor	1 15-hp					1 11.25-kw	3,000 units
Bearings	13 units					13 units	39,000 units
Rubber	15 lbs					0.0068 MT	20.40 MT
Labor	253.8 man-hrs				x 1.5	381 Soviet man-hrs	1,143,000 Soviet man-hrs

a. A US manufacturer's figures for a 300-foot scraper conveyor designed to deliver 50 short tons per hour were converted back to raw steel and other inputs by the same methods used in Table 38. Although slightly shorter than 100 meters, this conveyor is believed to be similar to the average Soviet scraper conveyor.
b. Production from Table 25, p. 160, above.

* Spaces left blank in this table indicate that data are not applicable.

Table 42

Estimated Inputs to the Average Soviet Gathering Belt Conveyor*
762 MM (30 In), 15 Kw, 225 MT per Hr, 170 M (558 Ft) Long a/
1951

	1	2	3	4	5	6	7
	Stock b/		Inputs per Conveyors		Total Inputs for 108.5 M of Intermediate Sections c/ (From Col. 5, Table 43)	Total Inputs for 170 M of 762-MM Belt Conveyor, 15 Kw 225 MT per Hr (Col. 4 + Col. 5)	Total Inputs d/ (Col. 6 x 1,500)
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units			
Steel Castings	1,100 lbs	0.50 MT	x 1.08	0.54 MT			
Rolled Steel	15,200 lbs	6.89 MT	x 1.39	9.58 MT			
Total Ferrous				10.12 MT	8.62 MT	18.74 MT	28,100 MT
Copper and Brass							
Brass Strip	10 lbs	0.005 MT					
Copper Sheets	10 lbs	0.005 MT					
Copper Wire and Cable	100 lbs	0.045 MT					
Copper Base Castings	100 lbs	0.045 MT					
Total Copper Base Alloys	220 lbs	0.100 MT		0.100 MT		0.1 MT	150 MT

* Spaces left blank in this table indicate that data are not applicable.
** Footnotes for Table 42 follow on p. 221.

Table 42

Estimated Inputs to the Average Soviet Gathering Belt Conveyor*
762 MM (30 In), 15 Kw, 225 MT per Hr, 170 M (558 Ft) Long a/
1951
(Continued)

	1	2	3	4	5	6	7
	Stock b/		Inputs per Conveyors		Total Inputs for 108.5 M of Intermediate Sections c/ (From Col. 5, Table 43)	Total Inputs for 170 M of 762-MM Belt Conveyor, 15 Kw 225 MT per Hr (Col. 4 + Col. 5)	Total Inputs d/ (Col. 6 x 1,500)
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units			
Tin	10 lbs	0.005 MT		0.005 MT		0.005 MT	7.5 MT
Mica	5 lbs	0.002 MT		0.002 MT		0.002 MT	3 MT
Wood	5 lbs	0.002 MT		0.002 MT		0.002 MT	3 MT
Rubber Belt, 4-ply, 42 oz	2,000 lbs	0.9 MT		0.9 MT	1.60 MT	2.5 MT	3,750 MT
Motor and Controller	975 lbs	0.4 MT		1 20-hp (15-kw)		1 15-kw	1,500 units
Bearings	168 units		14 per 8-ft section x 25 sections	350 units e/	623 units	973 units	1,459,500 units
Labor			1.5 x 460 man-hrs	690 Soviet man-hrs	349 Soviet man-hrs	1,039 Soviet man-hrs	1,558,500 units

a. The inputs in Columns 1 and 2 are for a US 200-ft, 20-hp, 30-in conveyor, complete with head and tail, equipped with rubber belting, and rated at 250 short tons per hour, but extensible to 1,500 ft by the addition of intermediate sections and belting. This conveyor is believed to be similar to the average Soviet gathering belt conveyor, except for the length adjustments of Column 5.

Table 42

Estimated Inputs to the Soviet 170-M, 225-MT-per-Hr Gathering Belt Conveyor
1951
(Continued)

b. In this instance the US manufacturer supplied the weight of the manufacturer's stock. It was therefore necessary only to convert these figures back to raw steel and other components. This was done, as in Table 38, by applying the factor of 1.39 to rolled steel and 1.08 to castings.
c. From data supplied by the same manufacturer for inputs per each 100 additional feet of conveyor that it was desired to add to the original unit, inputs were computed in Table 43 for enough intermediate sections and belting to extend the structure to 170 m, which it is estimated would be a frequently occurring Soviet length. The additional sections are entered in Column 5 of Table 42 and totaled in Column 7.
d. Production from Table 25, p. 160, above.
e. The US conveyor was built up of 8-ft sections each of which contained 14 bearings. The basic unit thus contained 25 sections, or 350 bearings.

Table 43

Estimated Inputs to Intermediate Sections of the Soviet Belt Conveyor Shown in Table 42 a/
1951

	1	2	3	4	5
	Stock		Inputs to Intermediate Sections		Inputs per 108.5 M of Intermediate Sections
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units	(Col. 6 x 3.56)
Rolled Steel	3,840 lbs	1.74 MT	x 1.39	2.42 MT	8.62 MT
Rubber Belt, 4-Ply, 42 oz	1,000 lbs	0.45 MT		0.45 MT	1.60 MT
Ball Bearings	96 units		14 per 8-ft section x 12.5 sections	175 units	623 units
Labor			1.5 x 65 man-hrs	98 Soviet man-hrs	349 Soviet man-hrs

a. That is, to 30.5 m (100 ft) of intermediate sections for 762-mm (30-in) belt conveyor. See explanation in Table 42, note **c**.

Table 44

Estimated Total Inputs
to Soviet Underground Scraper and Belt Conveyors a/
1951

		1	2	3
Item	Unit	Scraper Conveyors	Belt Conveyors	Total
Raw Steel	MT	25,560	28,100	53,660
Copper Base Alloys	MT	0	150	150
Tin	MT		8	8
Motors and Controllers	units	3,000	1,500	4,500
Mica	MT		3	3
Bearings	units	39,000	1,459,500	1,498,500
Wood	MT		3	3
Rubber and Rubber Belt	MT	20.40	3,750	3,770
Labor	Soviet man-hrs	1,143,000	1,558,500	2,701,500

a. Consists of the sum of Table 41, Col. 7, and Table 42, Col. 7.

S-E-C-R-E-T

Table 45

Estimated Inputs to Soviet Heavyweight Coal Mine Locomotives*
1951

	1	2	3	4	5	6	7
	Inputs to US 15-Short-Ton or Soviet 14-MT DC Trolley Locomotive a/**						
	Stock		Inputs per Unit		Inputs to Soviet 10-MT DC Trolley Locomotive b/ (Column 4 by Factor -- 10 ÷ 13.6 = 0.74)	Total Inputs	
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units		14-MT (Col. 4 x 300)	10-MT (Col. 5 x 125)
Steel Castings	321 lbs	0.15 MT	x 1.08	0.16 MT			
Rolled Steel	27,097 lbs	12.3 MT	x 1.39	17.10 MT			
Cast Iron	4,892 lbs	2.2 MT	x 1.08	2.38 MT			
Total Ferrous	32,310 lbs	14.7 MT		19.64 MT	14.53 MT	5,892 MT	1,816.25 MT
Lead	59 lbs	0.027 MT		0.027 MT	0.020 MT	8.10 MT	2.50 MT
Tin	31 lbs	0.014 MT		0.014 MT	0.010 MT	4.20 MT	1.25 MT
Total Nonferrous	90 lbs	0.041 MT		0.041 MT	0.030 MT	12.30 MT	3.75 MT
Motor and Controller	6,815 lbs	3.09 MT		3.09 MT			
Motor Type	2 50-hp	2 37.50-kw		2 37.50-kw	2 25-kw	600 units	250 units

* Spaces left blank in this table indicate that data are not applicable.
** Footnotes for Table 45 follow on p. 226.

S-E-C-R-E-T

Table 45

Estimated Inputs to Soviet Heavyweight Coal Mine Locomotives
1951
(Continued)

	1	2	3	4	5	6	7
	Inputs to US 15-Short-Ton or Soviet 14-MT DC Trolley Locomotive a/						
	Stock		Inputs per Unit				
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units	Inputs to Soviet 10-MT DC Trolley Locomotive b/ (Column 4 by Factor -- 110 ÷ 13.6 = 0.74)	14-MT (Col. 4 x 300)	10-MT (Col. 5 x 125)
Bearings	13 units			13 units	13 units	3,900 units	1,625 units
Total Weight Less Bearings	39,215 lbs	17.83 MT		24.23 MT			
Labor			1.5 x 2,971 man-hrs	4,457 Soviet man-hrs	3,298 Soviet man-hrs	1,337,100 Soviet man-hrs	412,250 Soviet man-hrs
Total Finished Weight	30,000 lbs	13.6 MT					

a. A US manufacturer supplied the input information for 15-short-ton DC trolley-type mine locomotives. Inputs were given by this manufacturer for the stock used in manufacture. Therefore it was only necessary to convert back to raw steel and other components as in Table 41. The 15-short ton US locomotive was almost equivalent in weight to the 14-MT Soviet model.
b. Inputs to the USSR 10-MT mine locomotives were calculated in Column 5 by proportions from the 14-MT type as in Table 40.

S-E-C-R-E-T

Table 46

Estimated Inputs to Soviet Mediumweight and Lightweight Coal Mine Locomotives*
1951

	1	2	3	4	5	6	7
	Inputs to US 8-Short-Ton and Soviet 7.2-MT Locomotives a/**						
	Stock		Inputs per Unit		Inputs per Soviet 3.2-MT Trolley Locomotives b/ (Col. 4 by Factor -- 3.2 ÷ 7.26 = 0.44)	Total Inputs	
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units		To Mediumweight Type (Col. 4 x 275)	To Lightweight Type (Col. 5 x 100)
Steel Castings	666 lbs	0.30 MT	x 1.08	0.32 MT			
Rolled Steel	14,905 lbs	6.76 MT	x 1.39	9.40 MT			
Cast Iron	1,551 lbs	0.70 MT	x 1.08	0.76 MT			
Total Ferrous	17,122 lbs	7.76 MT		10.48 MT	4.61 MT	2,882 MT	461 MT
Lead	44 lbs	0.020 MT		0.020 MT	0.008 MT	5.50 MT	0.8 MT
Tin	31 lbs	0.014 MT		0.014 MT	0.006 MT	3.85 MT	0.6 MT
Total Nonferrous	74 lbs	0.034 MT		0.034 MT	0.014 MT	9.35 MT	1.4 MT
Motor and Controller	2,732 lbs	1.24 MT		1.24 MT			
Motor Type	2 40-hp	2 30-kw		2 21-kw	1 12-kw	550 units	100 units

* Spaces left blank in this table indicate that data are not applicable.
** Footnotes for Table 46 follow on p. 228.

Table 46

Estimated Inputs to Soviet Mediumweight and Lightweight Coal Mine Locomotives
1951
(Continued)

	1	2	3	4	5	6	7
	Inputs to US 8-Short-Ton and Soviet 7.2-MT Locomotives [a]						
	Stock		Inputs per Unit		Inputs per Soviet 3.2-MT Trolley Locomotives [b]	Total Inputs	
Item	Units	(Col. 1 ÷ 2,205)	(Col. 2 by Factor)	Units	(Col. 4 by Factor -- 3.2 ÷ 7.26 = 0.44)	To Mediumweight Type (Col. 4 x 275)	To Lightweight Type (Col. 5 x 100)
Bearings	13 units			13 units	7 units	3,575 units	700 units
Total Weight Less Bearings	19,928 lbs	9.03 MT					
Labor			1.5 x 2,161 man-hrs	3,242 Soviet man-hrs	1,426 Soviet man-hrs	891,555 Soviet man-hrs	142,600 Soviet man-hrs

a. Calculated as in Table 45 from data supplied by US manufacturers.
b. Calculated by weight from Column 4.

Table 47

Estimated Inputs to the Soviet 2-MT Battery Locomotive, AK-2*
1951

Item	1 Finished Weight	2 Inputs per Unit (Col. 1 by Factor)	3 Inputs per Unit Units	4 Weights in Col. 3 ÷ 2,205	5 Total Inputs (Col. 4 x 900)
Total Finished Weight	4,410 lbs				
Less:					
Battery	400 lbs				
Plug	15 lbs				
Controller	20 lbs				
Switch and Resistor	28 lbs				
Motor	110 lbs			1 2-kw	900 units
Total Electrical Parts a/	573 lbs		573 lbs		
Other Metal	3,837 lbs				
Lead	33 lbs		33 lbs	0.015 MT	13.50 MT
Tin	20 lbs		20 lbs	0.009 MT	8.10 MT
Total Nonferrous	53 lbs b/		53 lbs	0.024 MT	21.60 MT
Steel	3,784 lbs	x 1.35 c/	5,108 lbs	2.32 MT	2,088 MT
Bearings				7 units	6,300 units
Labor		1.5 x 400 man-hrs d/		600 Soviet man-hrs	540,000 Soviet man-hrs

a. Estimated from US practice.
b. Estimated on basis of Table 44, p. 224, above.
c. Assumes same ratio of ferrous metal between input and finished weight as in Table 44.
d. Estimated on basis of output of 10.8 short tons per man-year.

* Spaces left blank in this table indicate that data are not applicable.

Table 48

Estimated Total Inputs to Soviet Coal Mine Locomotives
1951

		1	2	3	4	5	6
Item	Unit	Heavy		Medium	Light	Very Light	
		14-MT a/	10-MT b/	7.2-MT c/	3.2-MT d/	2-MT e/	Total
Raw Steel	MT	5,892	1,816	2,882	461	2,088	13,149
Lead	MT	8.10	2.50	5.50	0.8	13.50	30.40
Tin	MT	4.20	1.25	3.85	0.6	8.10	18.00
							48.40
Motors and Controllers	units	600	250	550	100	900	2,400
Bearings	units	3,900	1,625	3,575	700	6,300	16,100
Labor	Soviet man-hrs	1,377,100	412,250	891,555	142,600	540,000	3,323,505

a. From Table 45, Col. 6.
b. From Table 45, Col. 7.
c. From Table 46, Col. 6.
d. From Table 46, Col. 7.
e. From Table 47, Col. 5.

Table 49

Estimated Inputs to Soviet Coal Mining Equipment Produced in 1951*

		1	2	3	4	5	6
Item	Unit	Cutters and Combines a/**	Coal and Rock Loaders b/	Conveyors c/	Locomotives d/	Total	Total Including Repair Parts (Col. 5 x 1.5)e/
Raw Steel	MT	5,067	5,198	53,660	13,149	77,074	115,610
Copper Base Alloys	MT	94	104	150		356	534
Lead	MT				30	30	47
Tin	MT			8	18	18	27
Mica	MT			3		3	4
Wood	MT			3		3	4
Rubber	MT		97	3,770		3,770	5,655
Motors and Controllers	units	1,680	1,035	4,500	2,400	9,615	14,423
Bearings	units	35,480	38,010	1,498,500	16,100	1,588,090	2,382,135
Labor	Soviet man-yrs (2,496 hrs)	707	683	1,082	1,295	3,767	5,651
Power	thousand kwh f/	2,982	2,300	19,721	5,386	30,389	45,584
Coal	Soviet standard fuel in MT g/	2,456	1,893	16,237	4,437		25,023

* Spaces left blank in this table indicate that data are not applicable.
** Footnotes for Table 49 follow on p. 232.

Table 49

Estimated Inputs to Soviet Coal Mining Equipment Produced in 1951
(Continued)

a. From Table 39, Col. 11.
b. From Table 40, Col. 11.
c. From Table 44, Col. 3.
d. From Table 48, Col. 6.
e. Based on US practice.
f. Computed at 500 kwh per short ton of finished weights, or 551.26 kwh per MT of finished weights. See Table 50.
g. Computed for plants large enough to build equipment and spare parts as shown in Column 6. Based on heating plants to 50°F for 9 months.

Table 50

Estimated Finished Weight of Soviet Coal Mining Equipment Produced in 1951 a/*

Item	1 Finished Weight (MT)	2 Number Built 1951	3 Total Finished Weight (MT)	4 Subtotals (MT)	5	6 Total Including Repair Parts (Sum of Col. 5 x 1.5)
Coal Cutters						
GTK-35	2.55	200	510.00			
KMP-1	3.2	500	1,600.00			
MV-60	3.5	400	1,400.00			
Total Cutters		1,100		3,510.00		
Coal Combines	6.5	240	1,560.00			
Cutter-Loaders	3.4	100	340.00			
Total Cutters, Combines, and Cutter-Loaders					5,410	
Loaders						
Rock						
EPM-1	5.03	145	729.35			
PML-5	2.75	140	385.00			
UMP-1	8.5	255	2,167.50			
Total Rock Loaders		540		3,281.85		
Coal S-153	4.24	210	890.40			
Total Loaders		750			4,172	

* Footnote to Table 50 follows on p. 234.

Table 50

Estimated Finished Weight of Soviet Coal Mining Equipment Produced in 1951 a/
(Continued)

Item	1 Finished Weight (MT)	2 Number Built 1951	3 Total Finished Weight (MT)	4 Subtotals (MT)	5	6 Total Including Repair Parts (Sum of Col. 5 x 1.5)
Locomotives						
Heavy						
14 MT	14	300	4,200.00			
10 MT	10	125	1,250.00			
		425		5,450.00		
Medium	8	275	2,200.00			
Light						
3.2 MT	3.2	100	320.00			
2.0 MT	2.0	900	1,800.00			
		1,700		2,120.00		
Total Locomotives					9,770	
Conveyors						
Scraper		3,000	17,041.00			
Belt		1,500	18,734.00			
		4,500			35,775	
Total Finished Weight					55,127	82,691

a. Weights [redacted] as shown in III, above; combine weights assumed to be average of Donbas type; conveyor weights estimated from weights of raw materials; repair parts allowance based on US experience.

50X1

Table 51

Estimated Machine Tool and Manufacturing Facilities
of the Soviet Coal Mining Equipment Industry
1951

Item	Unit	Cutters and Combines	Loaders	Conveyors	Locomotives	Total
Machine Tools	units	119	100	770	210	1,199
Welders	units	15	14	97	27	153
Overhead Traveling Cranes	units	6	5	22	9	42
Jib Cranes	units	50	36	300	75	461
Cupolas	units	2 10 short tons per hr	1 10 short tons per hr	2 20 short tons per hr	2 10 short tons per hr	7
Floor Space	sq m	9,700	7,478	64,120	17,519	98,817

VIII. Conclusions.

A. Capabilities.

Because each of the Soviet Five Year Plans has aimed at the further industrialization of the USSR, coal mining, which is essential to industrialization, has received a high priority for more than 20 years. From 1932 to the end of 1951, coal output in the USSR was increased from 64.7 million MT to about 283 million MT per year. To facilitate this increase and to reduce the great quantity of labor that such an expansion would have demanded had it been attempted by hand-mining methods, the USSR has given a high priority to the development of a coal mining equipment industry. Such an industry has, in fact, been established in the USSR as a Main Administration of Coal Machine Building under the All-Union Ministry of the Coal Industry.

The Soviet coal mining equipment industry has been built up to a point at which it now has more than 40 machinery building plants, scattered through the major Soviet industrial and coal mining areas. It is estimated that in 1951 these plants turned out almost 83,000 MT (see Table 50*) of the specialized types of coal mining equipment treated by this report.** To establish this industry, the USSR not only assigned to it plants and equipment but also allocated considerable engineering talent and capital goods (see Table 51***). Where applicable, designs developed and matured in the West were copied by the USSR. Differences in mining methods, however, forced the USSR to strike out on its own, especially in the development of coal combines and cutter-loaders which function as continuous and semicontinuous mining machines, respectively. Although this equipment is difficult to produce and the ability to build it satisfactorily is a good test of the potentiality of an industrial economy, the USSR has over the years established what might be termed a fairly mature coal mining equipment building industry.

The intent of the USSR has been to render itself independent of the West for coal mining equipment. This has been a long-run goal rather than one born of the current international crisis. In quantita-

* P. 233, above.

** That is, coal cutters, coal combines, cutter-loaders, coal and rock loaders, coal conveyors, and coal mine locomotives.

*** P. 235, above.

tive terms this goal has been achieved. The USSR is now capable of meeting its own needs for coal mining equipment. It should be able to produce, at 1952 output rates, sufficient equipment to expand its underground coal output by the 20 million MT per year necessary to meet the over-all plan to raise the annual output of coal mined to a level of 500 million MT by 1960. It has also become the chief supplier of coal mining equipment to the Satellites. Although it appears that at current production rates the USSR will be able to meet its own needs for expansion of coal mining and make a sizable contribution to the expansion of mining in the Satellites, the USSR's output is such that many hand operations will be only gradually replaced by mechanical methods.

Despite the difference in basic economic philosophies between the USSR and the US, priority has been given to the coal mining equipment industry because it is more efficient to assign labor and materials to the building of this apparatus than to continue to assign large quantities of labor to hand-mining methods. This differential in favor of mine mechanization also applies in particular to the new types of coal combines as against the older longwall coal cutters, because they not only mine more coal than regular coal cutters but also break the bottleneck of hand loading that has been in large part responsible for the low output per man in Continental coal mines.

Although the USSR has been able to meet its demands for coal mining equipment quantitatively, the equipment does not appear to be so durable as equivalent US equipment. Because of this factor, since longwall mining methods subject equipment to more continuous service than do US methods, and, perhaps, since the USSR operates its equipment harder than do US mines, Soviet coal mining equipment does not appear to last as long as US coal mining equipment. At present, maintenance and replacement problems afflict the Soviet mines and drain the facilities of the mining equipment industry, which could otherwise be devoted to the more rapid mechanization of existing mines. Although there is on foot a Soviet campaign to improve output per machine by better scheduling of work, there does not appear to be any strongly publicized effort to conserve the equipment itself.

Because the USSR is independent of the West for coal mining equipment, it is not directly handicapped in this area by Western economic warfare. Proscription of trading with the Satellites, however, has forced the USSR to undertake to supply their needs for coal mining equipment as well as its own. This is no doubt a drain on Soviet

resources as a whole and may have retarded the rate of mechanization in Soviet coal mines. Moreover, since the USSR builds its own coal mining equipment, it is also called upon to supply raw materials such as steel and finished components such as antifriction bearings, electric motors, and controls. The extent to which these are in short supply or in greater effective demand by the military needs of the USSR may act as a limiting factor on the productive capacity of its coal mining equipment industry. Insofar as economic warfare is concerned, continued economic pressure against these and other machinery components would appear to be an appropriate means of handicapping the ability of the USSR to meet its needs for coal mining equipment.

B. Vulnerabilities.

As the possessor of a fairly mature coal mining equipment industry, the USSR is now relatively invulnerable to direct economic warfare against the equipment needed by its coal mines. However, economic pressure on the Satellites forces them to turn to the USSR for assistance and thus tends to absorb Soviet productive capacity. In addition, the interdiction to the Soviet Bloc of items such as bearings, motors, and controls tends further to absorb Soviet energies and facilities.

In the event of a hot war, the alternative of aerial attack upon the coal mining equipment industry as compared with attack upon the coal mines should be considered. The mines themselves are widely dispersed, as compared with the equipment plants. Just as it may be appropriate to attack the power supply and transportation networks of the mines rather than individual mining installations, so it may be wise to include in such considerations whether or not it would be good use of resources to proceed against the mining machine building plants.

This report shows the coal mining equipment plants of the USSR to be more widely dispersed than they were before World War II, but not so widely dispersed or inaccessible as to render them out of consideration as practical targets. While the greatest concentration of plants is still in the Ukraine, duplicate plants were built in the Urals during World War II. Concentration of manufacturing still appears to be determined more by the complexity and bulk of the product rather than by military considerations of vulnerability to attack. Hard-to-build combines are now built on a series basis in only two or three plants, while the easier-to-build conveyors are being fabricated in whole or in part at almost two dozen plants widely scattered throughout

the country. Because of the dispersal of the industry as a whole in more than 40 plants, it represents a spread-out target. However, attacks against the two major coal cutter and combine plants, the two large mine locomotive plants, and the six loading machine plants would seriously handicap the capacity of the industry to build some of its most essential items.

The effect of successful attempts to cripple the coal mining equipment building industry would tend to be cumulative rather than immediate. Such an accomplishment would impede the important flow of spare parts as well as of new equipment. Measured against the experience of World War II, the USSR would be forced to retrogress in part to the use of pneumatic picks and the blasting of coal from the solid without undercutting. This would reduce total coal output and output per man and at the same time tend to increase the demand of the mines for labor. Such effects should begin to become evident within a few months of the reduction or termination of the flow of equipment to the mines.

In addition to considering the vulnerability of the coal mining equipment plants to attack, attention should be given to the dependence of these plants upon outside sources of supply. Alternative to the direct crippling of the coal mining equipment industry would be the possibility of attacks upon the basic steel industry, the nonferrous metals refineries, the manufacturers of electric motors, the producers of antifriction bearings, or the power supplies of the industrial areas. Major reductions of the supply of any or all of these items would seriously embarrass the coal mining equipment industry and soon interrupt the flow of mining equipment and repair parts to the coal mines.

C. Intentions.

1. Of the Soviet Coal Mining Equipment Industry.

The coal mining equipment industry of the USSR is essentially a service industry. As such, it is subsidiary to and managed by the Ministry of the Coal Industry. The objectives of the coal mining equipment industry are therefore subordinate to the objectives of the coal industry as a whole. The aim of the coal industry is to expand its operations with sufficient rapidity to keep pace with the growth of the Soviet industrial economy and at the same time operate in an economical manner. Despite the communistic

orientation of its economy, it is therefore obliged to make plans in terms of the allocation of scarce labor and capital goods in the over-all economy. The major objectives of the Soviet coal mining equipment industry may therefore be stated as follows: (a) to increase coal output as called for by the national plans, (b) to help increase the output per coal miner so as to release labor from the mines to other segments of the economy including military service, and (c) to increase the productivity of mining machines in order to conserve capital goods and make the fullest use of the productive capacity of the economy.

The basic long-run objectives of the Soviet coal mining equipment industry have therefore been to facilitate the expansion of coal output while at the same time improving the efficiency of the operation in terms of both men and equipment. To bring this about, not only has the industry sought to mechanize individual operations, such as coal cutting, loading, and transporting, but also it has succeeded in contriving in the form of the Donbas coal combine a practical continuous miner that cuts, breaks, and loads coal onto a conveyor as part of an integrated operation. Technically speaking, it is the intention of the USSR to devise more flexible variations of the Donbas combine, which will be suited to coal seams of varying heights. It is also the intention of the USSR to devise comparable combines for special mining conditions such as thick seams, thin seams, and steeply pitching seams. Experimental models of equipment designed to perform these functions are now being tried in the mines, and some models may already be in series production. Work has also been underway on a very much-needed combine, similar to US continuous coal miners but adapted to the cutting of both rock and coal in mine development operations.

2. Of the USSR as a Political Organization.

It is believed that to accomplish its announced plans for the increase of the output of coal, the USSR will continue to require large quantities of coal mining equipment during the next several years. Maintenance of its present inventory level alone requires a considerable production of machinery. The recently assumed obligation of assisting in the mechanization of Satellite coal mines adds to the total requirement for equipment. Although the USSR does not report annual production of coal mining equipment and although direct accounts of operations within the plants are scarce, current indica-

tions, judging from the reports of coal production, are that there has been no major conversion away from the production of coal mining equipment. The coal mining equipment industry has equipment and facilities, however, which can be readily converted to military production. Because of the urgent need for coal mining machinery both for rapid expansion of the Soviet civilian economy and for the long-range development of a strong industrial base for the military, partial conversion would appear to indicate a policy of short-term build-up for war in preference to the long-term development of the economy. Full conversion seems to be highly improbable because of the need for continued repair and replacement of coal mining equipment during any prolonged struggle. Full conversion would thus seem to indicate not only preparation for hostilities but also a gamble on a swift victory or, alternatively, desperate preparation for a last-ditch struggle.

Further decentralization, such as the moving of plants from the Ukraine to the Urals or the Kazakh, as occurred during the last war, would also be a serious indicator. Since the Ukraine is still the most important single coal mining area within the USSR, however, it is evidently believed to be economic to build coal mining equipment in that area.

In conclusion, it may be stated again that the USSR has assigned a high priority to the mechanization of coal mining because it believes that coal is important to its industrial expansion. Over the years it has built a domestic coal mining equipment industry, supplied it with numerous, well-equipped factories, and provided it with engineering talent. Copying from the West when it could and devising its own apparatus when its needs were unique, the USSR has built a domestic coal mining equipment industry adequate to its aim of mechanizing and expanding the mining of coal. As a result, the coal mines of the USSR are now independent of the West for mining equipment and hence immune to direct economic warfare. The USSR is subject, however, to this kind of pressure as inflicted on the Satellites, which it is also endeavoring to equip. Likewise, the interdicting of industrial components, such as motors and bearings, may lead to shortages in equipment needed by the coal mining equipment building industry.

If self-sufficient for coal mining equipment, the USSR is nevertheless vulnerable in the event of a hot war to direct attack

on its major coal mining equipment plants or the plants that supply them with raw materials, power, and finished components. Because coal mining equipment has a high priority in the USSR, further dispersal of plants or cutbacks in production should be regarded as of grave import. If such moves have occurred, however, the facts have been closely guarded.

APPENDIX A

KEY PERSONNEL OF THE SOVIET COAL MINING EQUIPMENT INDUSTRY

The Minister of the Coal Industry is Aleksandr Fedorovich Zasyad'ko, a Ukrainian, who was born in the Donbas coal mining region. Zasyad'ko is a mining engineer and a Communist. Since 1939 he has held numerous administrative positions in the Ministry or its predecessor organizations. He became Minister of the Coal Industry of the Western Regions in January 1947 and assumed his present position on the merger of the eastern and western ministries in December 1948. He received the Order of Lenin as early as 1940 for bringing about an increase in coal output. He is credited with restoration of the war-ruined and flooded Donbas, the largest coal-producing basin in the USSR. As Minister he has encouraged the completion of mechanization, the development of coal combines, together with the 24-hour-cycle schedule and other methods of improving mine efficiency and output. 511/

Zasyad'ko is assisted by numerous deputy ministers. Of them, Georgiy Vladimirovich Krasnikovskiy is of interest as having held the position of the editor in chief of Ugol' (Coal), the monthly technical journal of the industry, since at least 1949. He has also been Chief of the Technical Administration (Glavtekhnika) of the Ministry. 512/

Another of the deputy ministers with a background in mining machine building is Nikolay Aleksandrovich Krylovskiy, an engineer, who was formerly Chief of the Main Administration of Coal Machine Building of the Western Regions. He is also a member of the Collegium of the Ministry. Krylovskiy shared the 1948 Stalin prize for the creation of the Donbas coal combine. 513/

Another leading deputy minister is Dmitriy Grigor'yevich Onika, descendant of a mining family, who was trained at the Moscow Institute of Mining Engineering. After many years as a consulting engineer and administrator in the coal industry, he became Minister of the Coal Industry of the Eastern Regions in 1947. Following the consolidation of the two ministries in the next year, Onika was made first deputy minister for general affairs. Onika has been cited several times for his inventions, but in recent years he has given more attention to public relations. Author of several articles on the status of the

industry in Ugol', he was spokesman in 1950 at the annual Miners' Day celebration, which traditionally occurs toward the end of August. 514/

Giprouglemash is directed by a mechanical engineer, Aleksey Vasil'yevich Topchiyev.*515/ As an engineer with Giprouglemash, Topchiyev shared a Stalin prize in 1945 for his share in making improvements in open-pit mining that yielded increases in labor productivity and coal production. 516/ He again shared a Stalin prize in 1948 for helping to design the VMTS-1 cutter-loader and for introducing this machine into the Donbas coal mines. 517/ In 1949 he wrote an article entitled "New Machines in the Donets and Moscow Coal Basins" in a leading Soviet technical periodical. 518/ In 1950 he headed a team of engineers that designed the new KKP-1 coal combine for the mechanization of steeply pitching coal seams. 519/**

Before the consolidation of the Eastern and Western Giprouglemash organizations, Aleksandr Kalinovich Serdyuk was chief of the SKB, or Machinery Designers' Bureau, of Giprouglemash of the West. Serdyuk, who has also designed coal cutters and combines in his own right, shared with Semen Semenovich Makarov, chief of the SKB of Giprouglemash of the East, a 1947 Stalin prize for the design and production of the Makarov combine for cutting, breaking up, and loading coal on conveyors from longwall faces. 522/

Although the two Giprouglemash organizations were united in 1948, the new combined institute has its regional affiliates. One such, located at Leningrad, is headed by A.G. Smirnov as director. 523/ Another affiliate, located in the Donbas, is under the directorship of Aleksandr Il'yich Bashkov. 524/ Bashkov shared a Stalin prize in 1948 for his part in the design and development of the Donbas combine. 525/

* Not to be confused with the Academician of the same name, a leading organic chemist and petroleum expert.
** The chief engineer of Giprouglemash has not been identified. Boris Filippovich Aleksandrov is a deputy chief engineer. 520/ While chief designer of the former Giprouglemash of the West, he shared a Stalin prize in 1947 for his work in the pumping out of the flooded Donbas mines. 521/

Available information does not permit the complete reconstruction of the internal organization and personnel of Giprouglemash. Certain of its engineers who are known to have specialized in the design of particular types of coal mining machinery may nevertheless be identified. Recognition for the creation of the celebrated Donbas combine, which may be regarded as the first really successful Soviet coal combine, was granted not only to A.I. Bashkov, as already indicated, but also to Aleksandr Davidovich Sukach, who directed the operation as a member of the Donbas affiliate of Giprouglemash, and to Vladimir Nikitin Khorin, engineer at Giprouglemash, aided by Maksim Fedorovich Gorshkov and Nikolay Aleksandrovich Krylovskiy, both engineers being directly affiliated with the Ministry of the Coal Industry. Credit was also shared for this achievement by the director of the Gorlovka Coal Mining Equipment Plant imeni S.M. Kirov and by an engineer of the coal trust at which the machine was first tried. 526/ This suggests that close collaboration is maintained among various branches and levels of administrative, research, and operating organizations, insofar as the design and development of new equipment is concerned.*

After the war the USSR systematically shifted its mines from the use of shaker, or reciprocating trough, conveyors to chain, or scraper, conveyors for underground transport. For significant work in the improvement of scraper conveyors, Nikolay Deomidovich Samoylyuk, then Chief of the Machinery Designers' Bureau of Giprouglemash of the West, received a Stalin prize in 1946. Collaborators with him were Suren Khorenovich Klorik'yan, chief designer for Giprouglemash of the East, together with Flor Grigor'yevich Savlukov, designer for the Podmoskovnyy Scientific Research Coal Institute of Giprouglemash of the West, and Aleksandr Anisimovich Spivakovskiy, corresponding member of the Academy of Sciences of the USSR and professor of the Moscow Mining Institute imeni I.V. Stalin. 528/

For the development of a coal-loading machine to be used in the sinking of vertical mine shafts, Yakov Ivanovich Balbachan, head of the Technical Administration of Construction of the Ministry of the Coal

* S.S. Makarov's award for the design of the combine that bears his name has already been mentioned, together with the name of A.K. Serdyuk. They shared honors with Mikhail Vinofeyevich Kolentsev, chief designer, and Paul Pavlovich Denisov, group chief of the SKB, both of Giprouglemash of the East. 527/

Industry, aided by other mine construction experts, received a Stalin prize in 1949. 529/

Improvements in mine cages for the elevating of men and equipment have also received considerable attention in the USSR in recent years. Specialists in this area are Mikhail Kuz'mich Galushko, head of the mine transport station, Makeyevka Scientific Research Institute for Work Safety in the Mining Industry, who has collaborated with Ivan Andreyevich Arbemanskiy, director of the same institute, and Nikolay Aleksandrovich Magnitskiy, engineer of the Donets Affiliate of Giprouglemash. This team designed a car to permit the mechanization of the raising and lowering of miners in sloping mine workings, for which they received a Stalin prize in 1949. 530/

Blatant as is the disregard for life, safety, and human welfare in the USSR, some interest has been shown in mine safety to the extent of designing explosion-proof electrical equipment for use in mines. Abram Markovich Kotlyarskiy, deputy director of the Makeyevka Scientific Research Institute; Petr Fedorovich Kovalev, station chief of the same institute; Vladimir Sergeyevich Kravchenko, senior scientific associate of the Institute of Mining of the Academy of Sciences of the USSR; and Vladimir Konstantinovich Skurat, department chief of the State Main Mining Engineering Inspection Ministry of the Coal Industry, aided by various plant engineers and officials, cooperated in the development of explosion-proof electrical equipment for coal mines, for which each of them received a Stalin prize in 1950. 531/

APPENDIX B

COAL MINING EQUIPMENT PLANTS IN THE USSR BY ECONOMIC REGION

Region I

Leningrad

50X1-HUM

*Pnevmatika Mining Equipment Plant
**Gosudarstvennyy Zavod Pnevmaticheskikh Mashin "Pnevmatika
***State Factory of Pneumatic Machinery "Pneumatics"

Region III

50X1-HUM

Barvenkovo

Krasnyy Luch Mining Equipment Plant
"Red Light" or "Red Ray" Machine Factory

Brianka

Brianka Mining Equipment Repair Plant

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* Working name used in text.
** Soviet name.
*** Literal translation (translation not given when it is the same as the working name).
**** World Aeronautical Chart Numbers.
***** Product Code:

1. Cutters or Combines
2. Coal Loaders
3. Conveyors
4. Locomotives
5. Cars
6. Pumps or Ventilators
7. Drills, Compressors, or Picks
8. Processing Equipment
9. Miscellaneous

Appendix B (Continued)

Region III (Continued)

Druzhkovka 0234

50X1-HUM

Toretsk Mining Equipment Plant imeni Voroshilov
Toretskiy Gorno Mekhanicheskiy Zavod imeni Voroshilova

Gorlovka

Gorlovka Mining Equipment Plant
Gorlovskiy Mashinostroitel'nyy Zavod imeni Kirova
Gorlovka Machine Construction Plant imeni Kirov

Khar'kov

Svet Shakhtera Mining Equipment Plant
Khar'khovskiy Ordena Lenina Mashinostroitel'nyy Zavod "Svet Shakhtera"
Khar'kov Order of Lenin Machine Building Plant "Miners' Light"

Konotop

50X1-HUM

Krasnyy Metallist Electrical Plant
Konotopskiy Zavod "Krasnyy Metallist"
Konotop Red Metallist Plant

Krivoi Rog

Kommunist Mining Equipment Plant
Krivorozhskiy Kommunisticheskiy Zavod Gororudnogo Oborudovaniy
Krivoi Rog Kommunist Mining Equipment Factory

Kramatorsk

50X1-HUM

Novo Kramatorsk Heavy Machine Building Plant (NKMZ)
Novo Kramatorskiy Zavod Tyazhelogo Mashinostroyeniya imeni Stalina

Appendix B (Continued)

Region III (Continued)

Rutchenkovo

15 Years of the Komsomol of the Ukraine Mining Equipment Plant
Mashinostroitel'nyy Zavod 15-Letiya Leninskoy Kommunisticheskoy Molodezhi Ukrainy
15th Anniversary of the Lenin Communist Youth Union of the Ukraine Machine Building Plant

Sergo-Kadiyevka

Sergo-Kadiyevka Mining Equipment Repair Plant
Rudoremontnyy Zavod
Repair Plant

Stalino

Stal'most Steel Construction Plant

Voroshilovgrad

Voroshilovgrad Mining Equipment Plant
Voroshilovgradskiy Mashinostroitel'nyy Zavod imeni Parkhomenko
Voroshilovgrad Machine Building Plant imeni Parkhomenko

Region IV

Novocherkassk

Novocherkassk Mining Equipment Repair Plant imeni Nikol'sk
Rudoremontnyy Zavod imeni Nikol'skogo
Nikol'sk Repair Plant

Shakhty

Shakhty Mining Equipment Repair Plant

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Appendix B (Continued)

Region V

50X1-HUM

Kutaisi

Gornyak Mining Equipment Plant
Zavod Ugol'nogo Mashinostroyeniya "Gornyak"
Coal Mining Machinery Plant, "The Miner"

Yerevan

Yerevan Mining Equipment Factory

Region VII

Electrostal'

Electrostal' Machine Building Plant
Novo Kramatorskiy Mashinostroitel'nyy Zavod imeni Stali
Novo Kramatorsk Machine Building Plant imeni Stalin

Laptevo

Laptevo Mining Equipment Plant

Moscow

Moscow Dynamo Electric Plant
Moskovskiy Ordena Lenina i Ordena Trudovogo Krasnogo Znameni Zavod Dinamo imeni Kirova
Moscow Order of Lenin and Order of Labor Red Banner Dynamo Works imeni Kirov

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Rudovka

Rudovka Mining Equipment Plant

Skopin

Skopin Mining Equipment Repair Plant
Skopinskiy Rudoremontnyy Zavod
Skopin Mining Machinery Repair Plant

Appendix B (Continued)

Region VII (Continued)

50X1-HUM

Tula

Batishchev Mining Equipment Plant

Tula

Tula Machine Building Plant
Tul'skiy Mashinostroitel'nyy Zavod

Uzlovaya

Uzlovaya Mining Equipment Plant

Region VIII

Karpinsk

Karpinsk Coal Mining Equipment Plant

Kizel

Kizel Mining Equipment Plant
Kizel Gornyy Zavod
Kizel Mining Plant

Kopeysk

Kopeysk Mining Equipment Plant
Kopeyskiy Zavod Gornorudnogo Oborudovaniya imeni Kirova
Kopeysk Mining Machine Plant imeni Kirov

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Kopi (Formerly Aleksandrovsk)

Aleksandrovsk Mining Equipment Plant imeni Voroshilov
Aleksandrovskiy Mashinostroitel'nyy Zavod imeni Voroshilov

Nev'yansk

Nev'yansk Armament Plant

Appendix B (Continued)

Region VIII (Continued)

50X1-HUM

Sverdlovsk

Sverdlovsk Transport Machinery Plant
Sverdlovskiy Zavod Transportnogo Mashinostroyeniya

Region IX

Anzhero-Sudzhensk

Anzhero-Sudzhensk Mining Equipment Repair Plant, "Svet Shaktera"
Anzherskiy Rudoremontnyy Zavod "Svet Shaktera"
Anzhero Repair Plant, Svet Shakhtera

Kiselevsk

Kiselevsk Coal Mining Equipment Plant (UMZ)
Kiselevskiy Mashinostroitel'nyy Zavod
Kiselevsk Machine Building Plant

Omsk

Voroshilov Tank and Locomotive Combine

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Mashinostroitel'nyy Zavod imeni Voroshilova
Machine Building Plant imeni Voroshilov

Prokop'yevsk

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Prokop'yevsk Mining Equipment Plant
Prokop'yevskiy Zavod Gornogo Oborudovaniya

Stalinsk

Kuznets Mining Equipment Plant

Appendix B (Continued)

Region IX (Continued)

50X1-HUM

Tomsk

Tomsk Electromechanical Plant imeni V.V. Vakhrushev (TEMZ)
Tomskiy Elektro Mekhanicheskiy Zavod imeni V.V. Vakhrusheva

Region X

Alma-Ata

Alma-Ata Heavy Machine Building Plant
Alma Atinskiy Zavod Tyazhelogo Mashinostroyeniya

Karaganda

Karaganda Mining Equipment Plant imeni Parkhomenko (KZP)
Karaganda Zavod Ugol'nogo Mashinostroyeniya imeni Parkhomenko

Tashkent

Tashkent Mining Equipment Plant imeni Ilyich
Tashkent Zavod Gorno Mekhanicheskogo Oborudovaniya imeni Ilyicha

Region XI

50X1-HUM

Cheremkovo

Cheremkovo Mining Equipment Plant imeni Karl Marx
Cheremkhovskiy Zavod imeni Karla Marksa
Cheremkovo Plant imeni Karl Mark

Appendix B (Continued)

Region XI (Continued)

Krasnoyarsk

Voroshilov Arms Plant [redacted] 50X1-HUM

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Region XII

Vladivostok

Primorskiy Metallist Mining Equipment Plant [redacted]

Table 52

Estimated Facilities Needed by the Soviet Coal Mining Equipment Industry
1951

Item	Coal Combine and Cutter Plant a/*	Loader Plant	Conveyor Plant	Locomotive Plant	Total
Total Finished Output including Repair Parts (MT)	8,115	6,258	53,663	14,655	82,691
Total Machine Tools Needed (Units)	119	100	770	210	1,199
Cold Saws	1	0	7	0	
Lapping Machines	3	0	4	0	
Lathes	29	25	178	54	
Milling Machines	15	11	87	23	
Grinding Machines	24	20	154	43	
Drill Presses	14	14	90	26	
Boring Mills	5	3	26	6	
Broaching Machines	1	1	7	4	
Gear Cutters	8	5	25	13	
Bending Machines	1	1	0	1	
Bending Rolls	1	1	0	2	
Key Seating Machines	1	1	0	3	
Screw Cutting Machines	1	2	18	9	
Planers	1	1	7	3	
Presses	8	8	43	14	
Shears	3	3	17	5	
Shapers	3	3	18	4	

* Footnotes for Table 52 follow on p. 261.

Table 52

Estimated Facilities Needed by the Soviet Coal Mining Equipment Industry
1951
(Continued)

Item	Coal Combine and Cutter Plant a/	Loader Plant	Conveyor Plant	Locomotive Plant	Total
Total Machine Tools Needed (Units) (Continued)					
Punches	0	1	0	0	
Hobbing Machines	0	0	12	0	
Slotters	0	0	14	0	
Forge Presses	0	0	14	0	
Drop Hammers	0	0	4	0	
Heat Treating Furnaces	0	0	14	0	
Welders	15	14	97	27	153
Acetylene Cutters	1	0	0	1	2
Miscellaneous Machine Tools	0	0	31	0	0
Overhead Traveling Cranes	6	5	22	9	42
Jib Cranes	50	36	300	75	461
Cupolas	2 b/	1 b/	2 c/	2 b/	7
Air Compressors	1 d/	1 d/	2 e/	1 f/	5
Positive Blowers	2 g/	1 g/	2 h/	2 g/	7

Table 52

Estimated Facilities Needed by the Soviet Coal Mining Equipment Industry
1951
(Continued)

a. Working two shifts, 6 days.
b. Capacity of each 10 tons per hour.
c. Capacity of each 20 tons per hour.
d. Each driven by 100-hp motor, capacity 1,000 cu ft free air per minute, at 100 lbs pressure.
e. Each driven by 400-hp motor, capacity 7,000 cu ft free air per minute, at 100 lbs pressure.
f. Each driven by 200-hp motor, capacity 2,000 cu ft free air per minute, at 100 lbs pressure.
g. Positive blowers, each driven by 25-hp motor.
h. Positive blowers, each driven by 50-hp motor.

Table 53

Estimated Coal Requirements of the Soviet Coal Mining Equipment Industry a/
1951

	1	2	3	4	5	6	7	8	9
							Coal Required		
	Finished Weight						At 5.7 Short Tons per 10,000 Cu Ft		
Item	(MT)	(Short Tons) (Col. 1 ÷ 0.907)	Output per Mo (Col. 2 ÷ 12)	Area (Sq Ft per Short Ton per Mo) (Col. 3 x 280)	Area per Shift (Sq Ft) (Col. 4 ÷ 2)	Cu Ft (Col. 5 x 40)	(Col. 7 ÷ 10,000)	(Col. 7 x 5.7)	Total in Soviet Standard Fuel (MT) (Col. 7 x 13,000 ÷ 12,600)
Cutters	8,115	8,947	746	208,880	104,440	4,177,600	417.8	2,381	2,456
Loaders	6,258	6,900	575	161,000	80,500	3,220,000	322.0	1,835	1,893
Conveyors	53,663	59,165	4,930	1,380,400	690,200	27,608,000	2,760.8	15,737	16,237
Locomotives	14,655	16,158	1,347	377,160	188,580	7,543,200	754.3	4,300	4,437
Total	82,961	91,170	7,598	2,127,400	1,063,720	42,548,800	4,254.9	24,253	25,023

a. For space heating.

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Figure 16

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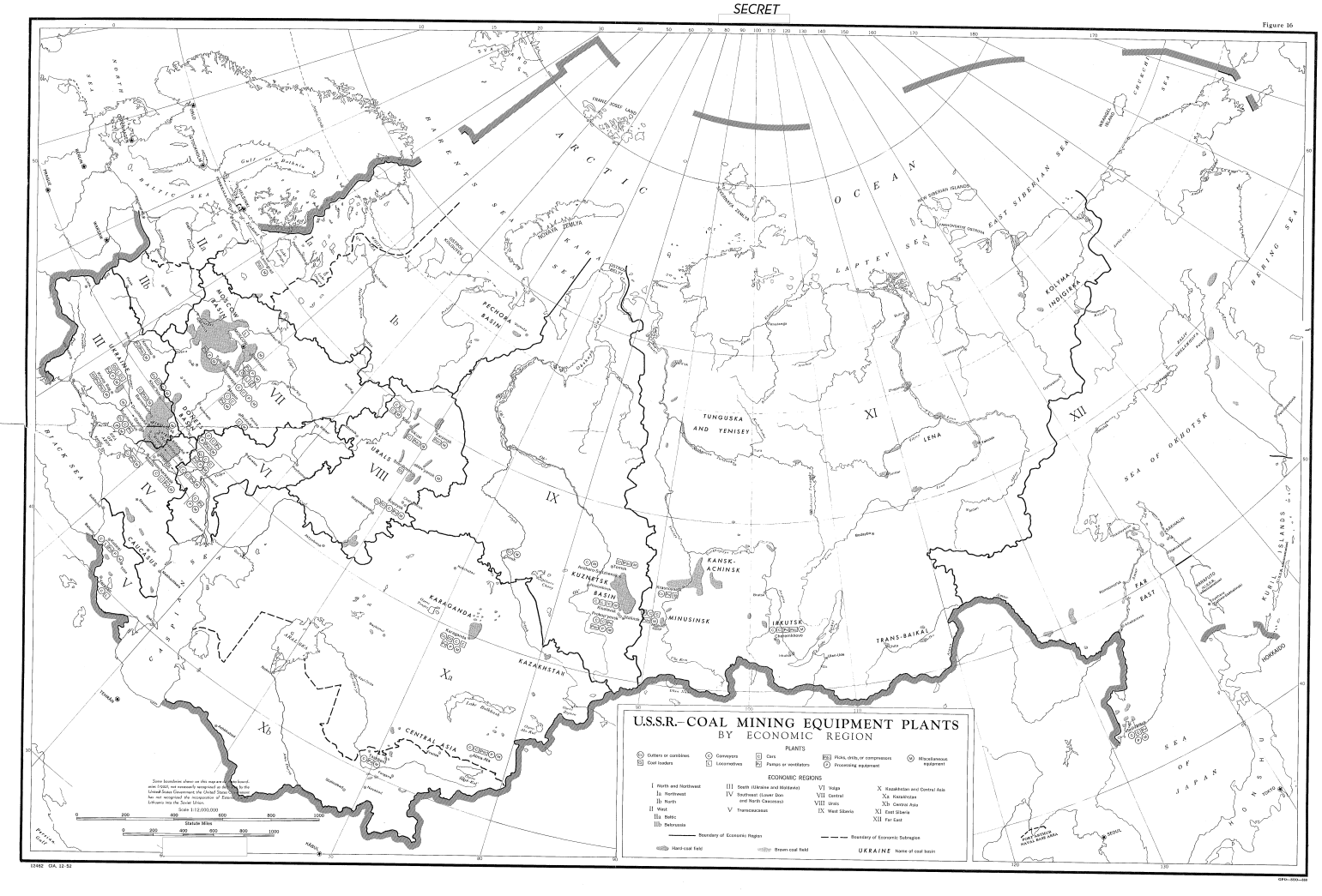

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