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RESEARCH AID 20

BEADWIRE IN THE SOVIET BLOC

(ORR Project 22.167)
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CENTRAL INTELLIGENCE AGENCY

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BEADWIRE IN THE SOVIET BLOC*

Summary

All Soviet Bloc countries, with the exception of Albania and Bulgaria, have facilities to produce high-tensile steel wire. The high-tensile steel wire used for tire reinforcing and known industrially as beadwire is produced in sufficient quantities to meet Soviet Bloc tire requirements.

The Soviet Bloc consumed an estimated 21,679 tons** of beadwire in 1953, and in 1954 will consume an estimated 23,231 tons. Although there are both surplus and deficit areas in the Soviet Bloc beadwire economy, the Bloc as a whole is self-sufficient in this commodity. The USSR, Hungary, Czechoslovakia, Poland, and Rumania are capable of producing enough beadwire for their own needs. East Germany is capable of fulfilling only 50 percent of its beadwire requirements. Bulgaria is entirely dependent on imports for beadwire, and Albania has no beadwire requirements.

The quality of Soviet Bloc beadwire, as determined by analyses described below, equals that of US beadwire, although the technology of its production varies slightly. For example, samples of beadwire manufactured in the USSR are not bronze or brass-plated as is the case in the Free World.

The Soviet Bloc has no apparent vulnerabilities affecting the production of beadwire. Beadwire requirements made upon the steel industry are so small that ample allocation can undoubtedly be made. Furthermore, since there has been to date no practical substitute for high-tensile steel wires for reinforcing tires, the allocations to tire plants for this type of wire receive a high priority. Because of the small demand that the tire industry makes upon the steel industry and because of the strategic importance of beadwire

* The estimates and conclusions contained in this research aid represent the best judgment of the responsible analyst as of 30 June 1954.
** Throughout this research aid, tonnages are given in metric tons.

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in both a military and a peacetime economy, wire plants in the Soviet Bloc are assured the raw materials, equipment, and skilled manpower required for the production of beadwire.

It is not believed that any shortage of steel within the Bloc would curtail the production of motor vehicle tires.*

I. Introduction.

Beadwire is that component element of any motor vehicle tire which is used as a reinforcing agent to secure the tire to the rim of the wheel. Beadwire is twisted** wire and appears as rubber-impregnated, fabric-covered cables made of carbon steel.

These wire bead cores vary in diameter with the over-all cable (number of wires), the diameter of the individual strand, and the tensile strength in pounds per square inch (psi), depending on the size and use of the tire. These weigh approximately 2.5 to 5 percent of the weight of the tire. 1/*** The largest percentage in this ratio is found in twin-bead tires -- that is, heavy truck and airplane tires.

The proper beading of a tire helps to insure tire longevity. Since a well-constructed truck tire carcass may be recapped as many as three times, it is essential that beadwire quality be adequate. 2/

II. Production and Consumption.

A. USSR.

There are 13 tire combines in the USSR. They are located in Dnepropetrovsk, Kazan', Kirov, Leningrad, Lopasnaya, Moscow,

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* Throughout this research aid, the term motor vehicle tires includes airplane, automobile, and off-the-road tires.

** The "beads" or "knots" which appear when the steel wires are twisted together give beadwire its name. These "beads" give the wire better adhesive properties.

*** Footnote references in arabic numerals are to sources listed in Appendix E.

Omsk, Riga, Sverdlovsk Uktus, Ulyanovsk, Voronezh, Yaroslavl', and Yerevan. 3/ The estimated production of these plants in 1953 was about 11 million sets* of tires. 4/ Using the maximum average weight of beadwire as described in Appendix C, the estimated 1953 beadwire consumption in the USSR was 17,400 tons, and it is estimated that 1954 consumption will be 18,500 tons.

Beadwire cannot be stockpiled as are various other components of the tire; hence it is either immediately delivered to the assembly line or stored on barbed rods in such a manner that each cable will have no contact with another cable.

Steel wire is usually beaded in installations which are located in the tire plants themselves or in a part of the rubber combines. This is done because the beaded cables cannot be readily transported. Therefore, these cables must be stored either in the tire assembly plant itself or in a shop in its immediate vicinity.

There is no available information accurately indicating which wire plants in the USSR produce wire for beading. Plants which presumably produce wire suitable for tires also produce wire for other applications, such as for high-pressure hoses, industrial belting, and musical instruments.

Plants producing wire suitable for tire-reinforcing purposes and located in near proximity to the tire combines are listed as follows:

Dnepropetrovsk
Komintern Steel Combine, Petrovski Metallurgical Plant, Nizhnedneprovsk Wire and Nail Plant. (Region III)

Kazan'
Kutschu AC Acces Plant. (Region VI)

Leningrad
Krasnyy Gvozdilshchik, Sevkable Cable Factory. (Region I)

* A "set" is one tire and one tube.

Moscow
Moskable Cable Factory, Stalin MV Plant, S. I. Molotov Steel Plant. (Region VII)

Sverdlovsk
Verkhniye Sergi Nail Plant. 5/ (Region VIII)

Soviet motor vehicle tires which have been analyzed have been found to contain wires with diameters ranging from 0.46 mm to 1.02 mm. 6/ For this reason, any high-tensile steel wire with a diameter of over 0.46 mm may be considered usable by the Soviet tire industry.

B. Albania.

Albania has neither the facilities to produce steel wire nor a motor vehicle tire industry. 7/

C. Bulgaria.

Tires are produced at the Georgi Dimitrov Tire Factory in Sofia. 8/ Bulgaria, however, has no wire-producing plant and is dependent upon imports for requirements. It is estimated that 90,000 sets of tires were produced in the factory in 1953. 9/ Using the average for beadwire of 3.75 percent of the weight of the tires, 107 tons of wire were required. The 1954 tire production is estimated at 102,000 sets, 10/ for which 121 tons of beadwire will be required.

D. Czechoslovakia.

Information available indicates that in Czechoslovakia there is no shortage of wire for beading great enough to hamper the manufacture of tires. Before 1950, Czechoslovakia not only produced its own beadwire but also exported large quantities to East Germany. 11/

The Matador Rubber Plant in Petrzalka received approximately 1 railroad car of steel wire (25 tons) monthly. It was packed on reels, each weighing about 50 kg. The wire came from the Coburg Wire Products Factory at Trnava, Czechoslovakia, and was 2, 4, and 6 centimeters in diameter. 12/ The wire was then processed and beaded at the Matador Rubber Plant.

With an estimated production of 1,860,000 motor vehicle tires for the year 1953, 13/ Czechoslovakia consumed 2,211 tons of beadwire at the average weight of 3.75 percent beadwire per tire. With a tire production estimated at 2 million sets in 1954, 14/ consumption of beadwire will be 2,378 tons.

E. East Germany.

Sources indicate that East Germany produces approximately 50 percent of its beadwire requirements and is dependent upon imports for the balance of its needs. 15/ From November 1952 to March 1953, East Germany received from the USSR 391 tons of steel wire which could be used for beading. 16/ Motor vehicle tire production for the year 1953, in East Germany, was estimated at 880,000 sets. 17/ Requirements for this amount would be 1,046 tons of beadwire. (See Appendix E.) Using this same method, 1,184 tons of beadwire will be required for 1954 production.

Available information, however, indicates that there is still an over-all shortage of steel wire in East Germany. In order to help alleviate this shortage, a project for making tire beads (Rundstahlwuste) from 10-mm steel rods has been in progress since 1950 at the Reifenwerk Furstenwalde in Heidenau. 18/

Experiments are being made here with a high-grade type of steel, and as of December 1953, 9,600 beads had been produced for truck tires which were then turned over to consumers with special instructions for use. Only one tire had been returned because of breakage (loosening of the welded seams). The oldest tire, tested on company-owned trucks, had already run over 40,000 km. The purpose of these experiments was to develop a bead in case the import of materials should stop entirely. 19/

F. Hungary.

Hungary's requirements for wire for beading are produced in the small wire shop of the Ruggyanta Rubber Products Plant in Budapest. Copper-coated wire for beading is made there. The necessary wire and fabric are adequately supplied by industrial plants. 20/

Estimated tire production for Hungary for the year 1953 was 250,000 sets. 21/ Estimated production of beadwire to fulfill this requirement was 297 tons. Estimates for 1954 show that Hungary will require 336 tons of beadwire.

G. Poland.

Poland has an adequate production of wire for beading. In 1950, approximately 55,000 tons of wire under 8 mm in diameter were produced at the Kosciuszko Iron and Steel Works at Chorzow, 22/ and the wire mill at Novy Bytom produces approximately 7,000 tons of wire per year. 23/

Estimated motor vehicle tire production in Poland for the year 1953 was 360,000 sets. 24/ Estimating the average amount of beadwire required for this figure, 428 tons of wire for beading was consumed. With an estimated production of 410,000 motor vehicle tires in 1954, 25/ 487 tons of beadwire will be required.

H. Rumania.

No information is available concerning the production of beadwire in Rumania. Wire which could be used in tires is manufactured at the Industria Metalurgica Danubia in Braila. This plant employs 1,800 skilled workers on a 24-hour-a-day schedule, produces finished iron and brass wire, and is equipped for the manufacture of wire for beading. 26/

With an estimated tire production of 135,000 sets of motor vehicle tires for the year 1953, 27/ the average weight of beadwire required (3.75 percent) was 160 tons. With an estimated production of 152,000 motor vehicle tires for the year 1954, 28/ 181 tons of beadwire will be required.

I. Summary of Consumption.

Estimated consumption of beadwire in the USSR and the European Satellites, 1953-54, is shown in Table 1.*

III. Trade.

Imports of steel wire and steel rods which could be processed into wire are the strongest indication that a wire shortage exists within the Soviet Bloc.** Shipments from Western countries to the

* Table 1 follows on p. 7.
** Discussion of steel wire shortage does not imply shortage of beadwire in the USSR.

Table 1

Estimated Consumption of Beadwire in the USSR and the European Satellites
1953-54

Metric Tons

Year	USSR	Albania	Bulgaria	Czechoslovakia	East Germany	Hungary	Poland	Rumania	Total
1953	17,430	0	107	2,211	1,046	297	428	160	21,679
1954	18,544	0	121	2,378	1,184	336	487	181	23,231

Bloc for 1953 indicate that Hungary received the greatest amount of steel wire (principally of alloy steel or high-grade carbon steel). The other Bloc recipients, in order of quantities of steel wire received from the West, are East Germany, Rumania, the USSR, Czechoslovakia, Bulgaria, and Poland. Large shipments of steel wire to Hungary confirm the statement of a recent defector who indicated that a shortage of high-grade carbon steel exists in that country. 29/ East Germany, which received the second largest shipment from the West, also has a serious steel wire shortage resulting from a decrease of shipments from Czechoslovakia in 1950 30/ and a lack of raw materials.

Intra-Soviet Bloc shipments further indicate shortages and focus these shortages on individual countries. East Germany received a minimum of 6,240 tons 31/ of steel wire from the USSR in 1953. Had this amount been used solely for beadwire in tires, this steel wire would have been a sufficient stockpile, considering increased rates in tire production, for at least 4 years. Since, however, there are many industrial uses for wire, complete allocation to the tire industry was impossible.

APPENDIX A

MANUFACTURING METHODS AND TECHNOLOGY

Technology in the manufacture of beadwire is essentially the same the world over, although some manufacturing methods may vary slightly. Individual wires for the production of beadwire are made by drawing steel rods through dies. This is done on a machine called a wire-drawing frame. The frame consists of a long table-like arrangement called the bench, a set of powered spools called blocks, the die holders, and the dies themselves.

To start a length of rod or wire through the dies, the rod is sharpened to a point and then is threaded through the die (sometimes with the help of a powered drawbar) and hooked up to the block. A horizontal shaft running through the bench supplies power to turn the block. As it turns, the block pulls the rod through the die, reducing its diameter and winding it on a coil for subsequent finishing operations.

The wire drawer checks the diameter of the wire and inspects it for any surface defects. Previously, frames could do only single-draft drawing -- that is, they could make only one reduction at a time and if wire had to be reduced several times, the operation had to be repeated each time. Many mills now have replaced wire-drawing frames with continuous drawing machines which pull a length of rod through a series of successively smaller dies in one operation. 34/

At this stage the wire is rolled on spools weighing 50 to 100 kilograms and is shipped to tire factories, where it is then wound into rings or beads. Unlike tire cord, wire is beaded solely in the tire manufacturing plant.

Wire designed for use in rubber products includes flat wire braid, Pierce tape, tubular wire braid, and fine wire rope. Flat wire braid is manufactured which consists of an odd number of wires interwoven to produce a flexible reinforcing member for use in rubber and plastic products, including tire beads. The flexibility of this braid permits it to withstand great abuse, and the interstices in the braid offer a mechanical adhesion that gives a greater safety factor in tires and high-pressure hose. Flat braids of standard

size are composed of 9, 13, 17, or 21 strands of wire in a "plain" weave. The wire diameter, the tensile strength, and the finish can be varied over a wide range to produce a construction which meets the requirements of individual specifications. A variation is the expanded braid, which has large-mesh openings for increased adhesion of the rubber. Flat braid is produced in continuous lengths and with finished edges.

Pierce tape is composed of a number of warp wires through which a weft or filler wire of finer gauge is woven. It is widely used as a tire bead reinforcement and as the load-carrying element in high-pressure tires. The individual wire lengths are equalized in the weaving process to give even distribution of tensile load. In tire bead building, the tape is wound in layers to provide a compact bundle and a stable group of reinforcing wires. The bulk of the tape used by the rubber industry utilizes warp strands 0.037 or 0.043 inch in diameter, with the number of parallel wires varied to meet a specific requirement. The tape is furnished with either a bronze plate or a zinc-brass finish to promote rubber adhesion. Tensile strength in a bead can be increased without increasing the diameter by the use of a weftless bundle consisting of larger diameter wires. Other finishes and wires other than steel can also be used. 35/

APPENDIX B

ANALYSES OF AVAILABLE SOVIET BLOC BEADWIRE

Two wire beads, an inside and an outside bead, were employed in the construction of each flange (rim) of the tire casing in two Soviet truck tires examined. Each bead contained nonplated wires of two gauges, 0.46-mm (millimeters) and 0.97-mm diameter, made of good-quality, cold-rolled, medium-carbon steel. In US practice, only the heavier wire is used. The 253,000 psi (pounds per square inch) tensile strength of the heavier Soviet wire compares favorably with the strength of beadwire used in the US. Apparently, the USSR has used the finer wire to hold the heavier wire in place during fabrication, since only one 0.46-mm wire was used to about every 8 of the 0.97-mm wires. The wires in US beads are usually more uniformly spaced than were those in the Soviet bead. The use of the fine wire and the random placement of the heavier wires may indicate that the USSR was experiencing some difficulty in bead construction when this particular tire casing was fabricated. This type of bead construction is known as Pierce tape (see Appendix A) and was abandoned by Goodyear several years ago because of the high cost of processing.

The outside bead contained 38 wires of 0.97-mm diameter and 5 wires of 0.46-mm diameter. The inside bead contained 48 wires of 1.97-mm diameter and 6 wires of 0.46-mm diameter.

Two different sizes of wire, 0.97 mm and 0.46 mm in diameter, from the inner and outer beads of the tire casing were examined for quality. The wires were not plated. In US practice, brass or bronze is sometimes employed as plating material for beadwires. Spectrographic analysis showed that both sizes of wire were made of plain carbon steel. Metallographic examination revealed that the steel was of medium carbon content (about 0.40 to 0.60 percent carbon). The steel was of good quality, showing very few nonmetallic inclusions. Both sizes of wire had been drastically cold-worked. This process, without proper annealing, increases brittleness. The 0.97-mm diameter wire showed evidence of more cold work than did the 0.46-mm diameter wire.

Vickers hardness and tensile tests on the two sizes of wire showed the following:

Diameter (mm)	Vickers Hardness Number	Bead Estimated Tensile Strength (psi)	Actual Tensile Strength per Wire
0.46	473	223,000	
0.97	534	252,000	253,000

The 0.46-diameter wire was too distorted and twisted from use in the bead to permit determination of the tensile strength. Wire with a .84-mm diameter which has a tensile strength of 253,000 psi is considered satisfactory in the US for use in aircraft tire casings. 36/

The following analysis of a Soviet 34 by 7 truck tire has been made available 37/:

Bead width	1.3 mm
Bead wire, heel	10 strands of 4 wires each ÷ .040 mm
Bead wire, toe	6 strands of 4 wires each ÷ .040 mm

A qualified commercial laboratory has made the reported analysis of two Soviet 600 by 16 passenger-car tires designated MCN-896 and MCN-1825. 38/

Weight of beadwire	1.01 lb	1.19 lb
Number of wires	32	32
Gauge of wires	1 mm	1 mm

Sponge-filled Tire (made in Yaroslavl') 5.50 by 19

Wire: 4 strands of 8 wires each - 1.02 mm

Soviet Tire (made in Yaroslavl') 6.50 by 16

Wire: 4 strands of 8 wires each - 1.02 mm

Soviet Sponge-filled Tire (made in Yaroslavl') 11.50 by 150

Wire: 40 to 48 strands - 0.64 mm

ZIS Jeep Tire, 1.60 by 16.6

Tire for ZIS-151 (Go anywhere) 39/

Wire 0.04 (made in Yaroslavl').
Wire 1 mm to 1.02 mm (made in Moscow).

Soviet 8.25 by 20 Cross-Country Tire

The beadwire consists of 8-strand wefted tape using wire of 1-mm to 1.02-mm gauge. It has a normal tensile strength. 40/

The Goodyear Tire and Rubber Company has made the following analysis of three Soviet-made tires captured in Korea. All bear the manufacturer's name, Yaroslavsky Tire Factory (or Yaroslavsky Rubber Combine).

5.50 by 19 - 4 strands of 8 wires each - 1.02 mm
6.50 by 16 - 4 strands of 8 wires each - 1.02 mm
11.50 by 150 - 40 to 48 strands each - .64 mm

The beadwire from a 6-ply East German tire was also analysed. 41/ This beadwire is made up of 7 layers, each containing 7 wires. These are standard steel beadwire with zinc-copper coating. The individual wires are 0.41 mm in diameter, the cables 1.25 mm, and the beadwire 3.67 mm. The coating contains 37.5 grams of zinc per kilogram of wire. The lines observed in the spectra correspond to those for iron, manganese, silicon, and copper, and there are traces of chromium and molybdenum. There are 45 wires, and the gauge is 0.035.

APPENDIX C

METHODOLOGY

This report attempts to estimate the requirements of beadwire needed for the production of tires in the Soviet Bloc. Estimates of wire for beading are based on the amount of beadwire required by estimated motor vehicle tire production.

The amount of beadwire contained in a tire varies with the size and use of the tire. The beadwire in a passenger-car tire is less, proportionately, to the contents of rubber and cord than the proportion of beadwire in a truck tire. Off-the-road tires contain more beadwire proportionately than do truck tires. Airplane tires, in order to withstand rough treatment, require proportionately much more beadwire.

The average content of beadwire in a tire is from 2.5 to 5 percent of the weight of the tire. 42/ Beadwire requirements for the Satellites were estimated by taking a median (3.75 percent) of the weight of an average tire (31.7 kilograms). Estimates for beadwire requirements in the USSR were made by using the maximum average percentage (5 percent), since the proportion of truck and airplane tires is greater in the USSR than in the European Satellites.

APPENDIX D

GAPS IN INTELLIGENCE

Gaps in intelligence concerning the production of steel wire for reinforcing tires in the Soviet Bloc are caused primarily by lack of specific data which indicate (1) how much wire is allocated to the rubber industry, and (2) what percentage of steel wire allocated to the rubber industry is used in the manufacture of tires as compared with other rubber products which contain steel wire.

In reported shipments of steel wire, the end use of the wire is not disclosed. Drums of steel wire destined for a plant which manufactures pianos or a plant which produces industrial belting could easily be diverted to tire factories if the need existed.

A further gap in intelligence results from the fact that analyses of Soviet Bloc motor vehicle tires rarely are so thorough as to include analyses of the beads.

APPENDIX E

SOURCES

Evaluations, following the classification entry and designated "Eval.," have the following significance:

Source of Information	Information
Doc. - Documentary	1 - Confirmed by other sources
A - Completely reliable	2 - Probably true
B - Usually reliable	3 - Possibly true
C - Fairly reliable	4 - Doubtful
D - Not usually reliable	5 - Probably false
E - Not reliable	6 - Cannot be judged
F - Cannot be judged	

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this report. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

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