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RAILROAD TRACK TECHNOLOGY IN THE USSR: THE STATE OF THE ART

SERGEI G. GUINS, et al.

OCTOBER 1974

FINAL REPORT

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Report contains limited assessment of the present state of the art of railroad track research, construction and maintenance technology in the U. S. S. R. It synthesizes the observations and opinions of a six-man team of U. S. railroaders which visited the Soviet Union during a 12-day period in the summer of 1974, for the purpose of evaluating Soviet railroad track technology. The major evaluation priority was to isolate aspects of Soviet technology that would be of value to the U. S. scheme and as identified, the steps necessary to introduce the concepts or procedures to the U. S. maintenance of way community.

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S.G.G.

RAILROAD TRACK TECHNOLOGY IN THE USSR:

THE STATE OF THE ART

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INTRODUCTION

The following report contains an essentially limited assessment of the present state of the art of railroad track research, construction and maintenance technology in the USSR. It synthesizes the observations and opinions of a six-man team of US railroaders which visited the Soviet Union during a 12-day period in the summer of 1974, for the purpose of evaluating Soviet railroad track technology. Paramount in the applied evaluation criteria were the questions: Would it be of value to the US scheme? And, if the answer to this question was in any way affirmative, then: What steps were necessary to bring the concept or procedure to the notice of the US maintenance of way community?

Beyond doubt, the USSR is the most railroad-intensive country in the contemporary world. Extensive track and rolling stock testing facilities have been operative in the Soviet Union for the last four decades. Here at home there has been a belief that this experience, if known and understood, may well have developed techniques and processes that could be beneficially integrated into domestic practice. Earlier team visits, particularly that of the Association of American Railroads (AAR) sponsored by the Department of State in 1960, returned with descriptions of Soviet track, rolling stock and operating procedures. But in general it was left to the reader of these materials to conclude what, if anything, could be directly grafted onto American practice. Obscure at best were details of requisite modifications to make potentially attractive Soviet methodologies adaptable for use in the US. The following report is largely descriptive in the manner of its predecessors, but with one notable difference: the tour reported upon was not a stand-alone event. Rather, it was the first of a series of exchanges, specifically track-related, which will occur within the scope of a newly created matrix of protocol agreements facilitating transfer of information between the railroad communities of the two countries.

Application of the evaluation criteria cited above did not produce an immediate catalogue of specific recommendations - expectation of such an achievement during an initial visit is evidently unrealistic - but, instead, permitted identification of suitable technical areas for future exploration. During the formulation of an end-of-tour document for sign-off by representatives of the two countries, the mechanics of continued, in-depth probing of unspecified technical subject areas were established. At two similar and sequential subsequent events in the fall of 1974, these procedures were further refined by mutual agreement. Meanwhile, Federal Railroad Administration (FRA) staff consulted with representatives of the US railroad community to obtain counsel on the selection of subjects to be investigated. In December 1974 proposals were submitted to the Soviet Ministry of Railroad Transportation (the Ministry) requesting exploration of three topic areas in 1975 by three-man teams of specialists drawn from industry, research centers and government. The three topics are:

1. improved rail performance technology;

2. non-destructive testing, including advanced techniques for locating rail defects in track; and

3. analytic and experimental methods for investigating track system behavior and performance.

Each of these three teams will have the same general objectives:

A. to progress an exhaustive critical evaluation of Soviet accomplishments in the specific field;

B. to identify those subject area elements that appear of near-term usefulness to the US rail community;

C. to isolate promising concepts or techniques that require modification to be of use in this country; and

D. to determine the direction of follow-on phases (if any) in the specific field.

An extensive technical report addressing each of these items will be completed by each team within four months following a subject area survey. Copies of these reports will be made available to the US maintenance of way community.

The foregoing discussion is intended to establish a perspective to which the contents of this report may be related. Cooperative activities between the two countries relevant to all modes of civil transport are constantly expanding. FRA will diligently pursue rail-oriented opportunities within this framework in order to uncover and make available options useful to the US railroad industry. In addition to track-related topics, other subject areas include electrification and rolling stock. From this anticipated exposure will come a resolution of the uncertainty concerning possible benefits derivable from Soviet technology to the advantage of US railroads.

BACKGROUND

An agreement of November 24, 1959 between the United States and the Union of Soviet Socialist Republics provided for exchange visits by selected delegations of technical, scientific, cultural and educational leaders of the two nations during 1960-61. Pursuant to the agreement, the AAR, at the request of the US Department of State, organized in 1960 an 8-member task force of American railroaders to visit the Soviet Union, the first such delegation in thirty years. The delegation toured various Soviet railroad facilities, including track, locomotive and car maintenance shops, classification yards, and road operations. Its observations were extensively reported by the Association of American Railroads.[1/]

On May 24, 1972, during President Nixon's visit to Moscow, an "Agreement between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on Cooperation in the Fields of Science and Technology" was consummated. Subsequently, in March, 1973, a US - USSR Joint Commission on Scientific and Technical Cooperation was established to implement the Agreement; further discussion suggested the desirability of separate intergovernmental arrangements with respect to each discipline or activity which the Agreement comprehended. As a

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1/ "Railroads of the U.S.S.R.: Report on the Visit of the United States Railroad Exchange Delegation to the Soviet Union During June, 1960," Washington, D.C., 1961.

result, an "Agreement on Cooperation in the Field of Transportation" was signed on June 19, 1973, by the Secretary of State of the United States and the Foreign Minister of the Union of Soviet Socialist Republics. The Agreement provided for exchange of technical knowledge concerning all modes of transportation, to be achieved by

Exchange visits of scientists and specialists;

Exchange of scientific and technical information and documentation;

Convening of joint conferences, meetings and seminars;

Joint planning, development and implementation of research programs and projects; and

By such other forms of cooperation as may be mutually agreed upon.

Under the terms of the June 19 Agreement, a US - USSR Joint Committee on Cooperation in the Field of Transportation was established and held its first meeting in Moscow, January 14-16, 1974. At that meeting Joint Working Groups were organized by mode and the following topics selected and approved as subjects of first priority for the Joint Working Group on Rail Transport (JWGRT);

Track construction and maintenance;

Transportation of perishable foodstuffs;

Electrification; and

Railroad research on matters of mutual interest.

In accordance with the understanding reached at the January, 1974 meeting of the JWGRT, arrangements were made for a US delegation to visit the Soviet Union during the period July 1-10, 1974, to pursue the initial priority subject, Track Construction and Maintenance.[2]

2/ A USSR delegation of six track specialists visited the US between October 27 and November 6, 1974.

The delegation had the following members:

W. B. O'Sullivan, Staff Engineer, Federal Railroad Administration, US Department of Transportation, Head of Mission

W. S. Autrey, Chief Engineer (System), The Atchison, Topeka & Santa Fe Railway Co.,

L. S. Crane, Executive Vice President (Operations), Southern Railway System,

H. M. Williamson, Chief Engineer-System, Southern Pacific Transportation Company,

S. G. Guins, Consultant, Federal Railroad Administration, (indirectly)

Dr. Arnold D. Kerr, Visiting Professor of Civil Engineering, Princeton University.

SUMMARY AND CONCLUSIONS

The atmosphere during the visit was one of cordiality, cooperation and an uninhibited desire to explain the technical bases for Soviet track technology decisions.

Some members of the delegation had initially believed that one-to-one discussions on various topics would have been preferable to the group format which was actually used, yet all concurred at conclusion of the visit that the on-site inspections of various operations which only the group format made possible clarified many of the points that otherwise would have been hard to resolve in terms of individual discussion confined to offices. An understanding of how railroads fit into the overall Soviet economy also contributed importantly to jusitification of some of the observed maintenance procedures.

While many operations observed by the delegation could not be considered economically viable to the US at present, they must be given weight in planning for a future in which, as time passes, it seems ever more likely that traffic densities on the US railroads will begin to approach those now experienced in the USSR. On the other hand, USSR experience with rail technology and rail defect inspection equipment and track system performance analysis might well be considered for future application in the United States once greater understanding is achieved.

It seems likely, based on the experience of the visit here reported, that there is much additional knowledge of a technical nature yet to be acquired from visits to the USSR, and that further exchange of small delegations concerned with rail, track and roadway technology would be in the public interest. Were such visits to take place, they might well include not only representatives of the railroads themselves, but also personnel of the railway supply industries and research institutes familiar with such specialties as rail metallurgy, failure analysis, defect propagation and the development of performance prediction capability.

ITINERARY

US RAILROAD DELEGATION TO THE USSR, 1974

Sunday - June 30th	Air Arrival at Moscow. Accommodation at Hotel Metropol.
Monday - July 1st	Meetings at the USSR Railroad Ministry.
9:00 AM to 11:00 AM	a. Discussion of itinerary. b. Introductory presentation by V. V. Bassilov[3/] describing the USSR railroad operating conditions which led to development of current methods of heavy track maintenance.
12:00 Noon to 5:00 PM	Visit Test Track at Shcherbinka. Professor Phouphrianski and Dr. Albrekht described the track and equipment research approach used by USSR railroads, including: - modern track design, utilization of different concrete structures in track construction; - problems of increasing rail service life; - lateral and vertical track stability; - security of continuously welded track subjected to extremes of temperature; - behavior and performance of non-conventional track concepts (beams and slabs); - evolution of stressed concrete tie design and usage; and - roadway maintenance.

Visit included a ride around test ring, with stops to observe various installations, as well as tour of several laboratories.

11:55 PM	Leave Moscow for Leningrad by train.

3/ For position titles of individuals cited in text, see Appendix A.

Tuesday - July 2nd	Leningrad
8:25 AM to 10:00 AM	Arrival in Leningrad. Briefing at October Railroad Headquarters. Briefing by V. V. Chabarov as to its history, including the many developments in track structure, use of concrete ties and modernization of track to increase operating speeds to 200 kilometers per hour (120 m.p.h.). Some financial aspects of railroad operation also discussed.
12:30 PM to 3:00 PM	Ride on special train including track geometry measurement car and magnetic rail defect detection car.
Wednesday - July 3rd	Leningrad
9:00 AM to 5:00 PM	Inspection of Chudovo track section: tracks laid on concrete ties, high speed switches, running track maintenance and maintenance equipment.
5:00 PM	Leave Leningrad for Kiev by air.
Thursday - July 4th	Kiev
	Visit track assembly station No. 121 at Post-Volynsk (near Kiev). Movie of track panel assembly and installation. Observation of work on assembling of panels, loading of panels on trains and disassembly of panels removed from track.
7:30 PM	
Friday - July 5th	Kiev
7:44 AM to 3:00 PM	Special train to observe heavy track maintenance operation. Observation of ballast cleaning, track removal and installation of new panels with concrete ties.

Friday - July 5th (Continued)

8:58 PM	Leave Kiev for Slavyansk (Donetsk RR) in regular train service over track section previously visited for on-site inspection.
Saturday - July 6th	Krasnyi Liman
7:06 AM	Arrival at Slavyansk station. Transfer to automobile for final leg to Krasnyi Liman.
7:45 AM	Arrive at Krasnyi Liman.
9.00 AM to 11:00 AM	Inspection of rail welding installation: observation of rail welding practices.
11:00 AM to 1:00 PM	Inspection of Track Assembly Station No. 10, observation of track assembling practices. Inspection of wood tie reconditioning shop.
6:00 PM	Leave for Donetsk (automobile).
8:00 PM	Arrive in Donetsk.
Sunday - July 7th	Donetsk
9:00 AM	Visited Headquarters of Donetsk Railroad. V. V. Priklonski described operation of railroad, a relatively short high density line carrying ore and coal for steel industry, and a bridge railroad between South and North Russia.
12:00 PM	Visit to coal mine and to railroad-support sports center.
4:05 PM	Leave Donetsk for Moscow by train.
Monday - July 8th	Moscow
9:05 AM	Arrive Moscow.
11:00 AM	Attendance at meetings of Soviet-American Railroad Working Group (JWGRT); discussion of plan for 1975 cooperation.
3:00 PM	Inspection of mobile rail welding machine PRSM-3, at Losino-Ostrovskaya station, Moscow Railroad. Also, discussions with members of All-Union Railroad Research and Development Institute.

<u>Tuesday - July 9th</u>		Moscow
	AM	Concurrent meetings of USSR-US railroad working group and discussions between US delegates and USSR specialists on various subjects related to track structures and maintenance.
	PM	Continuation of technical discussions.
<u>Wednesday - July 10th</u>		Moscow
	AM	Formal signing of protocol and visit with V. C. Gavrilov. (see page 97)
	PM	Conclusion of technical discussions.
<u>Thursday - July 11th</u>		Moscow
	AM	Morning air departure for Paris and US.

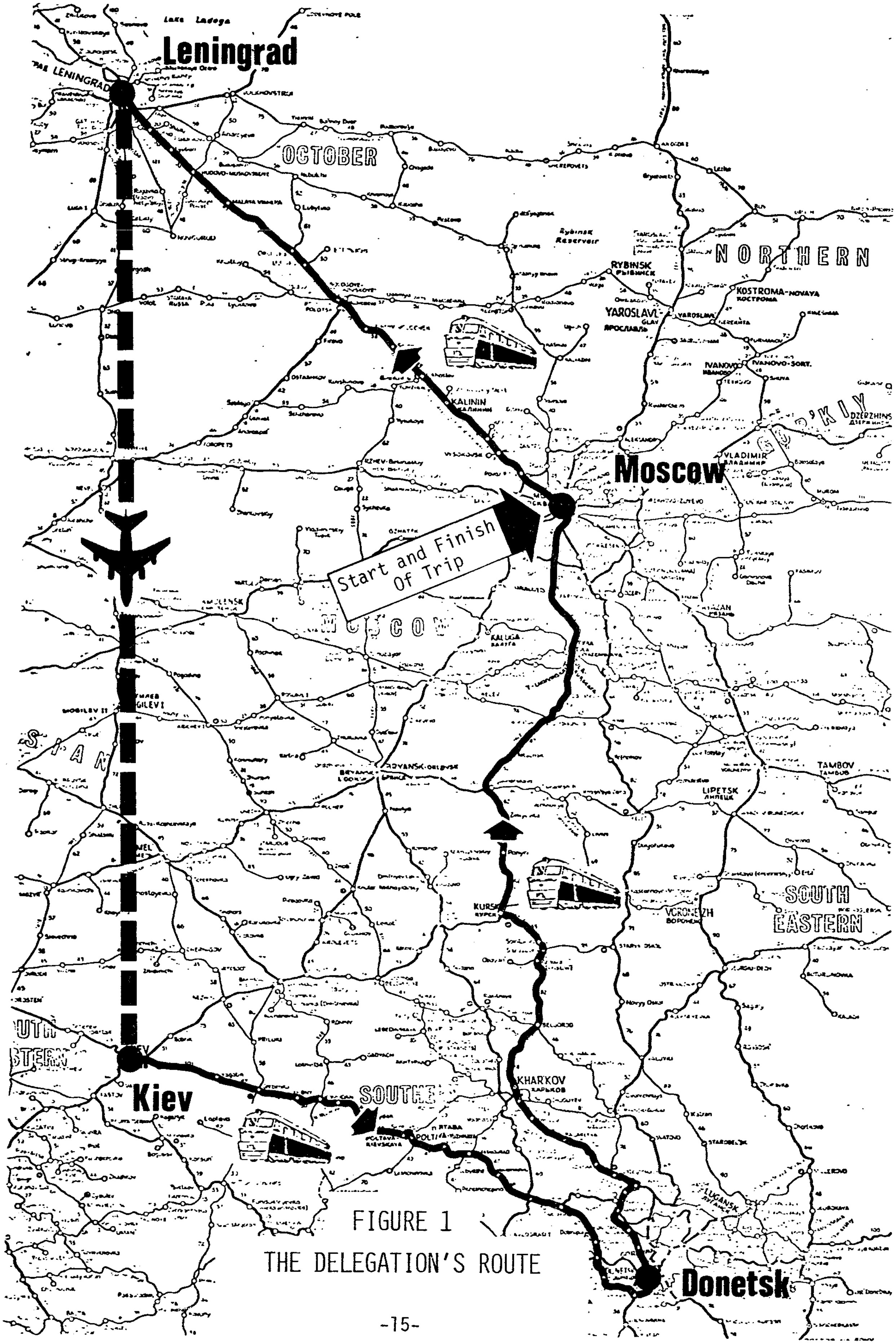


FIGURE 1

THE DELEGATION'S ROUTE

OPERATING AND FINANCIAL CONTEXT

To understand fully the differences in current track maintenance practice between the US railroads and those of the USSR, it is important to define the political and economic climate within which the latter operate.

The Soviet railroads are a government enterprise and as such have certain advantages, of which one of the most important is the absence of highway competition. By official decree, traffic moved for distances exceeding 50 km is reserved to rail, while trucks move all traffic for lesser distances. Notwithstanding their reserved market, the USSR railroads are a profit oriented operation. This was brought out in discussions with V. V. Chuberov, Head of the October Railroad, who stated that his railroad netted 300 million rubles on gross revenues of 800 million.[4/] Of the net, about 10 percent is distributed as bonuses, and approximately one-quarter, or 75 million rubles is plowed back into the railroad for capital improvements (as distinguished from new construction).

At the end of World War II, Soviet railroad track engineers were confronted not only by the need for physical restoration of a massively damaged plant, but with a concurrent condition of ever-increasing traffic, the latter a situation which has persisted to the present, and which constitutes a significant aspect of the USSR rail environment.

4/ At the official rate of exchange 1 ruble approximates US $1.40.
Note: There are 26 "Rairoads" which **comprise the Soviet network**

Some major main lines now have traffic densities ranging from 100 to 150 million gross tons per kilometer per year. Haulage of these magnitudes is achieved by moving 120 to 160 trains every 24 hours over these sections, most of which are double tracked and fully signalled. Statistics quoted to the delegation by V. V. Bassilov are that USSR railroads, with 10 percent of the world's trackage, move 50 percent of its tonnage.

Given the controlling nature of the above conditions, the development of USSR track engineering has emphasized (with equal stress) the following priorities:

1. Increase track service life, thus minimizing the need for maintenance;
2. Speed up track maintenance, so as to minimize traffic disruption; and
3. Maintain high safety standards.

The steps taken in addressing these objectives in some cases parallel and in others diverge from US practice.

To increase track service life, the weight and hardness of rail has been so substantially increased as to nearly double prior rail life expectancy. Wood ties are being replaced by pre-stressed concrete, a procedure to a degree influenced by lack of hardwood ties. Ballast section dimensions have been increased and research on ballast stabilization is under way. Alternate track structures, some somewhat similar to those tested by the FRA on its Kansas Test Track, are also being investigated.

To speed up track maintenance a whole series of large machines and of track facilities have been developed so as to concentrate related tasks, to the maximum possible extent, at off-track locations. In consequence, 50 percent of track maintenance activities are performed at non-wayside facilities designated as Track Assembly Stations (see Figure 21 and related text), 25 percent is accomplished on-site without operating interference, and only one-quarter of the total track maintenance effort results in train delay or schedule adjustments.

High safety standards are maintained by a rigorous program of daily inspection by road gangs, supplemented with frequent inspection of track components of track geometry cars and by rail defect detection equipment. These procedures require large inputs of both manpower and capital; both seem to be available. By rough estimate, the USSR railroads employ about 2 million persons and, as V. V. Chuberov indicated, significant plowback of capital for heavy machinery investment is standard practice.

All new practices and changes in extant track emanate from the Ministry of Railroad Transportation; these are instituted only after careful and detailed programs of research and development, both theoretical and experimental.

All railroad research, including that related to track, roadway and related structures, is accomplished by the All-Union Railroad Research and Development Institute (CNII), and tested at the experimental closed-loop laboratories at Shcherbinka Station near Moscow.

While it was physically impossible in the 10 days available to the delegation to become in all respects thoroughly acquainted with every phase of the extensive USSR track programs, the visit here reported was, despite some inconsistencies of detailed impressions, quite informative. It should provide the basis for a more comprehensive appreciation of USSR track maintenance technology.

Note: The earlier cited figure of 2 million employees includes those assigned to:

1. Training facilities as staff and trainees;
2. research institutes;
3. recreational facilities;
4. agricultural and dairy farms;
5. social services;
6. centralized management;
7. maintenance of fixed and mobile plant.

TRACK IMPROVEMENT

Long Range Research and Development

Since the visit centered on track maintenance technology, contact with the research arm of the Railroad Transportation Ministry, the All-Union Railroad Research and Development Institute (CNII), was limited to a discussion with some of its scientists on the subject of track stability when subjected to temperature increase, and a visit by the delegation to the Closed-Loop Ring near Moscow (Figure 2, next page).

Welded track stability problems were discussed with several experts in order to establish the direction of research related to axial track forces caused by moving trains; in this way a more direct acquaintanceship was established with authorities on the subject whose theoretical works in published literature have been studied in the US. The CNII authorities indicated that their track stability theories thus far developed are not confirmed by empirical observation or practical experience. In consequence, their research emphasis is shifting to studies relying on experimental methods. While the latter are concededly very important, the US delegation adheres to the view that a good theoretical understanding would be particularly important when new track structures are to be introduced.

Figure 2. Diagram of Closed-Loop Test Track at Shcherbinka

Professor V. N. Albrekht, now head of all track research at the Institute, and who, 20 years ago, wrote his doctoral thesis on the effect of axial forces due to "creep" produced by trains moving at constant speed, indicated that experiments show actual buckling force to be about .7 of theoretical value. He has recently been conducting experimental research related to the effect of decelerating trains on axial track forces. This work was accomplished with use of a 75 car train drawn by an electric locomotive decelerating to stop from between 70 and 80 km per hour. It was found that when the rail-tie (spring) fasteners are well tightened, axial forces are continued within 6 meters in the region ahead of the locomotive. When cut spikes are used, the region of active axial force is increased from 80 to 90 meters, and when anti-creep devices are used the region is reduced to about 10 meters.

Closed-Loop Ring

The other phase of the Institute's work related to track engineering is the operation of the Closed-Loop Ring at Shcherbinka, which the US delegation visited and inspected. This Test Ring, which is a facility of the All-Union Railroad Research and Development Institute, employs 380 permanent engineers and technicians, and also accommodates up to 100 visiting research scientists. This facility, with national responsibility to test all equipment, track and rolling stock prior to introduction on the USSR railroad system, was originally proposed by Professor Lamonosov in 1901, built in 1932 and has since been in continuous operation. Its current activities which, in addition to test track, include many testing laboratories for track and rolling stock equipment components, was described by Professor N. A. Phuphriansky and Doctor Albrekht who, working in close cooperation, are respectively responsible for rolling stock and track research.

The first ring, 6 km in circumference, has level track only and is used exclusively to test rolling stock. The other two rings were added later and are used to study track structure as well as the effect on track of various wheel loadings and suspension systems. To test new track structure and to accumulate mileage, a special train operates on the ring every day. This 9000 ton train with axle loads of up to 20 metric tons (22 short tons), operates for 12-13 hours a day at speeds of 45 km/hr , subjecting the test track to daily loads of as much as 1,200,000 tons.

Professor Phuphriansky indicated that closed-loop ring research has established that changes in locomotive suspension permitted increases in wheel loading and corresponding increases in traction effort, without detrimental effect on rails. He also confirmed that, although the USSR axle-loading standard is now 20.5 tons, experiments with 23 metric ton (25.3 short tons) axle-loads are being conducted and the effects of 25 metric ton (27.5 short tons) axle-loads, all of which are less than the 35 ton axle-loading common on US railroads, are being studied.

Doctor Albrekht discussed several problems: stability, design of concrete ties and proper sampling of new type rails for dependable results. He pointed out as an example of the types of track problems addressed in response to requirements for practical solutions, the discrepancy between theoretical track buckling values ranging from 254 to 262 tons on the one hand, and practical experience of track buckling under loads varying between 130-160 tons, on the other. Illustrative of the Institute's approach to new component development he outlined attempts which have been made, in concrete tie design, to distribute material so as to resist the true forces experienced by ties, pointing out that because wood ties are normally rectangular, it need not be concluded that concrete ties must also be limited to such shapes.

It is USSR practice to test at least 32 track sections, each 12.5 meters (41 ft) in length on a tangent and curved track: the test ring has 375, 600 and 1200 meter radii curves. Of 64 different sets of rail, tested in an illustrative track research program, only 10 were recommended for use. In another project, of 70 types of composition brake shoes tested, only one was found satisfactory. (r=375 m[4°-42'], 600m[2°-53'] and 1200 m[1°-27'])

The Shcherbinka Ring is primarily a slow speed operation. Track testing under high speed conditions is conducted on a fully instrumented section of line in regular revenue service, in the Northern Caucasus.

After discussions by and with Professor Phuphriansky and Doctor Albrekht, the delegation rode around the ring, stopping to observe various test installations, some of which are shown in Figures 3 through 13, as well as laboratory equipment. During the Test Ring tour, various test installations of "permanent" track structures were observed. Figures 3 - 7 show such structures under test. Track structure rigidity is one of the problems being investigated, as it was found that when structural rigidity is high, damage to roller bearings was experienced. This particular problem is being resolved by installation of elastic pads under tie plates and rail.

Since there is interest in high speed passenger service, track structure without gaps is under study. Figure 8 shows the installation of a movable point frog under wear test.

In the laboratories associated with the test ring, the delegation was shown a machine, Figure 9, capable of producing any desired wheel profile. Figure 10 shows an instrumented wheel set used to measure wheel-rail stress interaction, Figure 11 shows a longitudinal compression test stand, and Figure 12 shows an experimental test stand for rail inspection prior to welding.

Figure 13 shows the truck arrangement under one end of a 120 ton coal car. The system consists of two 2-axle trucks with a span bolster. A complete train of this car type is being tested on the closed-loop ring.

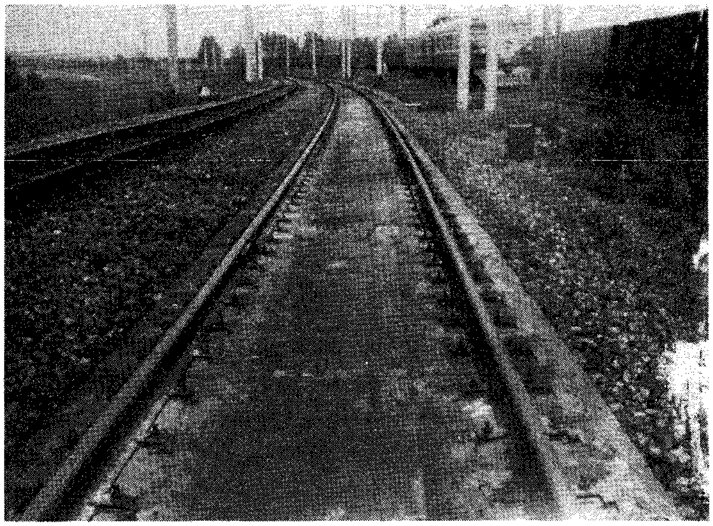


Figure 3. Slab Track at Closed-Loop Test Track

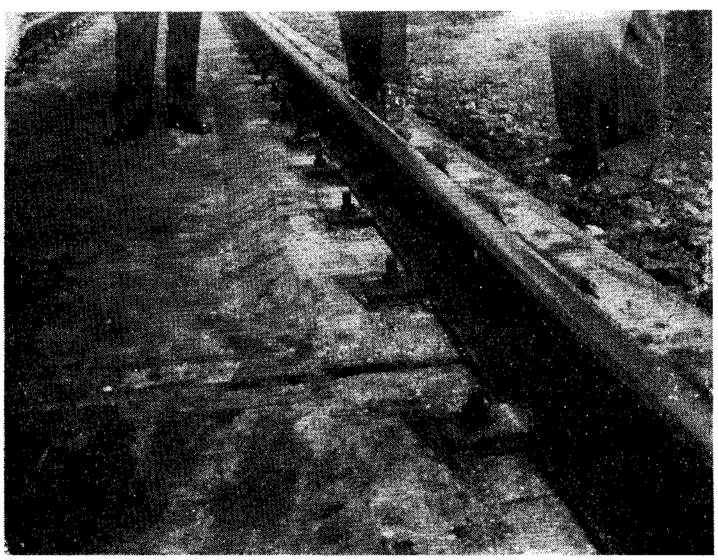


Figure 4. Close-up of Rail Fasteners for Slab Track

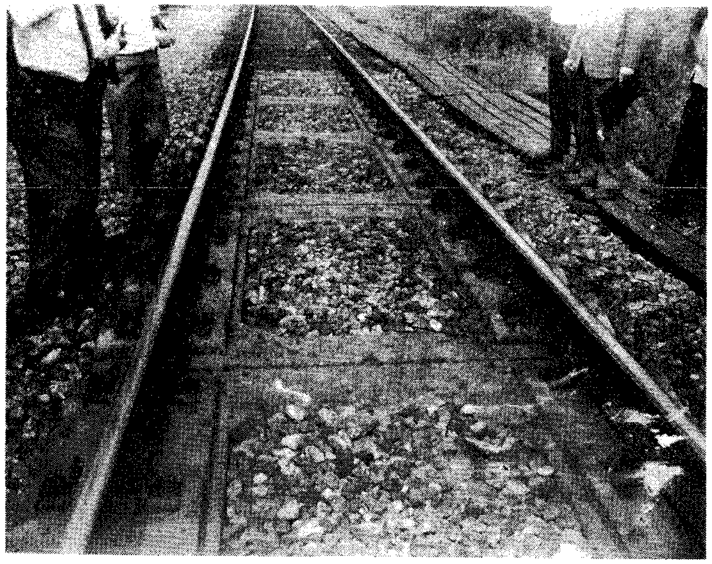


Figure 5. Panel Track at Closed-Loop Test Track

Figure 6. Close-up of Rail Fasteners for Panel Track

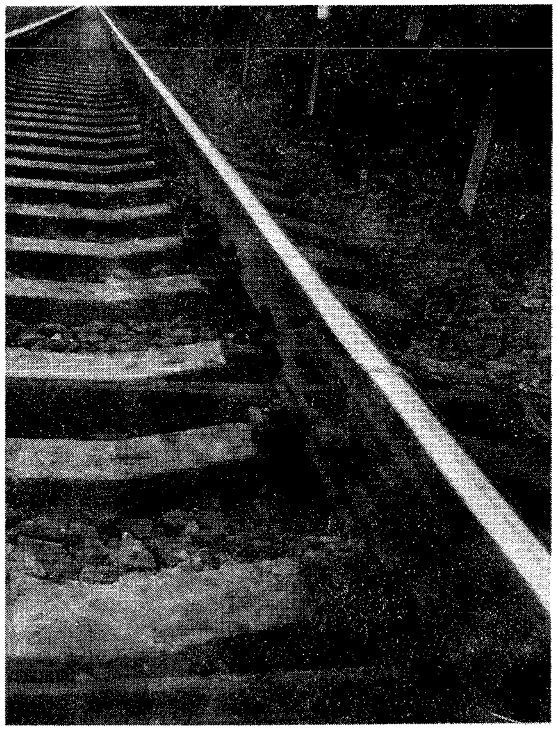
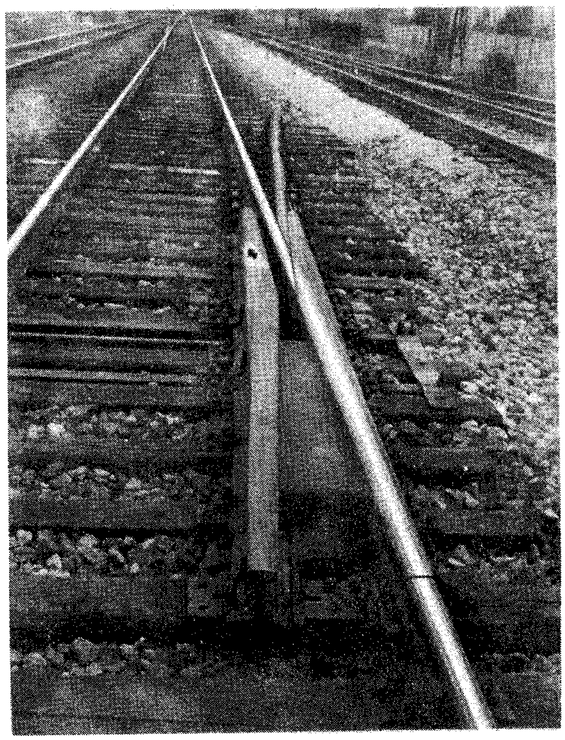


Figure 7. Concrete Ties



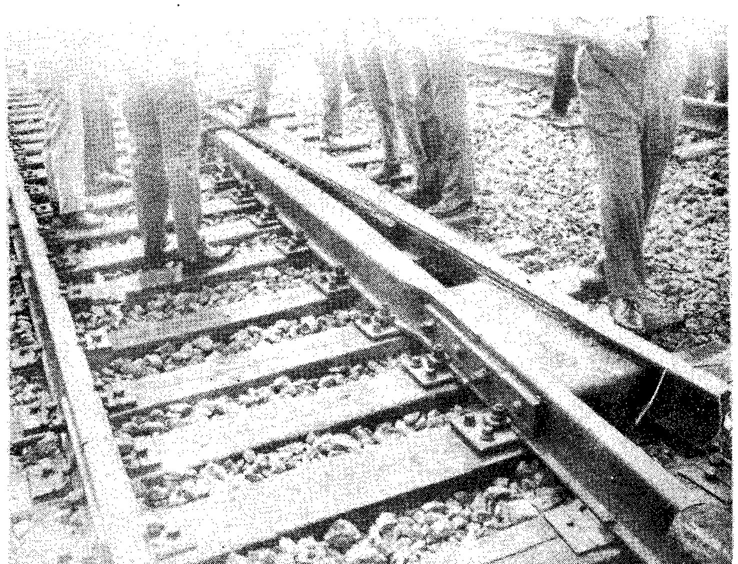


Figure 8. Test Installation of High Speed Movable Point Crossover

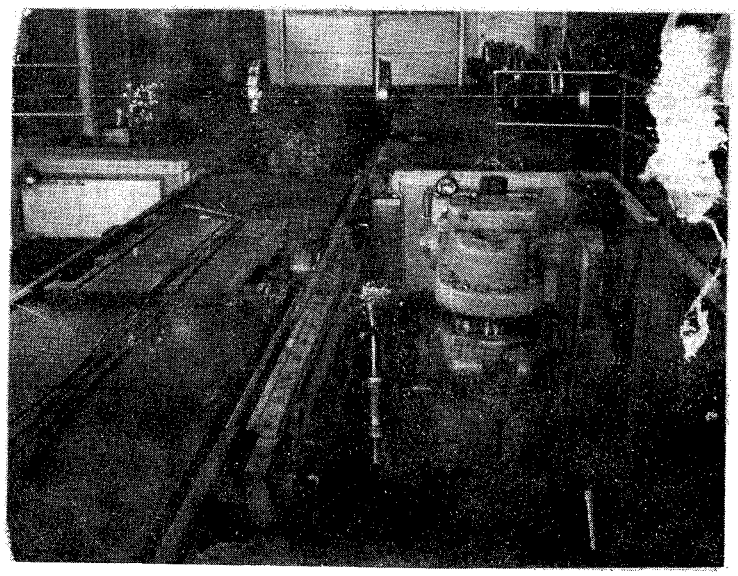


Figure 9. Wheel Profile Machine

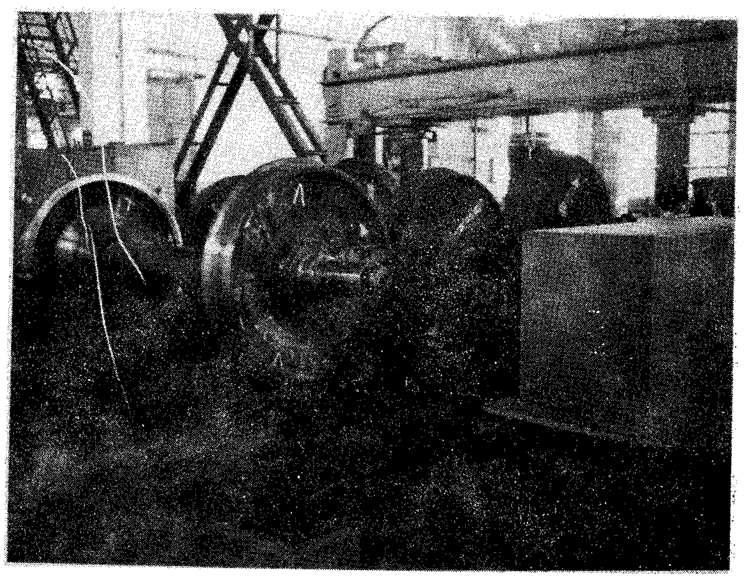


Figure 10. Instrumented Wheel Pair

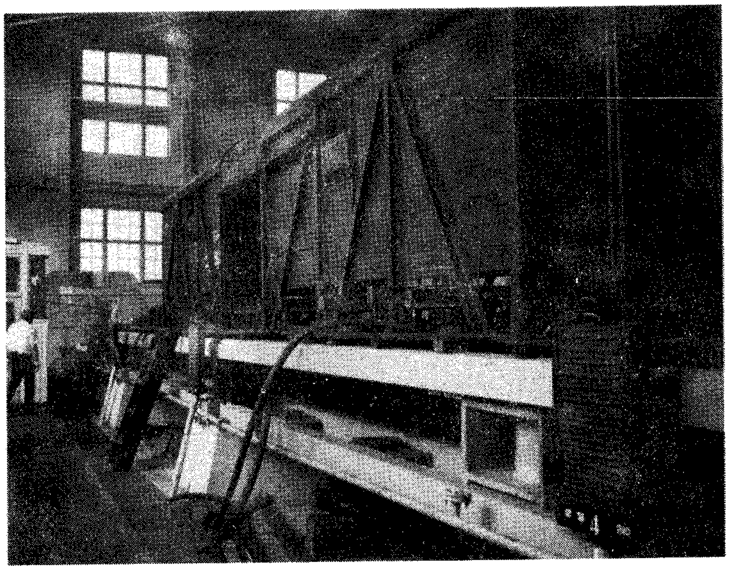


Figure 11. Compression Test Stand

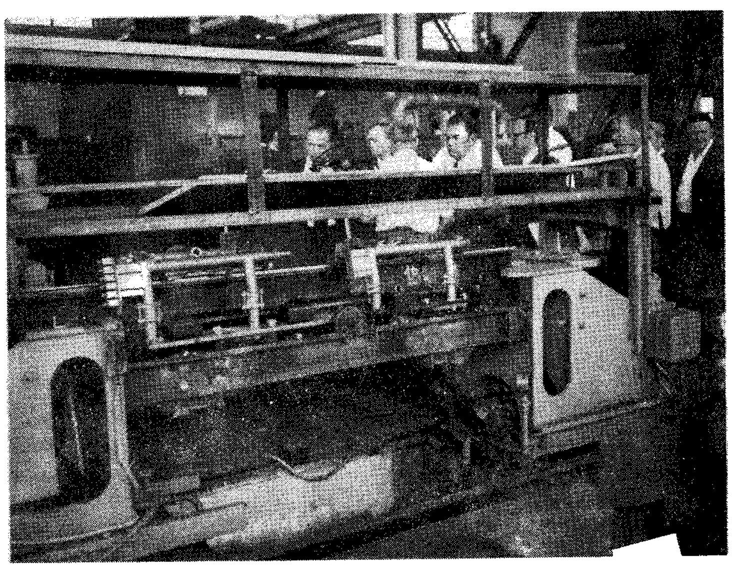


Figure 12. Rail Inspection Prior to Welding

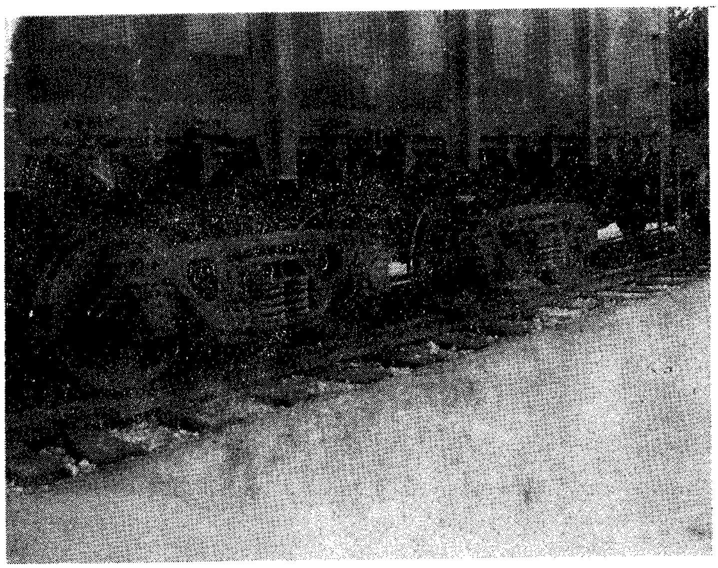


Figure 13. Truck Arrangement Under 120 Ton Coal Car

Short-Term Upgrading

To stress a point already made, but a point warranting reiteration, research aimed at improving the life of track components is a continuing effort in the USSR. In that country, track engineering policy not only addresses effort to the development of new track structures, as described above, but concurrently strives to improve conventional components.

Examples derived from data obtained by the delegation during its visit, as well as from the pertinent manual of engineering standards,[5/] illustrate the latter activities (i.e., those concerned with conventional components), and facilitate comparisons in this field between Soviet technology and that of the United States. To begin with, consider rail life, relying on statistics furnished the delegation. In 1953, the life of 65 kg. high carbon rail was 500 million gross tons. Given a traffic density standard of 100 million gross tons per annum, this implied rail renewal at five year intervals. With improvement of metallurgy and oil hardening, the life of 65 kg. rail has subsequently been increased to 800 million gross tons, but meanwhile traffic density standards have been increased to 160 million tons/year, still yielding only five years between rail changes.[6/]

5/ "Handbook for Track Engineers," edited by V. V. Bassilov and M. A. Chernisheka, Ministry of Railroad Transportation, Moscow, 1972, two volumes (both in translation by FRA).

6/ While it is part of the ultimate USSR railroad transportation plan to use hardened rail on all main lines, its use is at present limited to track with traffic densities exceeding 70 million gross tons per year. Also, because of production problems, hardened rail tends to be used in areas close to plants where the hardening process is available.

Chemical and strength characteristics of USSR production rail sections are shown in the following table:

Rail Section	Specification	Chemical Composition %						Minimac Tensile Strength
					Not to Exceed			
		C	Mn	Si	S	P	As	
P-75, P-65	ГОСТ 8160-63	.69 .82	.75 1.05	.13 .28	.045	.035	.15	85 Klg/Mn^2
P-65 with Cr .5-.9%	ЧМТγ2-64-68	.65 .75	.75 1.05	.13 .28	.045	.035	.15	90 Klg/Mn^2
P-65 Fully Hardened	ЧМТγ2-59-68	.68 .78	.75 1.05	.13 .28	.045	.035	.15	116 Kg/Mn^2

Source: "Handbook for Track Engineers," Op. cit., Volume 2, p. 275.

While not all rail rolling mills now have the required capability, all will be converted to the production of 25 meter (82 ft.) rail lengths.

There are several different heat treatment methods used by various USSR rail mills; the various methods and surface hardness achieved are as follows:

1 - Surface hardening by water quench after furnace heating.
Hardness: 311-401 Brinnell;

2 - Through hardening by oil cooling (all surfaces and full length).
Hardness: 321-388 Brinnell;

3 - Air-water cooling after induction heaters (using Model TB-4); and

4 - Rail not designated for welding has surface hardening.

Experiments are being conducted both in use of heavier weight rail sections, P-75, and in improved material strength.

Tensile strength was increased from 85 Kg/Mn^2 (120,871 lb./sq. inch) to 116 Kg/Mn^2 (164,954 lb./sq. inch) and experiments are being conducted with rail having tensile strength of 160 Kg/Mn^2 (227,523 lb./sq. inch).

Cascading of Rail

Rail sections of types P-50, P-65 and P-75 are removed from main lines after bearing 500 million gross tons of traffic. They are inspected, defects removed, cropped and relaid

(1) on track with traffic density less than 10 million gross ton km./km. per year; and

(2) as station track and industrial sidings.

Drawings of Rail Sections P-65 and P-75 are reproduced as Figures 14 and 15, respectively.

Welded Rail

The present pattern of laying welded rail is in 800 meter (2625 ft.) strings with 3 lengths of 25 meter (82 ft.) rails as jointed track between each 800 meter string. In the discussions between the US delegation and their Soviet hosts, questions were raised as to the selection of 800 meter strings and the practice of using three jointed sections. It developed that the decision to use 800 meter lengths was apparently based on available siding lengths and operating convenience, rather than

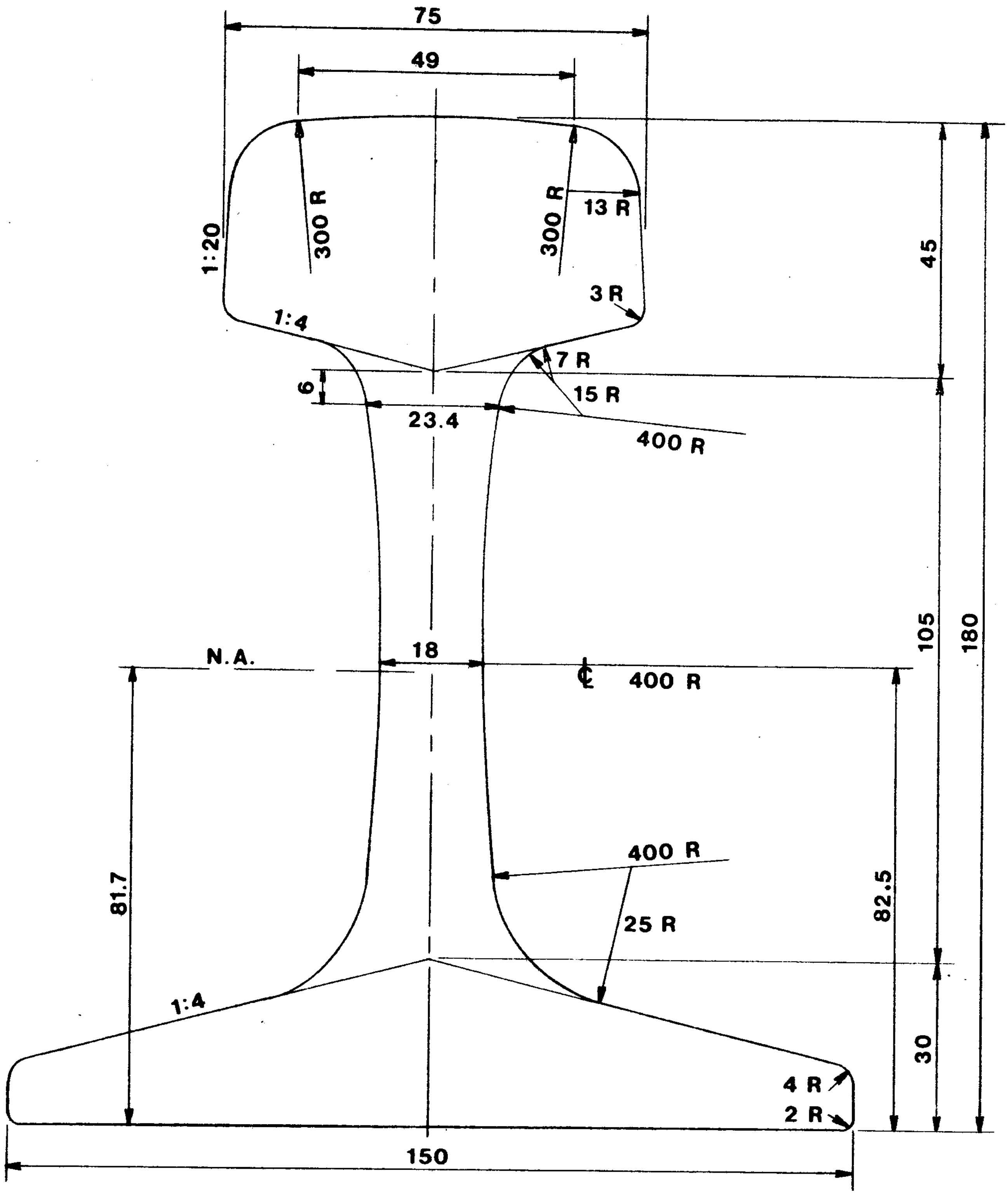


Figure 14. P-65 Rail Section (132 pounds/yard)
Full scale (dimensions in mm's)

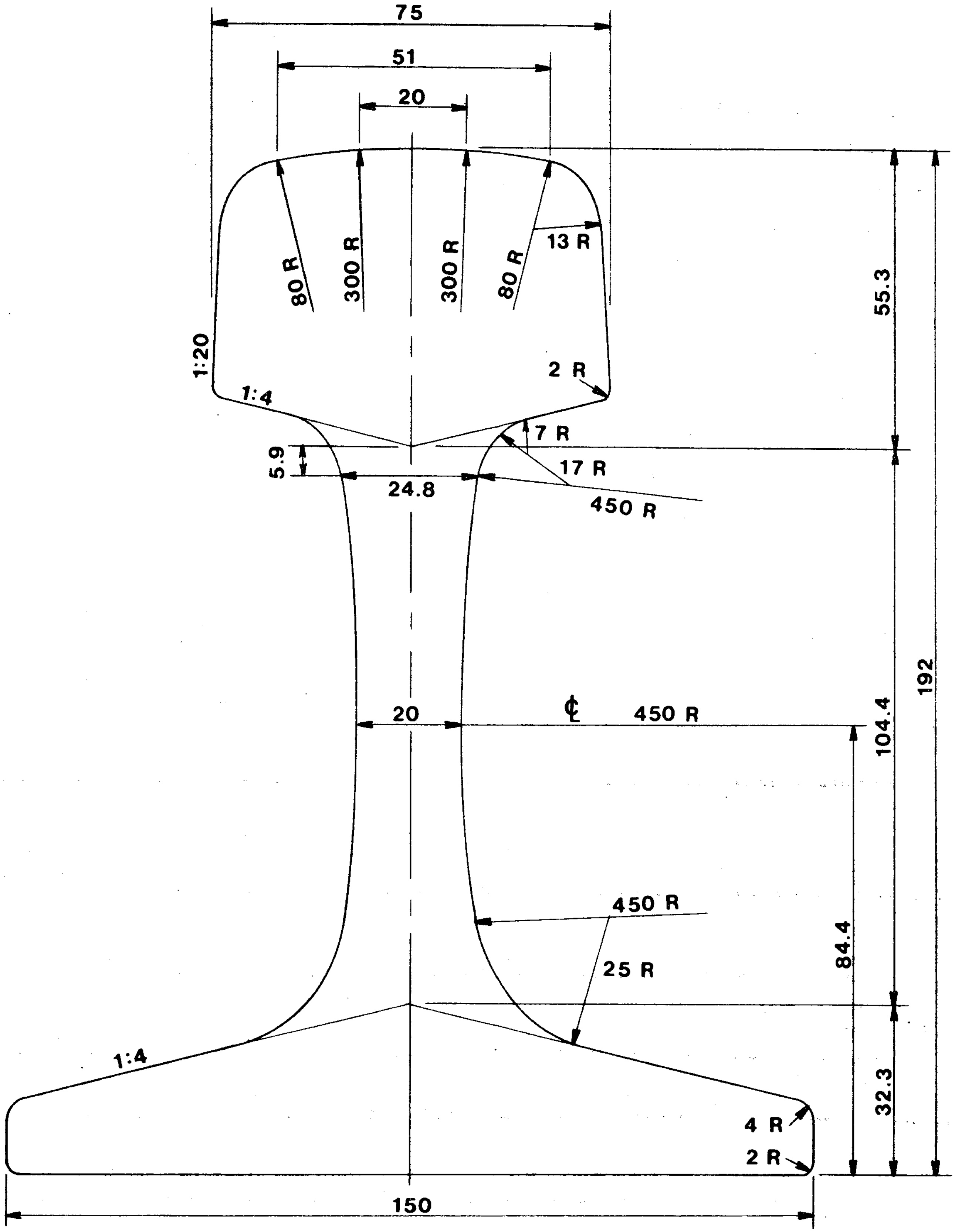


Figure 15. P-75 Rail Section (152 pounds/yard)
Full scale (dimensions in mm's)

on any technical considerations, whereas the use of three jointed sections was decided upon to facilitate rail installation at a variety of temperatures, other than that of equilibrium, with means to adjust for the temperature.

The Ministry regulations governing maintenance of welded rail strings and jointed sections are specific regarding maintenance performed under extreme deviations of temperature. These rules cover the time of maintenance, the procedures to be employed and the safety of involved personnel. If it is necessary to temporarily remove a section of rail for track maintenance or to relieve stress in the entire rail structure, precise procedures are provided, involving removal or adjustment of the tie-fastening devices, so as to avoid shifting other fixed sections of rail. Pertinent portions of these regulations are reproduced in the following table:

Restrictions Governing Maintenance Work
On Welded Track

Class of Work	Ties	Alignment-Lift Limits (cm)	Allowable Temperature Increment Above Temperature At Time Track Laid		
			Straight	Rating of Curvature (Meters) 800 & Over	500-799
			(Degrees of Centigrade)		
Correction of low joints and crossings with use of jacks	Wood and Concrete	2	20°	15°	10°
Adjustment of track Panels	Wood and Concrete	6	15	10	5
Alignment of track with hydraulic machines	Wood Concrete	1 6	15 15	15 10	15 5
Cleaning of ballast with removal to the level of ties or 25m.	Wood Concrete	0 0	15 20	10 15	5 5

Source: "Handbook for Track Engineers," Op. cit., Vol. 2, p. 61.

Qualification of New Rail Types

Innovative rail types, with either new section configurations or which have been subjected to new types of heat treatment, are given extensive tests at the closed-loop of the CNII test facilities prior to acceptance. For such testing, a minimum of 35 rail lengths is required. The rail is first tested for compliance with mandatory chemical and strength specifications, before ring track installation with control rails of known performance. Rail performance is then studied under test trains of 8000-9000 tons, operating with axle loadings of 20 $\pm$.5 tons, for 10-12 hours/day. As high tonnage is quickly accumulated under such conditions, the qualification tests are not of long duration. Only after such tests are passed satisfactorily, are main line service tests approved.

Ties

In 1971 a new specification, Γ OCT 10629-71, "Pre-stressed Concrete Ties for Main Lines of Broad Gauge" was adopted for all main line track. This specification is applicable both to new construction and to capital maintenance. All such ties, each of which requires approximately .1 meters of concrete and weighs 250 Kg., are pre-stressed by use of stretched wires and have two variations, for use with and without tie plates.

The specifications for pre-stressing wiresis as follows:

	Diameter of Wires		
	3mm	1mm	5mm
Number of wires	44	28	20
Limit of strength, Kg/Mn^2	180	170	160
Weight of arrangement, Kg	6.53	7.48	8.32
Amount of pre-stress tons	36.4	38.9	38.2

While concrete ties reenforced as described and illustrated in Figure 16 is the present standard, research at the Shcherbinka Test Track proceeds on a variety of arrangements, some of which are illustrated hereinafter. No conclusive results for these other innovative tie designs are available at present, and it is assumed that none are installed in service tracks.

Rail Fasteners

Rail toe load and tightness of rail fasteners is of great concern in the USSR. It was indicated that 50 percent of the work of section crews is spent on tightening fasteners. As result, fasteners of early design are being replaced by a KB fastener, which tends to maintain tension with a two coil spring washer under the nut.

Another concern involving rail fasteners is to reduce ride harshness caused by concrete ties. For this goal new fasteners, C-65-1 and ЖБР-65, are under test at the closed-loop test track. Both are designed to provide more elasticity between the rail and tie. (See Figures 17 through 20.)

Ballast

While various materials are used for ballast, depending on conditions, stone ballast is used on main line track. The specified size of ballast is 25-70 mm, with sizes above 70-90 mm and below 25 mm not permitted to exceed 5 percent.

Track Section with Asbestos Ballast

A section using asbestos ballast was laid at the experimental ring in October, 1971, for test under heavy traffic operating conditions.

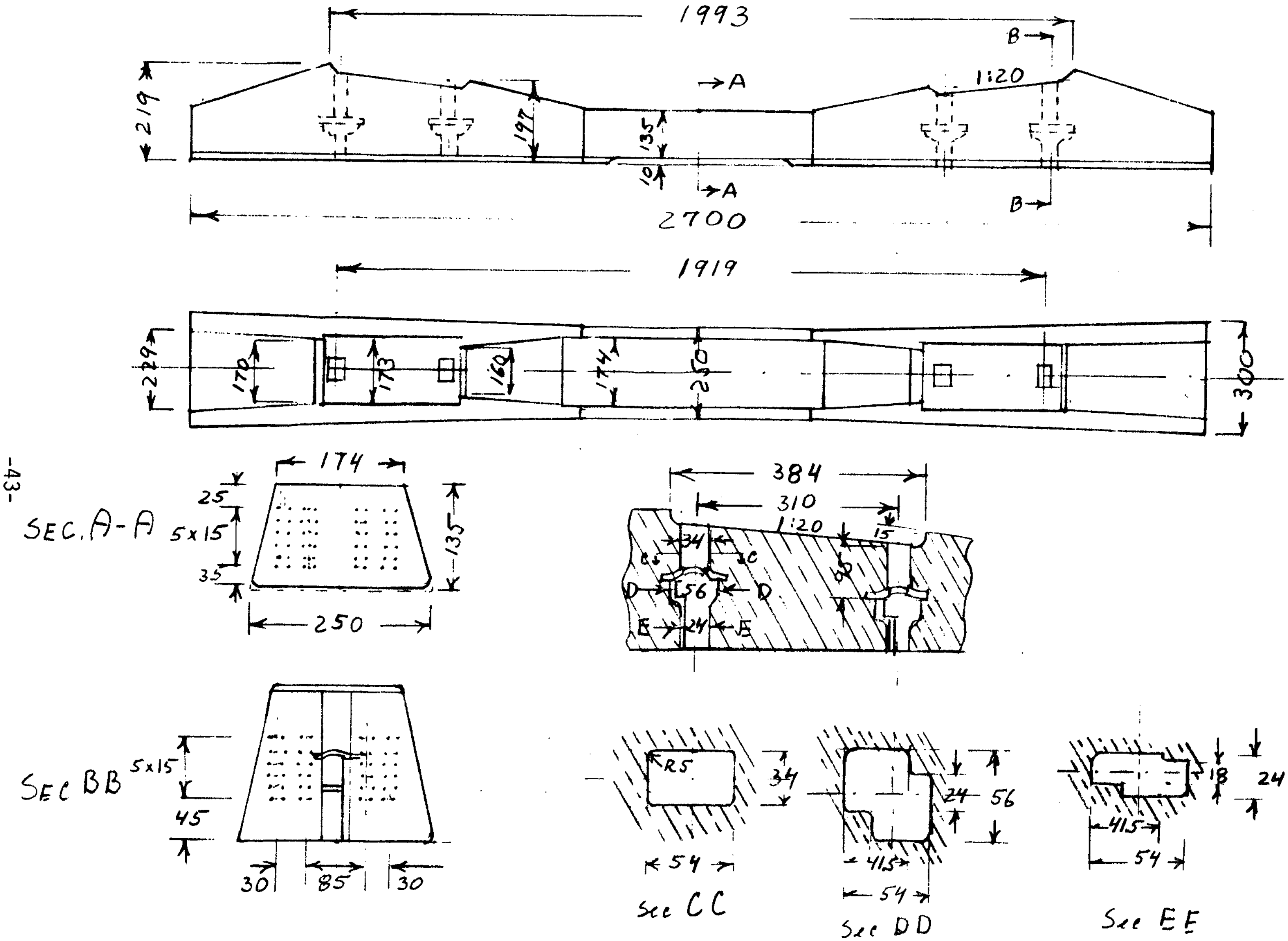


Figure 16. C-56-2 Prestressed Concrete Tie with 3mm Wires

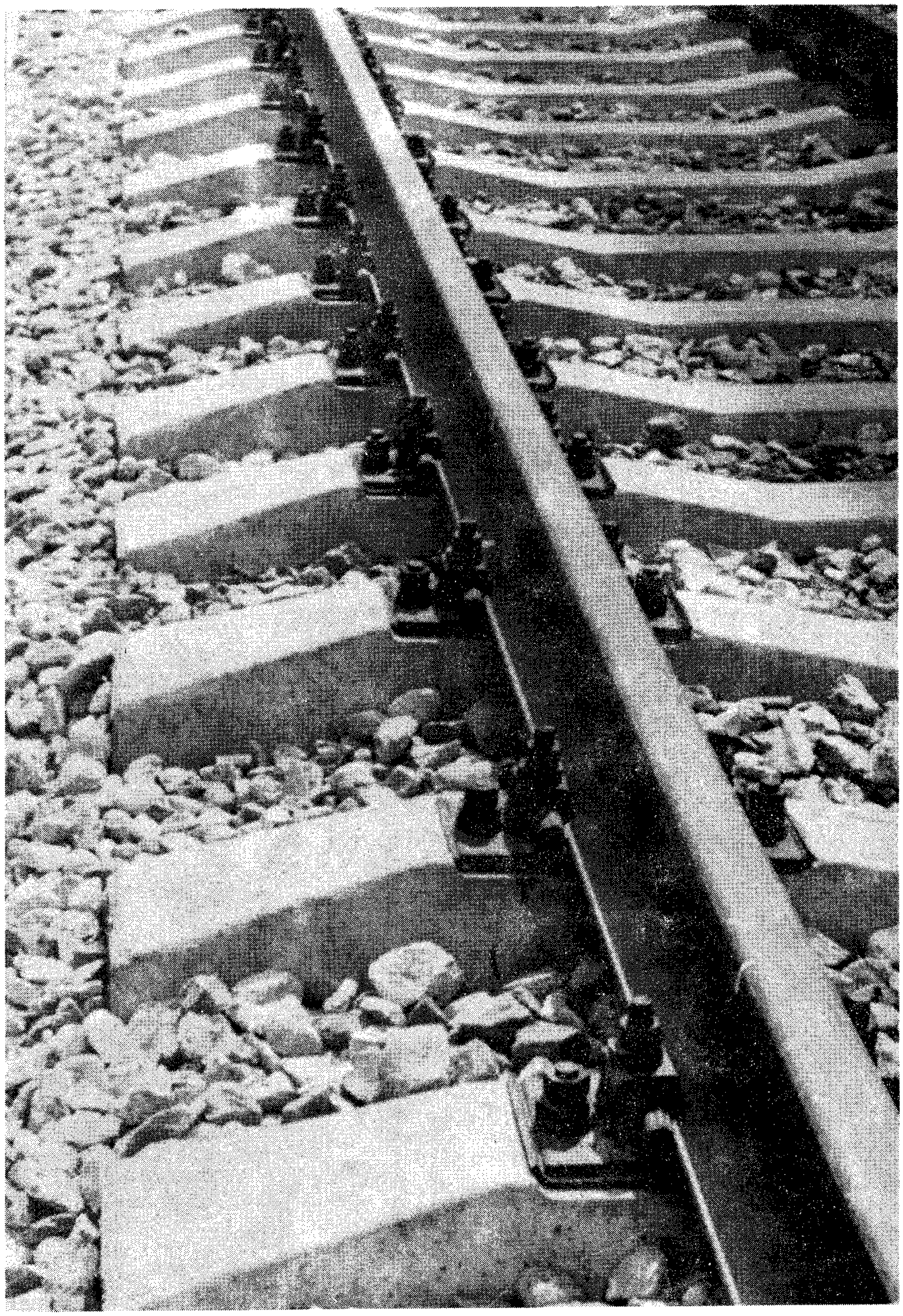


Figure 17. Track with Concrete Ties and KB Fasteners

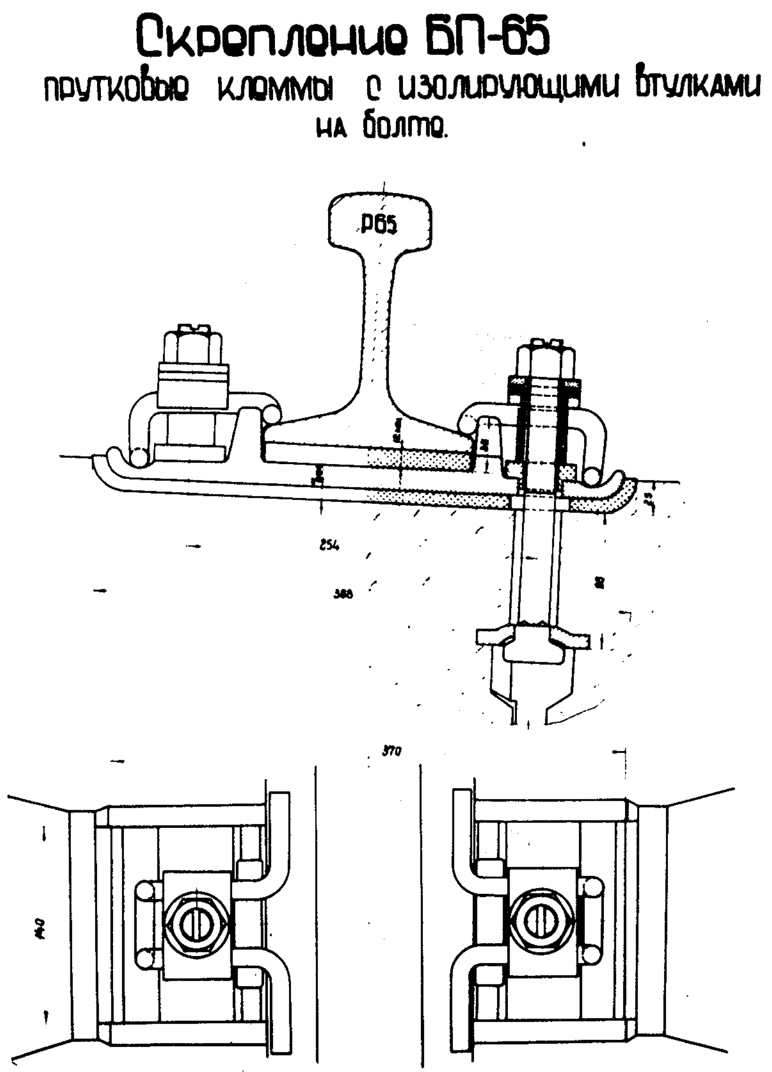


Figure 18. BP-65 Elastic Fasteners with Insulated Bolts

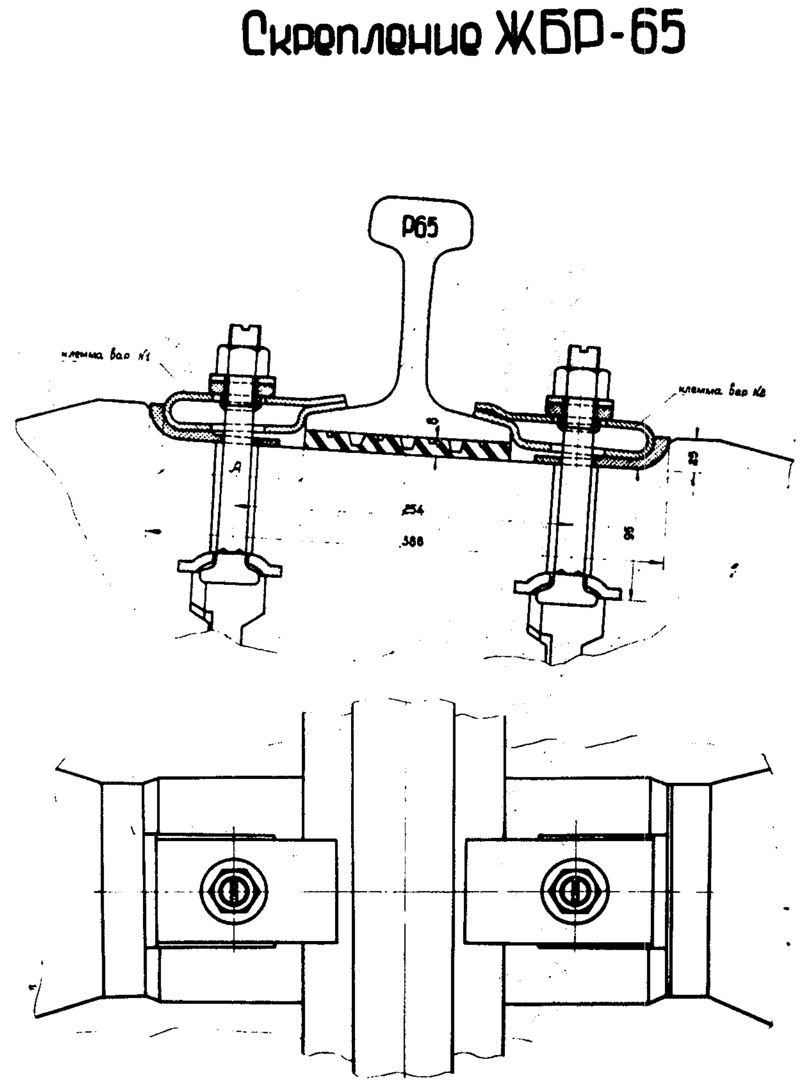


Figure 19. CZBP-65 Elastic Fasteners

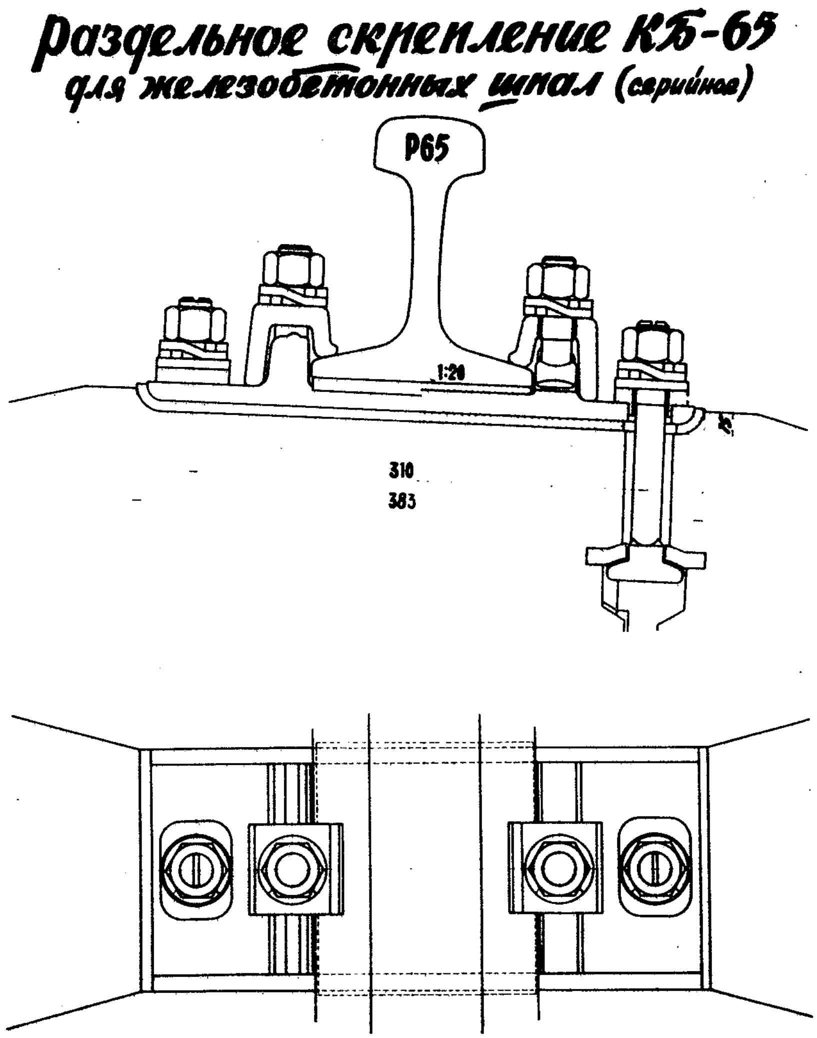
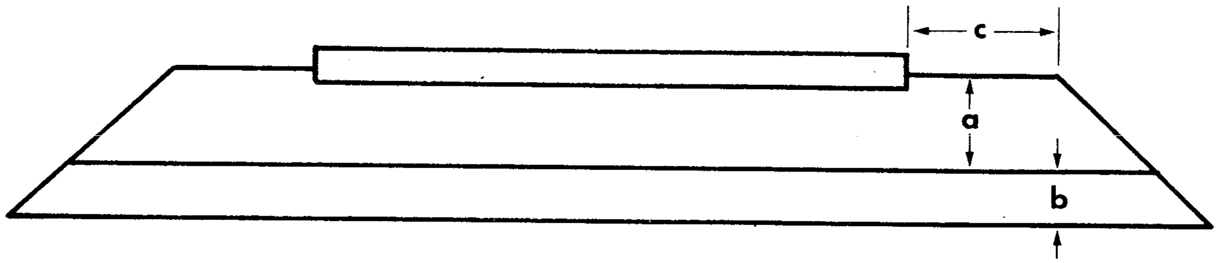


Figure 20. Production Fastener KB-65 Used with Concrete Ties

Track Structure



Standard ballast prism dimensions in the USSR are, in millimeters, as follows:

	I Heavy Traffic Main Line	II Main Line	III Secondary Line	IV Industrial Sidings
Rail	65 - 50	50	43 relay 50	43; 38; relay
No ties/Klm tangent	1840	1840-1600	1600-1440	1600-1440
Curves Radius <1200m	2000	2000-1840	1840-1600	1840-1600
Ballast	Stone & Asbestos	Stone & Asbestos	Asbestos	Diverse
Ballast with wood ties(mm)	(a) 25 mm (b) 20	25 mm 20	- -	- -
Concrete Ties (mm)	(a) 30 (b) 20 (c) 25	30 20 25	- - -	- - -

Asbestos ballast, an asbestos by-product, is the result of multiple steps of refinement of raw serpentine.

At the point of loading from processing plant bunkers, asbestos ballast is a small grained bulk material with no more than 2 percent moisture. This ballast contains over 50 percent of particles larger than .5mm, as well as a small quantity of asbestos fiber and other aggregates. These asbestos fibers and small dirt particles concentrate around larger grains of the rock particles, forming strong bonds between ballast components. This characteristic of asbestos ballast gives it high carrying capacity, comparing well with stone ballast at any traffic density and with varying track structures.

Under operating conditions which cause heavy ballast contamination, application of asbestos ballast has proven very effective, inasmuch as the surface of the asbestos ballast section develops a strong crust which inhibits or precludes ballast contamination. As a result, the intervals between ballast cleaning are significantly increased.

Asbestos ballast compacts very rapidly. Main settling (85-90 percent of total settling during the stabilization period) takes place under the first three to five trains. Alignment and leveling maintenance work is also reduced when asbestos ballast is used.

The characteristics outlined above explain why the Soviet railroads are continually increasing the number of in-service applications of asbestos ballast, notwithstanding indications that problems arise when cleaning becomes necessary, as crust development on the section surface substantially increases cleaning difficulties.

Such standards are adjusted, when main lines are being upgraded during capital repairs, as follows:

	Traffic Density		
	Very Heavy	Heavy	Normal
Million Ton-Km/Km	50	25 - 50	25
Rail Section	P-75	P-65	P-50
Tie Type	Concrete	Concrete	Concrete
Ties/Klm Tangent	1840	1840	1840
Ties/Klm Curve	2000	2000	2000
Ballast Type	Stone	Stone	Stone
Ballast Dimensions - millimeters			
a	40	35	30
b	20	20	20
c	45	35	25

TRACK MAINTENANCE

Organization

A full appreciation of track maintenance work on the railroads of the Soviet Union begins with a review of the pertinent organization structure. This is illustrated by Figure 21, which shows the organizational components and related channels of managerial authority. One major channel, pertaining to operational management, runs from the Minister to the Head of each Railroad and then to each Division Superintendent. A second and parallel channel, concerned with technical standards, practices and procedures, also begins at the Ministerial level, and runs through the Main Directorate of Track to the Railroad Track Services Sections and thence to the Track Department of each railroad. All standards and specifications come from the Ministry level and all levels below, technically, are responsible to the Ministry. Timing as to work comes from the operating end, with all planning as to schedule done at the individual railroad level. Individual railroads are also responsible for all supporting facilities such as panel construction stations, rail welding, etc. From Division level down to trackgangs there is strict responsibility for performance of light and current maintenance accomplished with rigid adherence to schedule.

The Railroad Track Services Section, by which the Maintenance of Way function is actually carried out at the operating level of each of the

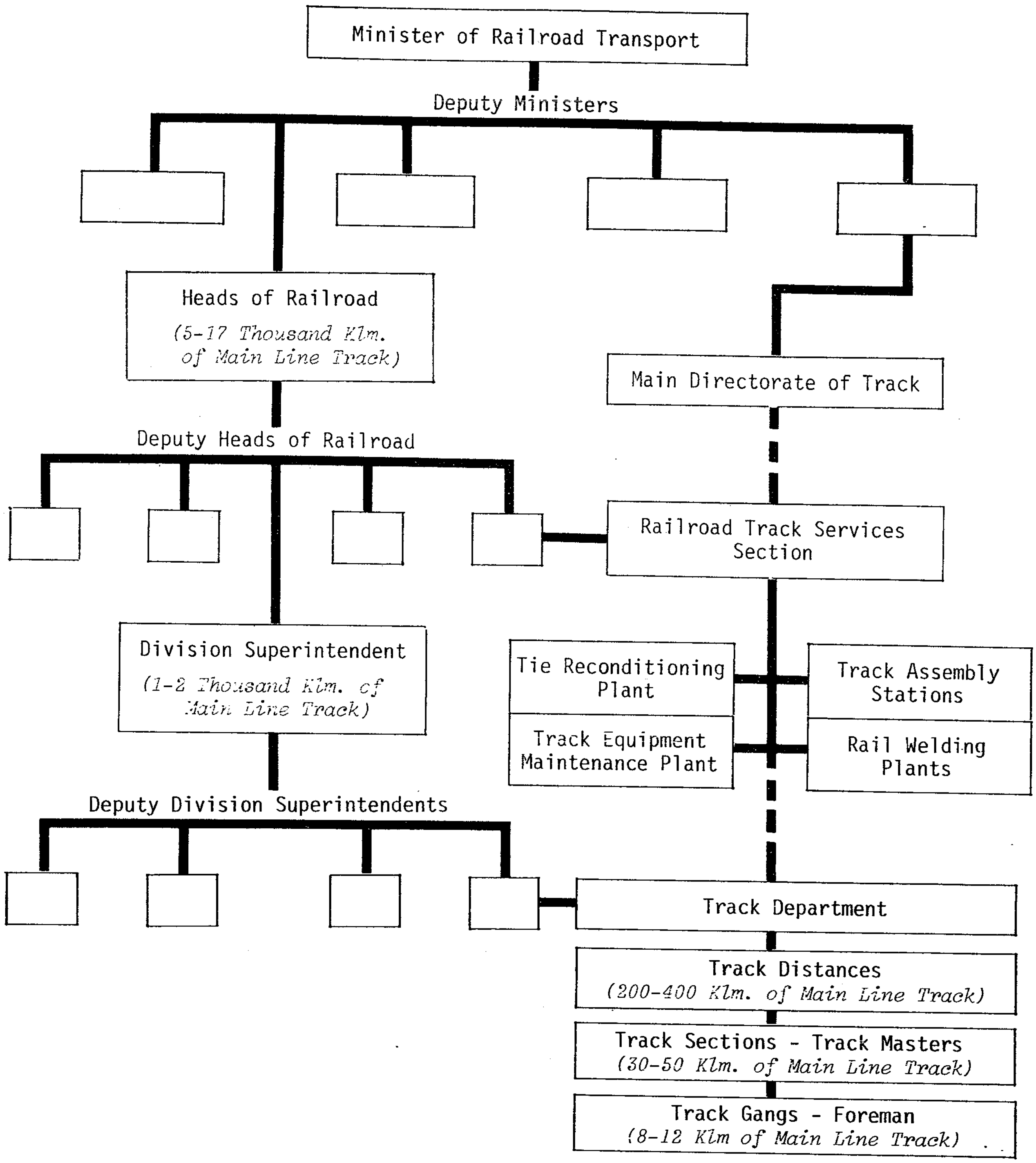


FIGURE 21

USSR TRACK MAINTENANCE ORGANISATION CHART

26 separate Soviet railroads, occupies a unique position in the organizational structure (see Figure 21). It is the lower of the two echelons at which track maintenance planning is performed, and is at the same time responsible for supervision of routine track maintenance tasks.

The Main Directorate of Track, located in Moscow, prescribes both the standards of maintenance and the methods to be used in their attainment, which are intended for uniform application throughout the system, i.e., how maintenance of way is to be performed.

Concurrently, each Railroad Track Services Section (e.g., that Section on the October Railroad between Moscow and Leningrad, or its counterpart on the Donetsk Railroad) is subject to instruction from the Deputy Chief of its Railroad as to the scheduling of its tasks, as well as budgeting control, i.e., when its work is to be done, and how much expenditure is to be incurred therefor.

Types of Maintenance Operations

Current Maintenance

This function is performed by section personnel, and consists of continuous inspection of track and its maintenance within permissible limits as set by standards.

Raising Repair (Track Surfacing)

This is work performed when track must be raised and tamped to provide for uniform track stiffness.

Middle Repair

This is performed on main line and station track when ballast sections must be renewed and strengthened. It includes:

1. Ballast clearing to a depth of 20-25 cm;
2. Replacement of defective ties;
3. Replacement of individual defective rails;
4. Repair or replacement of defective metal components in switches and other track elements; and
5. Alignment of track on curves.

Capital Repair

This is undertaken when rail must be replaced, at which time all ties are also replaced and ballast is cleaned and added to conform to new standards. The scheduling of such work depends on traffic density; it was indicated it is carried out when total traffic carried has reached 500 million gross tons/km.

Heavy Maintenance

As was previously indicated, heavy track maintenance is planned in such a manner as to create, when carried out, the least amount of interference with routine railroad operations. The USSR approach differs from that followed in the US in that it prescribes simultaneous replacement of all track components during heavy maintenance operations.

A window, or break in train operation, "okno" in Russian, is scheduled. The duration of this break is usually four hours. The required equipment is prepared in such a way that the work can start with minimum delay and proceed in the following steps:

1. A special train designed to receive track panels, consisting of a series of flat cars followed by a special crane, enters the section designated for heavy maintenance, and removes the track as it proceeds. The first panel removed from the track is turned upside down so that rails can be moved on the rollers with which each flat car is fitted. The following panels are stacked on the first. Each group of eight panels is then moved from the crane to the preceding flat cars. This process is repeated after each eight panel cycle. The train is made up with sufficient capacity to remove all track from the section worked on.

   In a case observed during the delegation's visit the track consisted of wood ties and 12.5 meter rails. The crane was designed to pick up panels of the size addressed. Figures 22 and 23 show the track panel removal process and crane, respectively, while Figure 24 shows the condition of the ballast left behind.

2. A tractor operated ballast cleaner follows the panel removal train, cleaning and grading the ballast (Figures 25 and 26).

   Another type of ballast cleaner, Model SCHOM-DO, is designed for operation under track in place, preceding the panel removal train (Figures 27 and 28). This unit is moved by a diesel locomotive but has its own power plant to operate the ballast cleaning

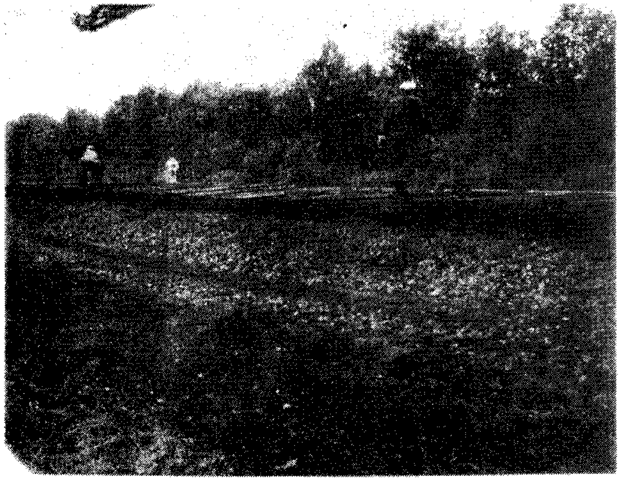


Figure 22. Wooden Tie Track Panel Being Lifted from Track

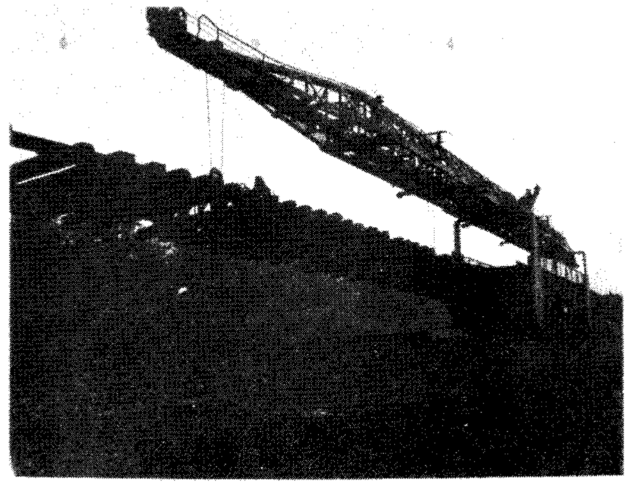


Figure 23. Crane Lifting Track Panel

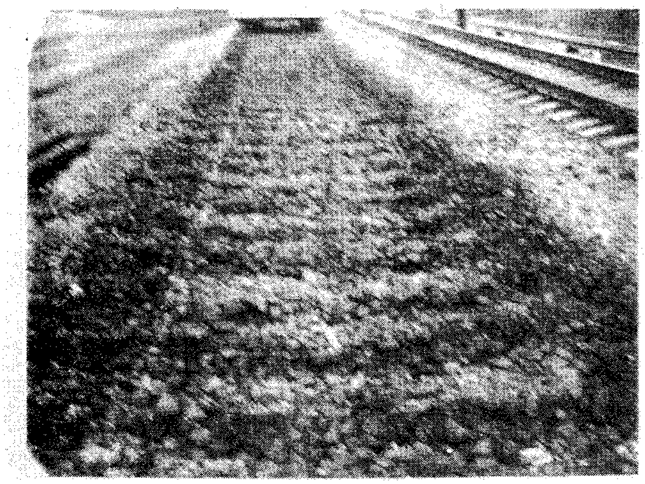


Figure 24. Ballast Under Removed Panel

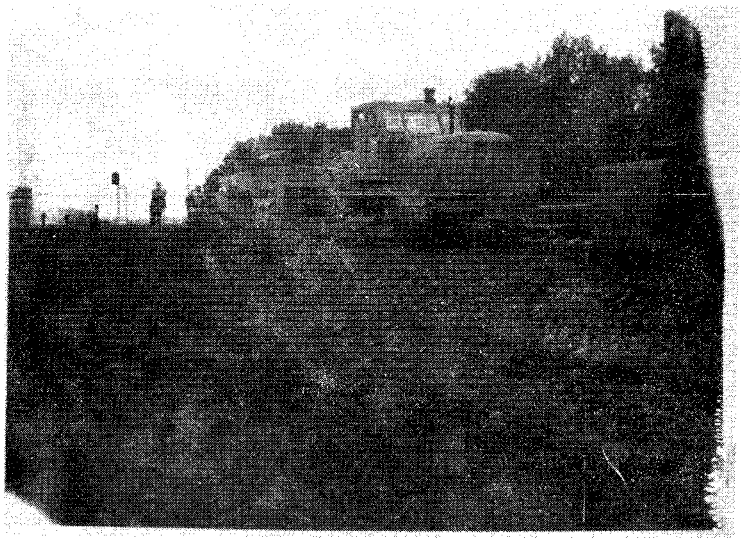


Figure 25. Tractor Operated Ballast Cleaner, Type BMY

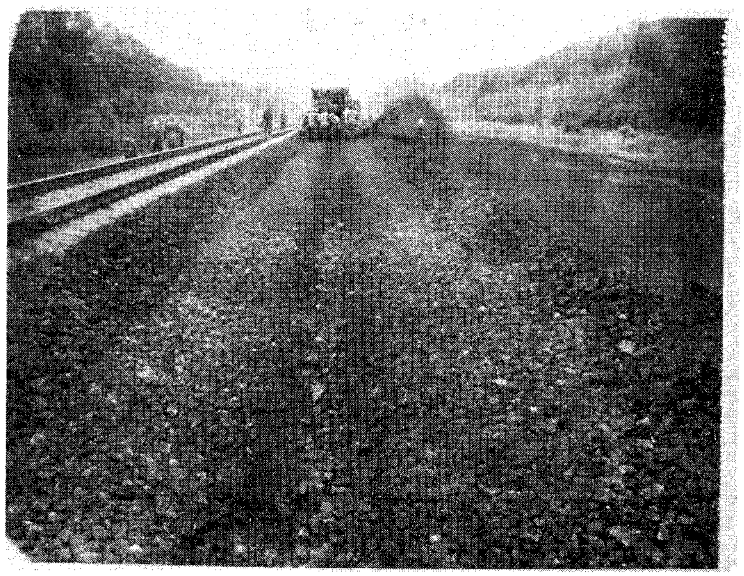


Figure 26. Condition of Ballast Behind BMY Cleaner

Figure 27. Ballast Cleaner, Type SCHOM-DO, in Operation

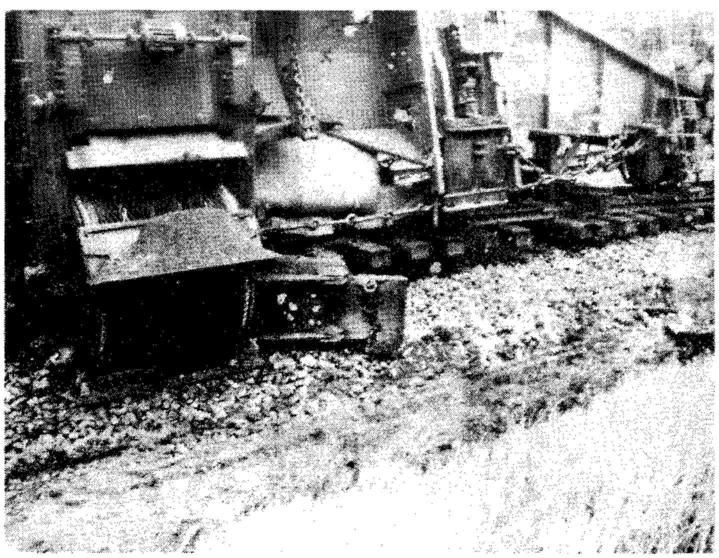


Figure 28. Close-up of Ballast Cleaning Belt

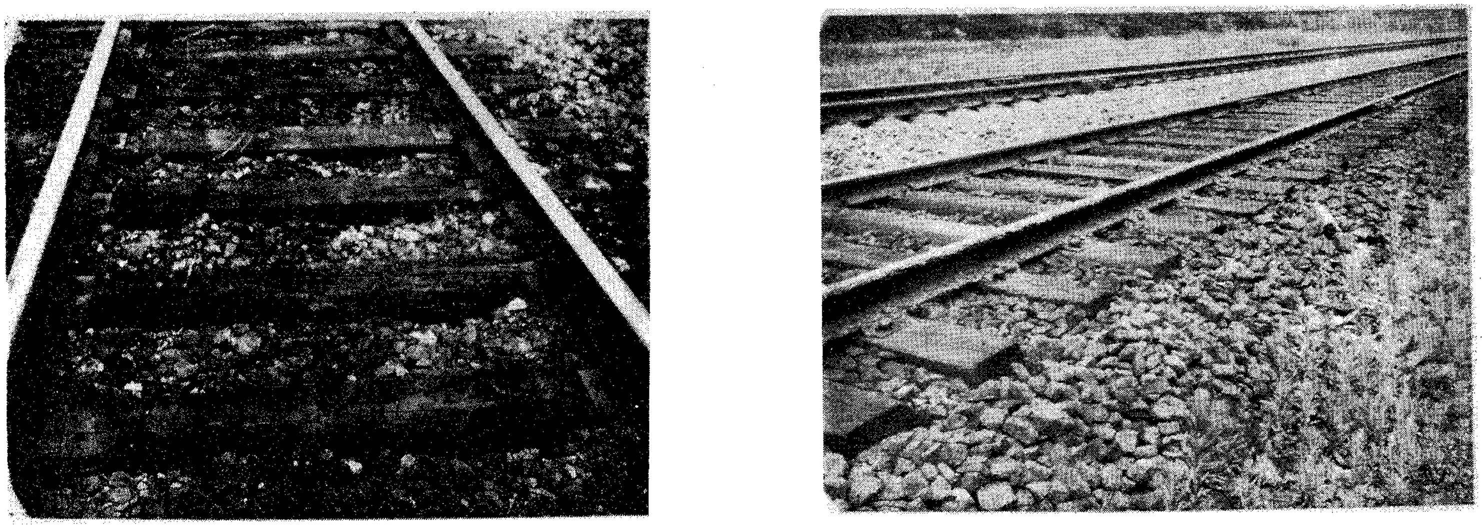
machine. In this model a plow is inserted under the track ahead of a belt which, by centrifugal force, separates the fines from the ballast and replaces clean ballast under the track. Figures 29(a) and (b) show the condition of the ballast in its original condition, while Figure 30 shows the same track after such a cleaning operation.

3. The ballast cleaner is followed by a panel placement train. The new track panels have been prefabricated at a special station that will be described later. The new track consisted, in the case observed, of 25 meter rail and pre-stressed concrete ties. Panel replacement trains consist of a crane followed by flats loaded with the exact number of panels required to rebuild the selected track segment.

   As the panels are lowered on the clean ballast they are temporarily attached to the track on the ground and aligned with the adjacent track, Figure 31. The train then advances over the just-placed panel.

4. Behind the panel-laying crane, a gang puts permanent connections, as illustrated by Figures 32(a) and (b). Figure 32(c) shows the completed panels in place.

5. A ballast train then follows, which meters the proper amount of ballast to fill the space between and at the end of the ties. The ballast cars, Figures 33, 34 and 35, are so designed that



(a) (b)

Figure 29. Condition of Ballast and Track Prior to Heavy Rebuild

Figure 30. Ballast Behind SCHOM-DO Ballast Cleaner

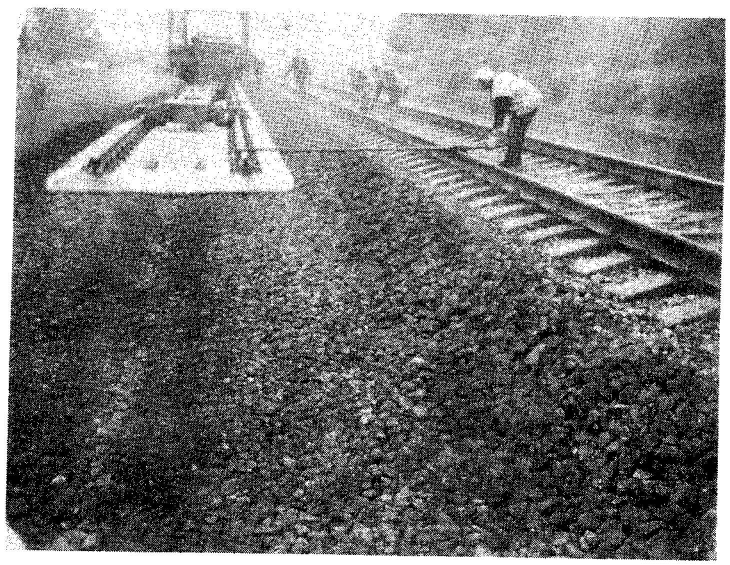
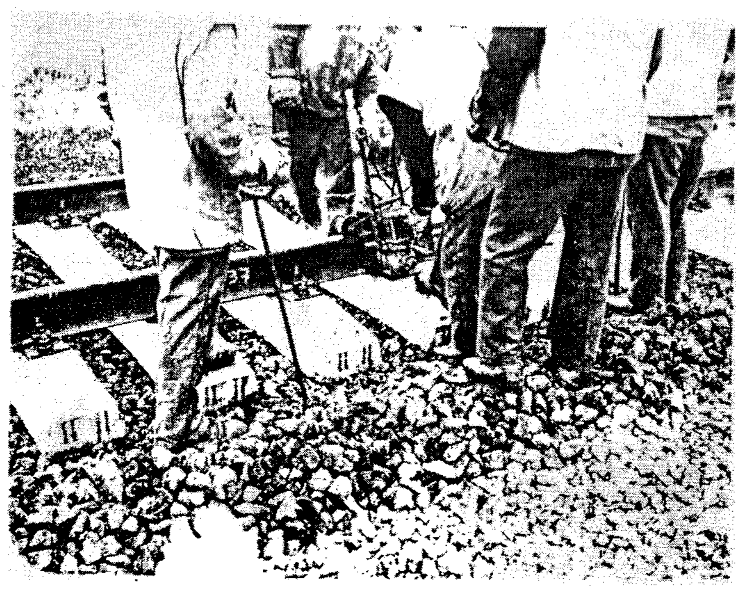


Figure 31. Lowering and Alignment to Adjacent Track of New Concrete Tie Panel



Figures 32(a) and 32(b). Joint Bar Installation and Completed Placement of New Track Panels

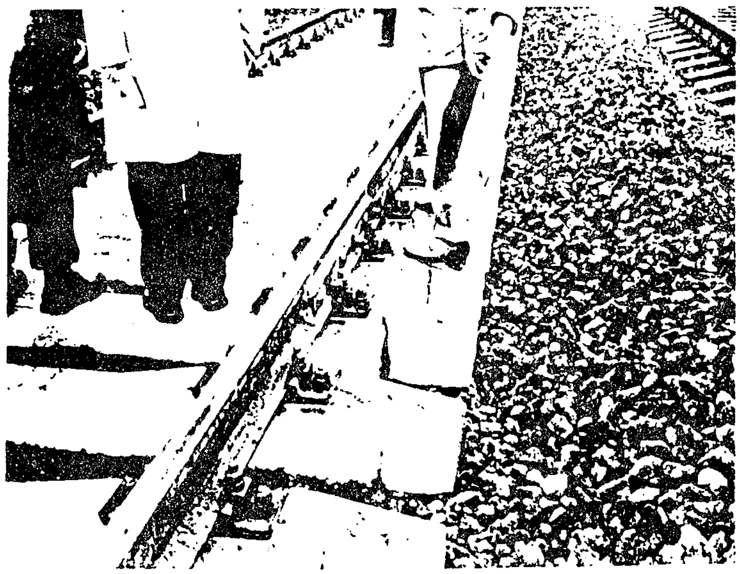


Figure 32(c). Joint Bar Installation and Completed Placement of New Track Panels

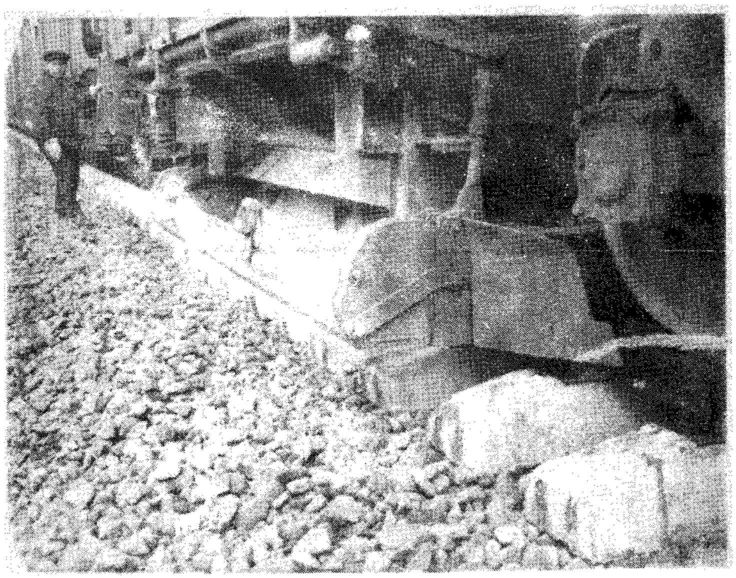


Figure 33. Ballast Metering Car, Type TSNII-DV3

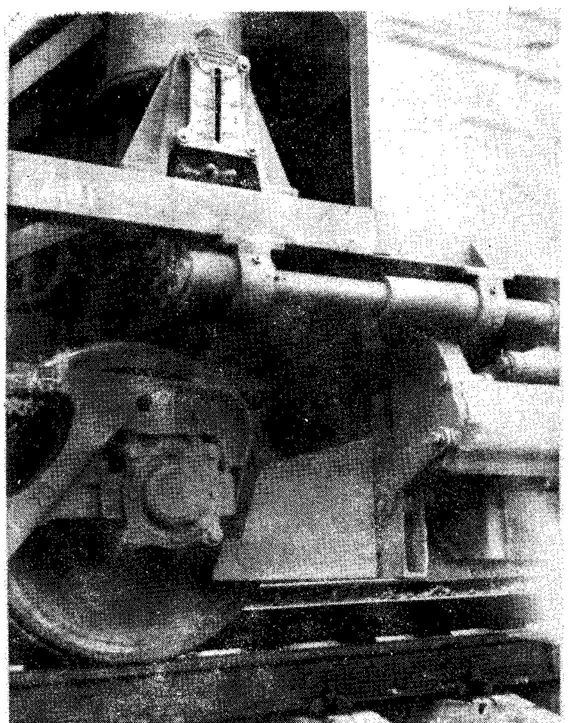


Figure 34. Detail of Metering Control

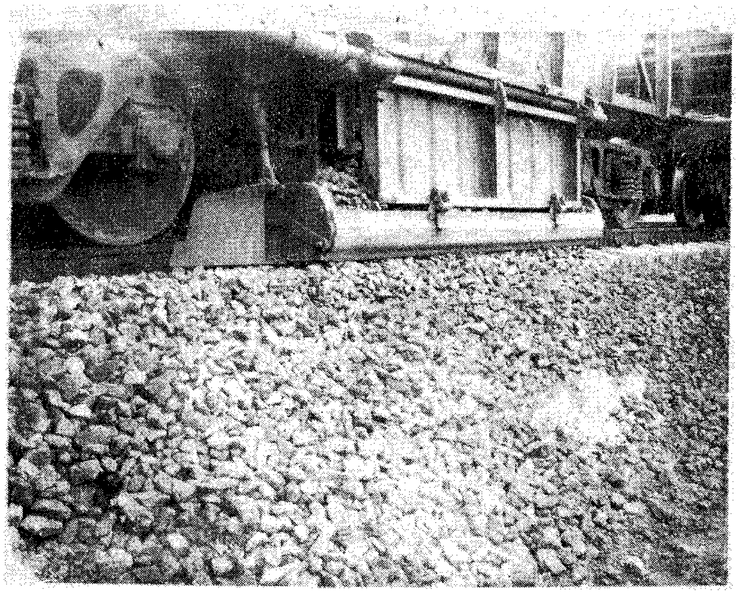


Figure 35. Ballast Metering Car in Operation

at a given speed they meter out proper amounts of ballast. A special metal skid is placed under each ballast car so that no ballast falls in the middle of the ties thus avoiding center binding.

6. The last operation is compacting the ballast and shaping the ballast crib, Figure 36. The unit we observed is a new machine that did the work by vibrating the ballast toward the track center from the tie ends, while continuously moving. Figure 37 shows track after completion of heavy repair.

It was stated that this heavy maintenance method can completely replace 1.5 track klm during a four hour period and the maintenance and operating schedule calls for two such intervals every week. Thus, 1.5 x 2 x 52 or 106 track klm can be completely rebuilt by one such complement of equipment in a year.

On completion of the work described the track is open for operation at speeds up to 30 klm per hour after the first train; at the end of 24 hours the speed restriction is removed.

Welded rail is applied at a later date. Some additional tamping is done by regular maintenance crews as needed between train operations.

Support Facilities

The immediately preceding discussion stressed the Soviet planning criterion which mandates minimal interference from track maintenance

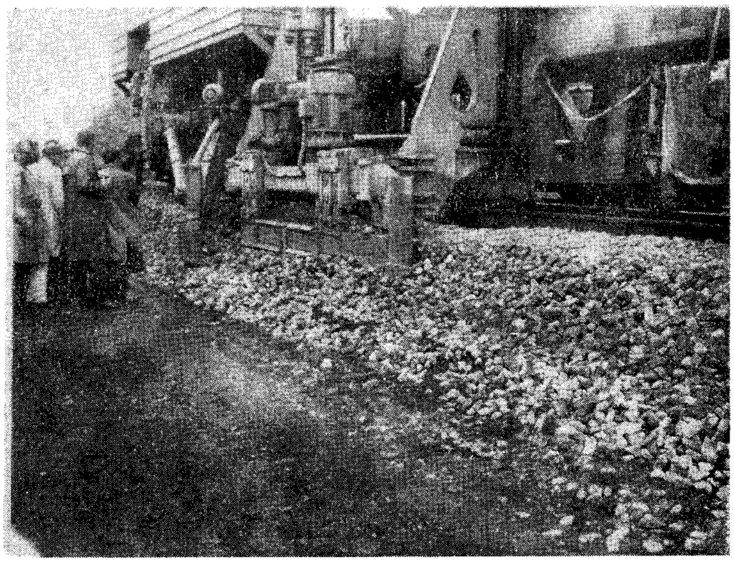


Figure 36. Continuously Operating, Raising, Tamping, and Dressing Machine, Type BPO-3000, in Action

Figure 37. Completed Track After Heavy Repair

activity upon normal operating patterns, in illustrative consequence of which, the movement of prefabricated track panels to maintenance sites was mentioned.

Track panels are prefabricated at facilities designated as Track Assembly Stations which, together with Rail Welding and Tie Reconditioning Plants, are support facilities for track maintenance on each railroad. The number and size of these facilities on a given railroad varies with the particular requirements of that railroad.

Two panel fabricating plants, one outside of Kiev and the other at Krasnyi Liman, each with a capacity quite different from the other, as well as a wood tie renovating or reconditioning plant, were observed.

Track Assembly Station

This facility, operating at the individual railroad level, is responsible on each railroad for:

1. Assembly of track panels;
2. Recovery of materials from old panels;
3. Actual panel placement in service; and
4. Operation of ballast cleaners.

Steps in Panel Assembly

The first step in panel assembly is proper tie spacing, which is accomplished by tie placement on specially marked rails. Next, tie plates with elastic pads are bolted to the ties. The rails are then laid on the tie plates and bolted down, with rail spacing controlled to the proper gauge. A second elastic pad is placed between tie plate and rail base. Figures 38, 39, 40 and 41, illustrate the track assembly process, while Figures 42, 43 and 44 show the completed panels in storage.

The panels returned from the track are disassembled and the material is classified for future use. Figures 45 and 46 show the removal of wood ties and their separation between those to be restored and those to be scrapped.

The work of this plant is scheduled so that it sends out a track laying group twice a week, normally on Tuesdays and Thursdays. It employs 450 people at the station location and 200 in the field. The field force consists of two 100-man gangs, each spending two weeks in the field and then laying off two weeks.

In addition to its track panel function, this station cleans about 500 klm. of ballast/year.

Rail Welding Plant

At Krasnyi Liman a rail welding plant was observed. While not the most modern in the USSR, this was a high production plant with two welding lines, one for relay and the other for new rail. Inspection occurred on a Saturday, an off-day, and the skeleton force on duty was there for

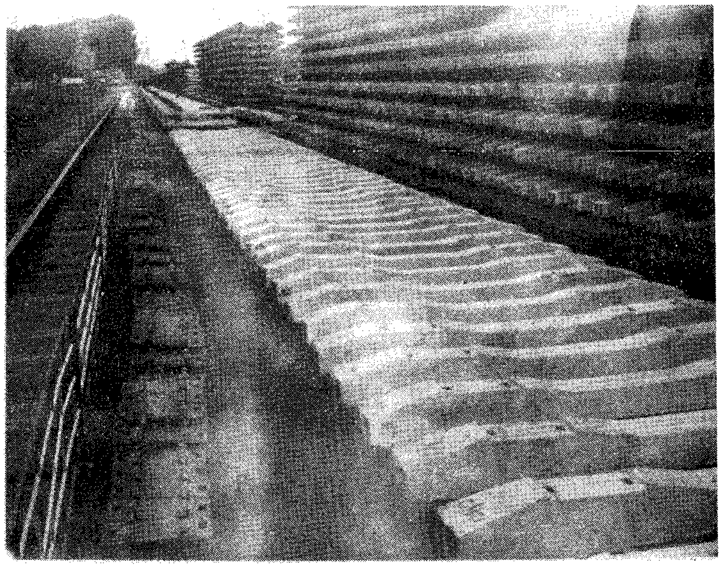


Figure 38. Concrete Tie Spacing

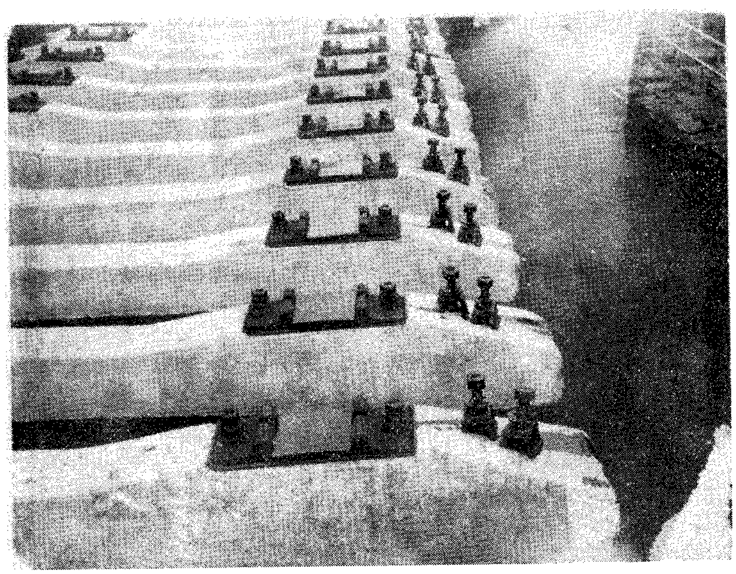


Figure 39. Tie Plate Installation

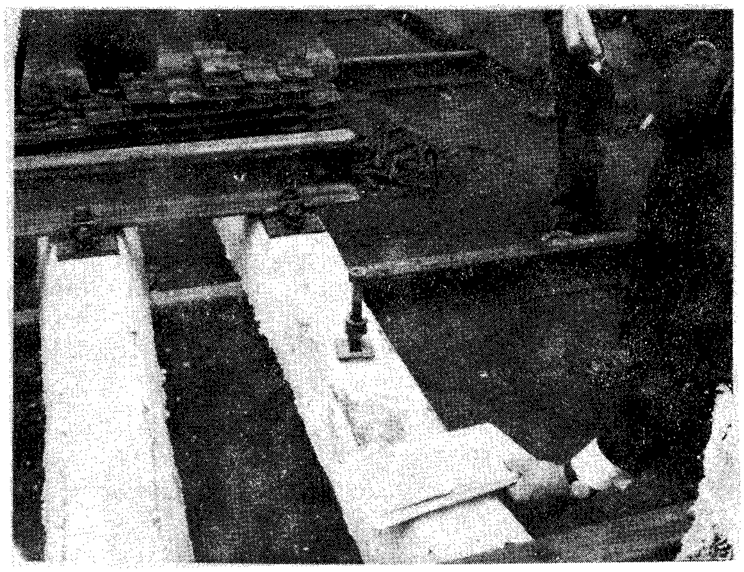


Figure 40. Rail and Rail Fastener

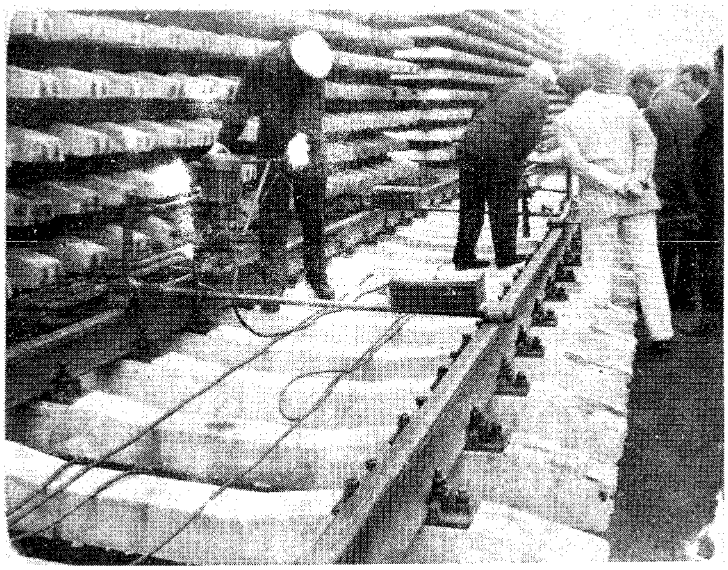


Figure 41. Tightening of Rail Fasteners

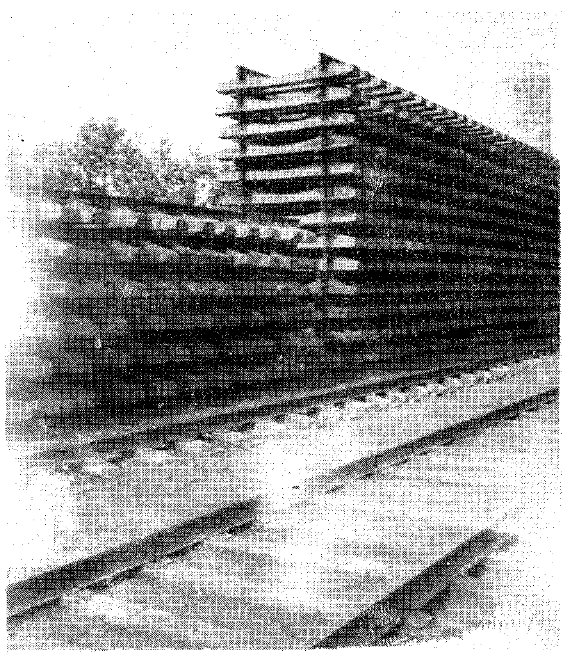


Figure 42. Storage of Completed Panels

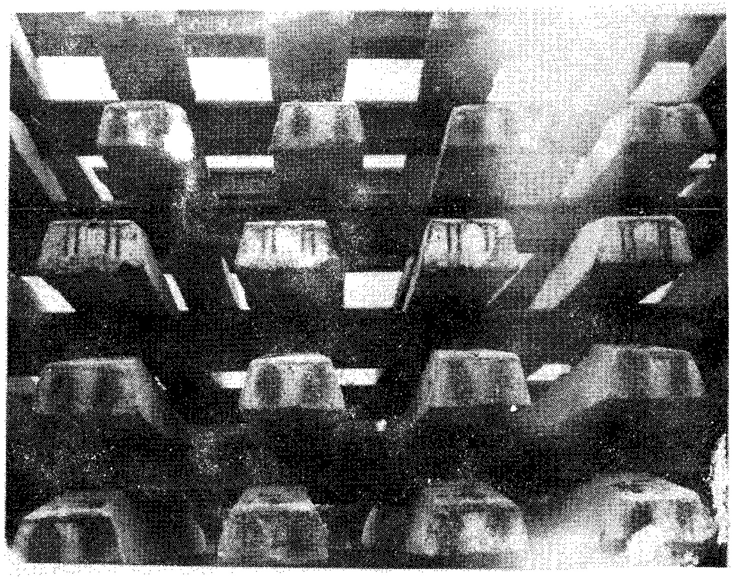


Figure 43. Detail of Tie Ends

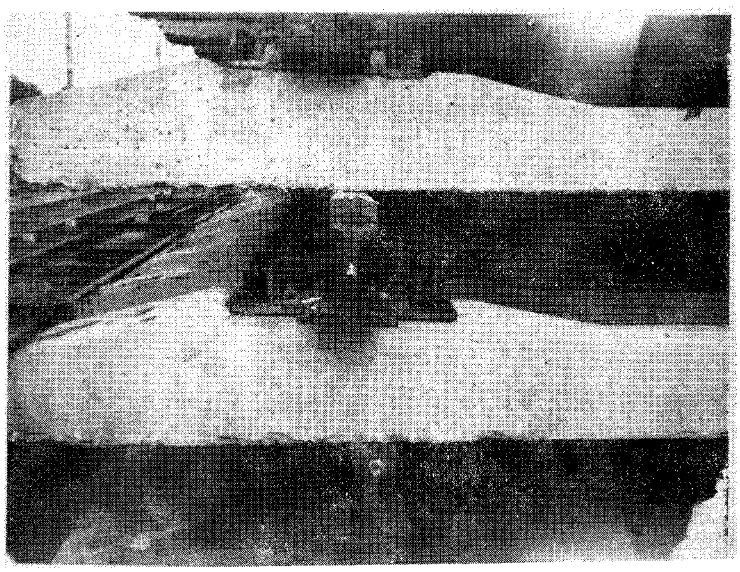


Figure 44. Detail of Rail Ends

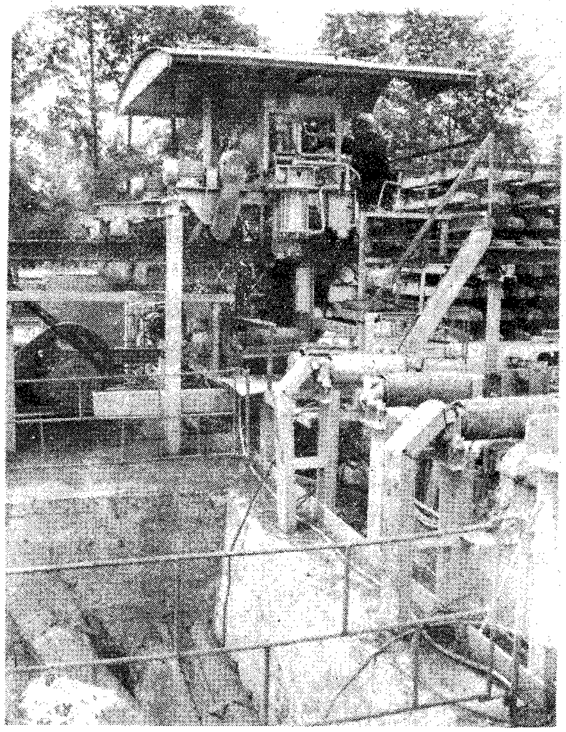


Figure 45. Disassembly of Old Panels

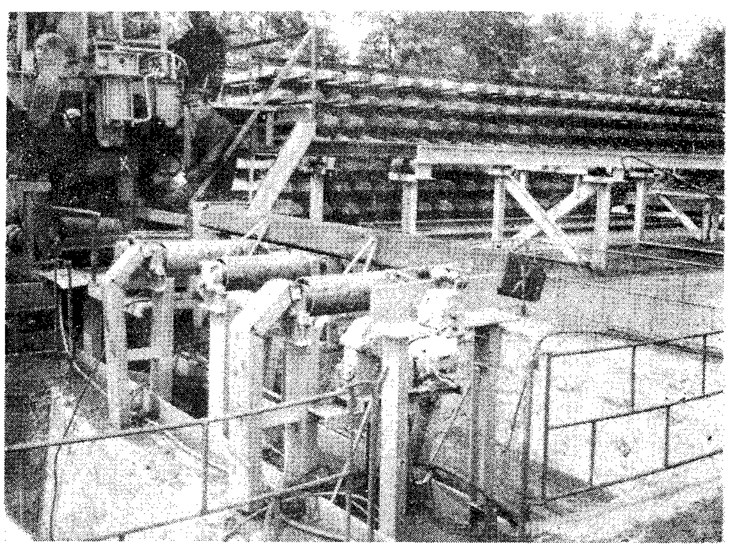


Figure 46. Classification of Old Ties

the sole purpose of demonstrating the operation. The plant has a normal working staff of 220.

Relay rail is first inspected and washed. Then the ends are cropped and the lengths welded in a continuous strip, which is subsequently cut in 25 meter lengths and drilled for jointed rail use, with drilled holes carefully reamed. New rail is welded in 800 meter lengths, with all welds ultrasonically inspected prior to storage. In both cases, the machinery used is positioned to maintain the sequence of operations; transfer of rail from position to position is automatic.

A rail washing station was just being installed; it appeared to be quite elaborate.

In addition to the fixed installation, the facility operates two grinding trains to grind in-place rail. The welding machines were developed by the Paton Welding Institute in Kiev, each weld taking 3 minutes 40 seconds to accomplish. The upset produced by the flash is chiseled off by two men and then ground smooth and normalized to assure that hardness at the weld is uniform with the remainder of the rail.

The output of this plant is 1200 lineal kilometers per year, with two shifts working five days a week. An additional responsibility of this plant involves restoration of frogs in the field. Figures 47-51 illustrate various activities at this facility.

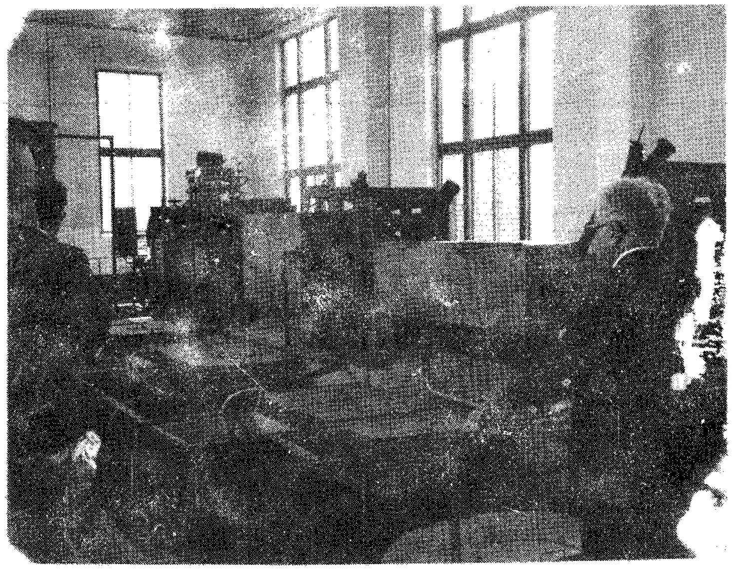


Figure 47. Cleaning of Used Rail, Prior to Welding

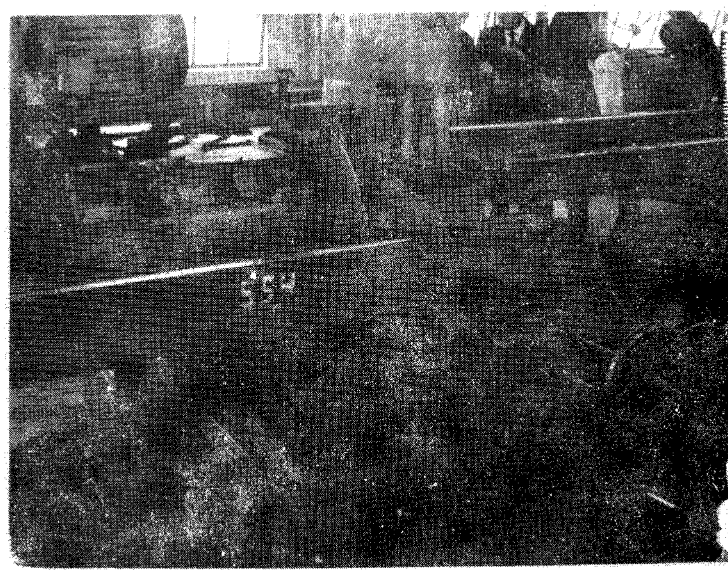


Figure 48. Cutting Ends of Used Rail, Prior to Welding

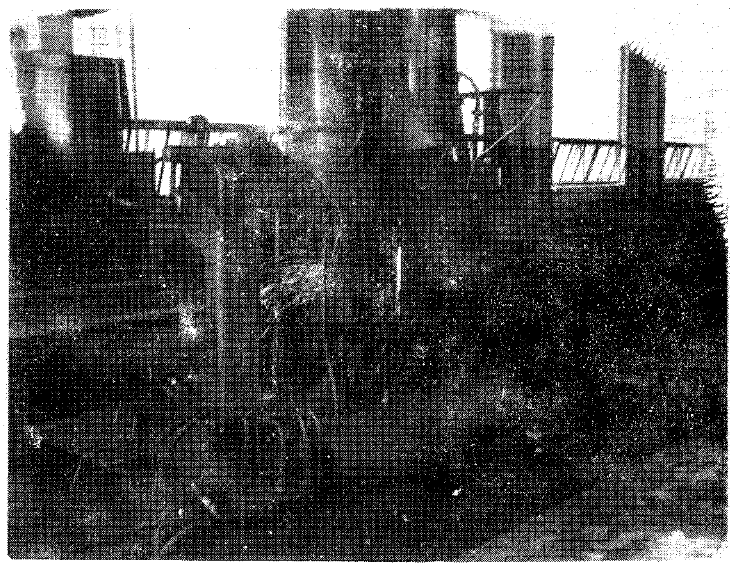


Figure 49. Welding Operation

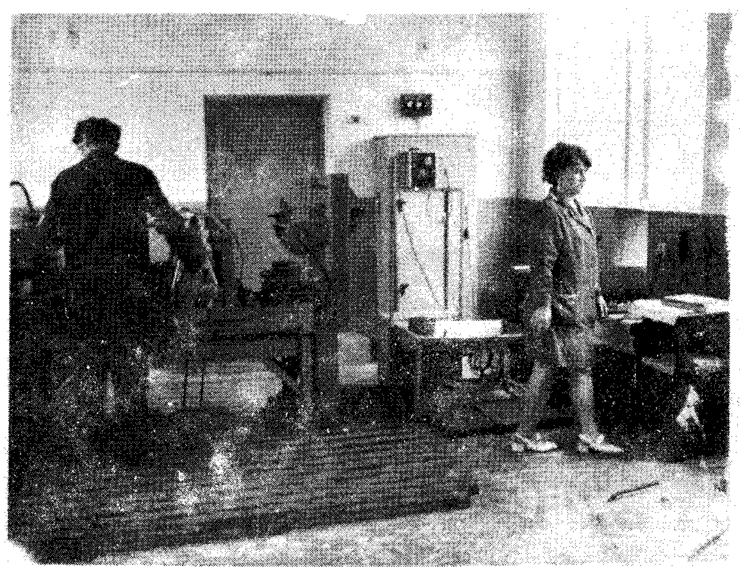


Figure 50. Rail Weld Inspection

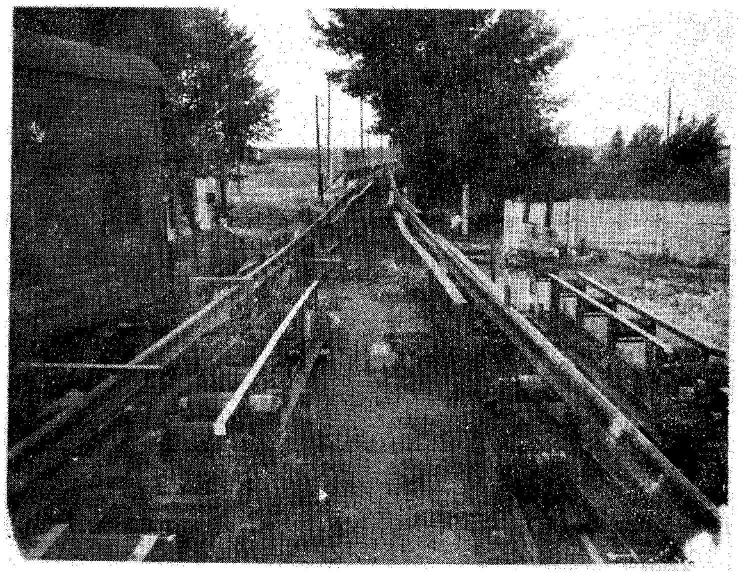


Figure 51. Storage of Rail Welded Strings

Tie Renovating Plant

Ties removed from track in service and selected for reconditioning are brought to special plants, one of which the delegation observed at Krasnyi Liman. Since the visit was on a Saturday, the plant was not in operation, but it was clear that the layout was production oriented; the plant was said to have a capacity of 800 ties per day.

Timber Tie Reclamation

A well-organized effort is made to salvage re-usable timber ties and recondition these for further service in secondary and yard trackage. Typical Station output is 800 reclaimed ties per eight-hour shift; staffing being 21 workmen. Ties per Station returned to service each year by the procedure described below, range from about 50,000 to a maximum of 200,000.

Rail-tie panels loaded during field rehabilitation of track are returned by carload to an appropriate Station for dismantling. Panels are stock-piled from the cars for subsequent processing. The break-down operation consists of extracting a panel from a vertical stack, advancing it past a work station manned by two laborers who simultaneously strike each tie from the paired-rails so that each falls upon a short conveyor (see fig. 46) operating normal to the production line. Spikes and plates are separated and at this point a quick, visually qualified decision is made selecting or rejecting candidate ties for reconditioning. If a decision is made to reject, then that tie is manually thrust off the conveyor to one side. Remaining ties proceed to the end of the conveyor and are discharged to a collection point at the other side of the conveyor.

The actual rehabilitation process consists of five steps sequentially progressed on a production line:

1. re-adzing of new plate seat;
2. re-drilling of over-size holes (1 to 1.5 inches [25.4 - 37.9 mm]) at previous spike hole locations;
3. insertion of cylindrical wooden plugs into drilled holes;
4. transverse dowelling of tie ends to arrest checking and splitting; and
5. unpressurized treatment of newly-exposed wood surfaces.

The technique described is of interest to the US maintenance of way community because it represents one way to accommodate the large numbers of re-usable ties that will accumulate should stressed concrete cross ties gain wide acceptance at home. Experience has shown that stressed concrete ties cannot be utilized on a one-for-one basis in timber tied track, they must be installed out-of-face, point to point. Evidently, if the performance benefits of concrete cross ties are to be completely realized, provision must be made for, not only salvaging re-usable timber ties, but, also the further use of these. Contemporary Soviet practice suggests a solution to a problem as yet unconfronted in the US.

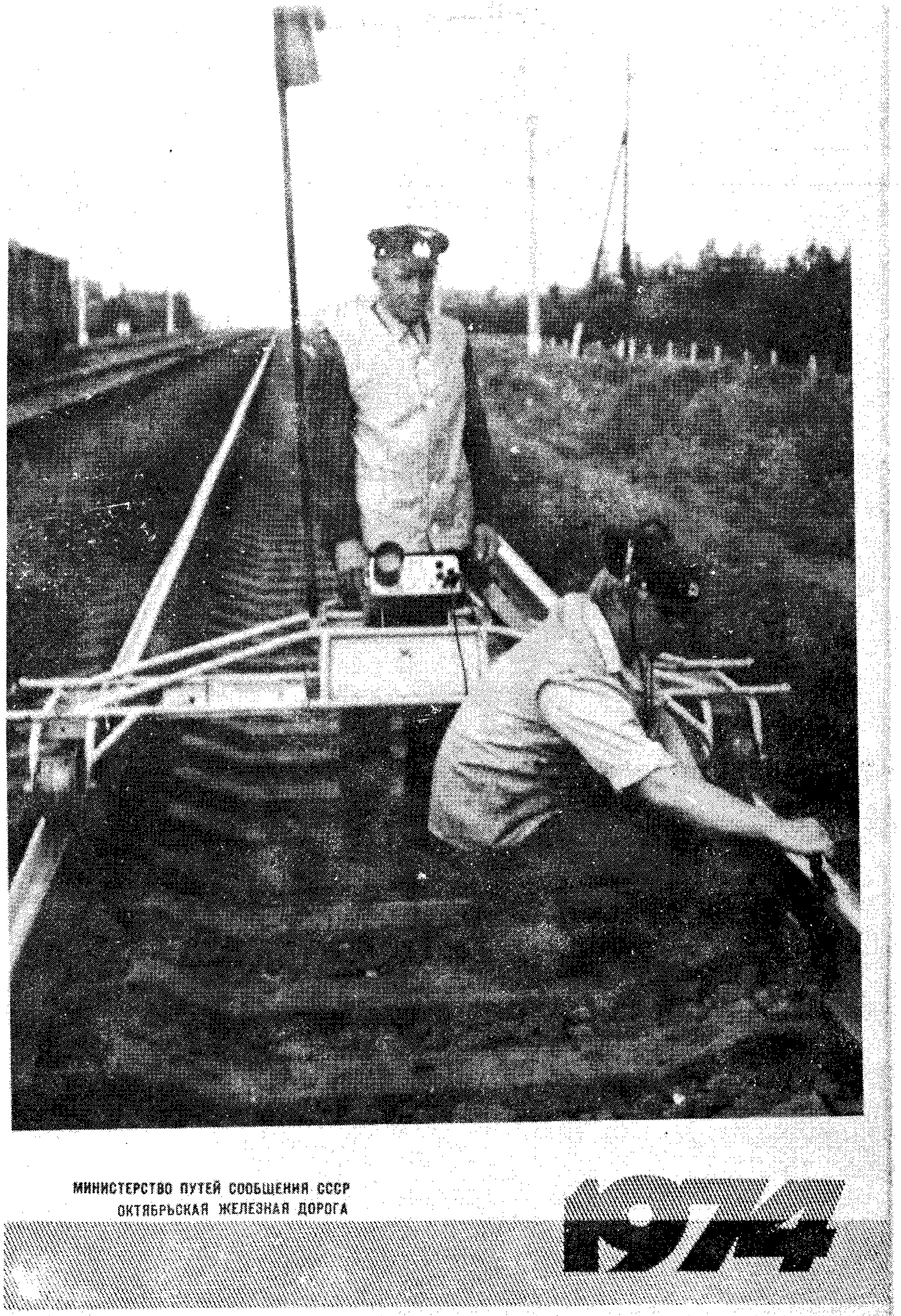
TRACK INSPECTION

One of the important means of maintaining safe operations on the railroads of the Soviet Union is by thorough and continuous track inspection.

First, the two lowest levels of the Railroad Track Organization (i.e., Sections and Gangs, see Figure 21) have the responsibility of conducting continuous systematic track inspection and maintenance as specified by the Ministry. One of their duties is tightening of rail fasteners and joint bars, carried out with concurrent careful inspection for rail flaws.

Figure 52 shows hand operated magnetic and ultrasonic rail defect inspection equipment, similar to Krautkramer L/C ultrasonic equipment used by local forces, and with which all sections are equipped. This equipment, with which the October Railroad checks its track twice a month, is used, among other things, to check for otherwise undetectable bolt hole cracks.

Manual inspection for track defects is supplemented by the operation of a magnetic rail defect detector car, which is described in detail below. In addition, track geometry cars operate on all the railroads, checking for alignment and other defects. As an example of the extent of inspection equipment available to track maintenance forces, the October Railroad



* Chudovo distance (of the way)
Testing of welding joints with the help of desectorscope DUK 13

Figure 52(a). Manually Operated Defect Detection Cart

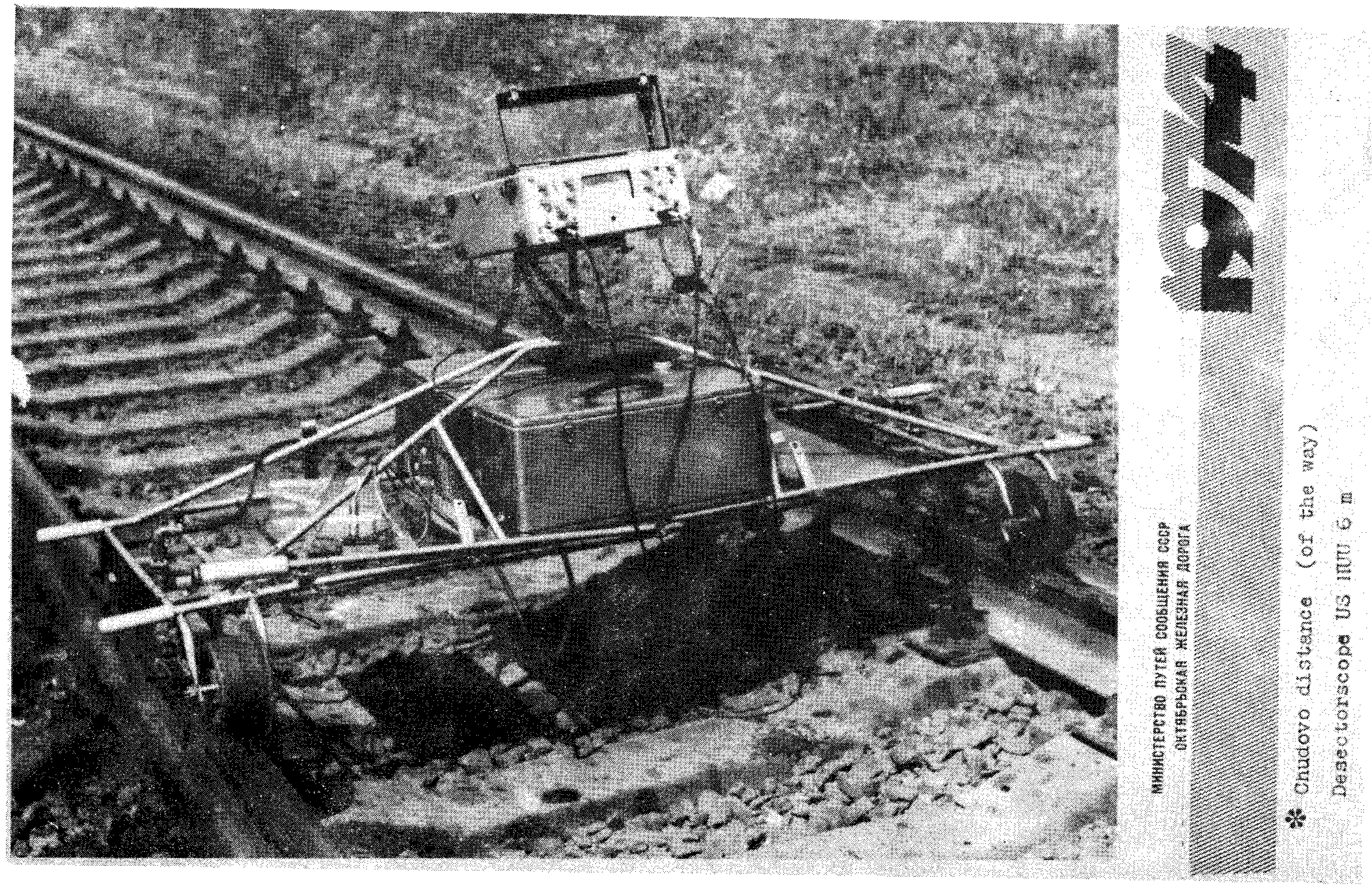


Figure 52(b). Manually Operated Defect Detection Cart has four magnetic inspection cars such as the delegation observed, and 240 of the manually-operated carts equipped with magnetic and ultrasonic detectors. It was indicated that all other Soviet railroads are similarly equipped.

It is estimated that there is a total of 6000 inspection carts in the USSR, and that all track is checked at least once every five days.

Performance of the rail gangs is judged from track condition, the rating being developed from data obtained by the track geometry cars.

It is instructive to observe the extant US equipment is more accurate than that used in the USSR, but much slower. A matter of common interest to both systems and now under investigation by both, is the growth of defects under current operating conditions.

Rail Defect Detector Equipment

Rail defect detection is accomplished with a variety of equipment, such as the magnetic defect detector car observed by the delegation in operation on the October Railroad. This car was designed to operate at 80 klm./hr. (48mph), and can detect rail flaws down to 20 percent of railhead cross section. While this is not as effective as L/C Ultrasonic or inductive L/C Equipment, which perceives defects reaching to 10 percent of head cross section, it performs defect detection at much greater speed and this facilitates frequent track inspections. Figures 53, 54 and 55 show, respectively, the car's recording equipment and sensor, and samples of rail defect recordings. The October Railroad was said to check most main line track with this equipment twice a month.

This equipment works on the principal that the sensing head induces two magnetic fields in the railhead, and the flaws produce a change that can be detected by the current variation induced in the sensing unit. This change in current is recorded on a chart. Various flaws have characteristic signatures by which they are identified. For example, Figure 55 shows defect 26.3, which has the following significance:

2 -- transverse crack in the head area

6 -- due to poor weld

3 -- in the weld area

The table of defect classification chart reproduced as Figure 56 illustrates the system of defect identification and codes used on the Soviet railroads.

With the type of detector equipment in use, such defects as transverse fissures, transverse defects caused by shelly spots, vertical split heads and horizontal split heads can be detected, but defects such as bolt hole cracks cannot.

Track Geometry Car

The track geometry car seen on the October Railroad was very similar to the Amsler design equipment used on some US Railroads, in that all

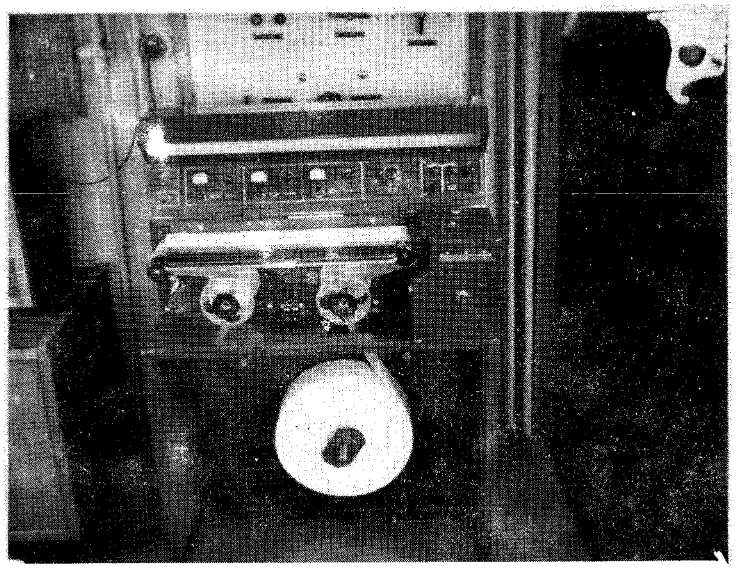


Figure 53. Recording Equipment on Magnetic Defect Detection Car

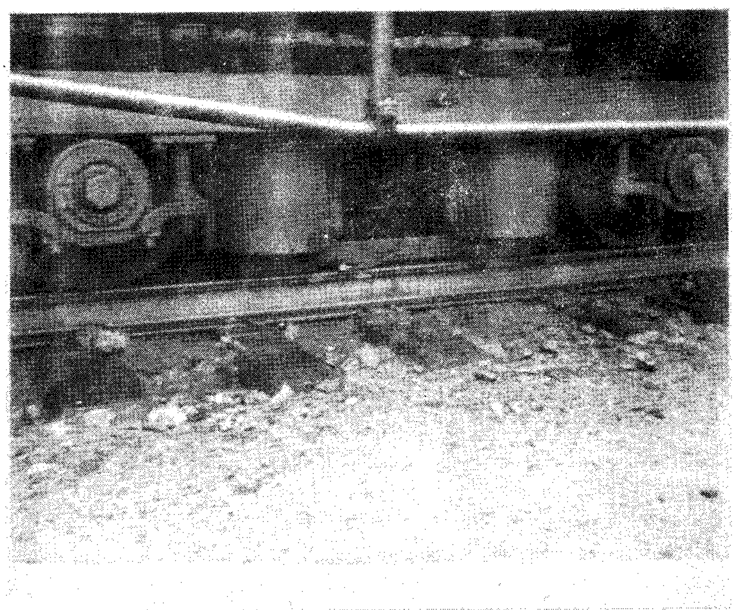


Figure 54. Sensing Unit on Magnetic Defect Detection Car

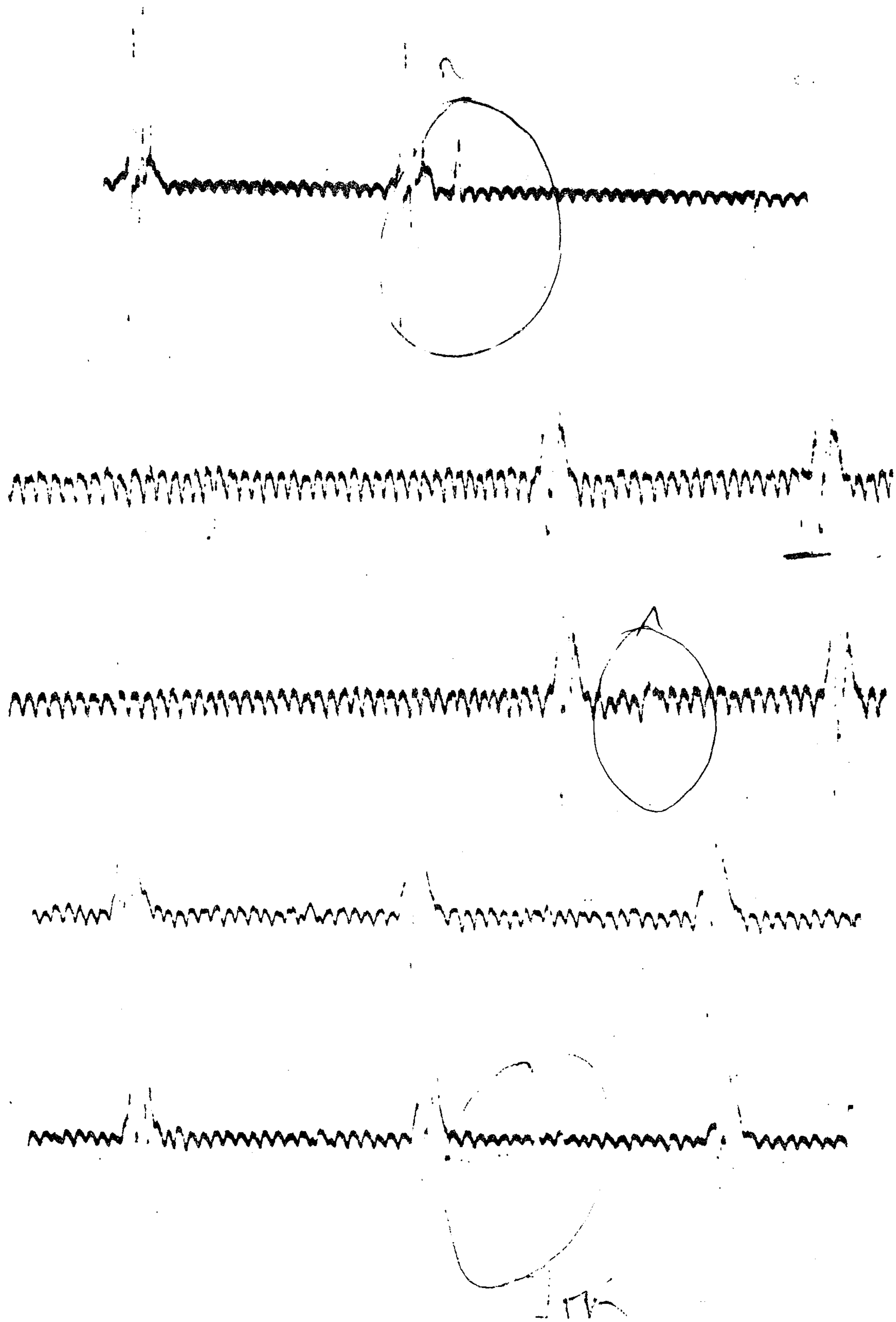


Figure 55. Samples of Rail Defect Recordings

Area of Rail Section	Location of Defect (First Number of Identification) \ Cause of Defect (Second Figure of Identificatuion)	0 Deficiencies due to Mfg.	1 Deficiencies due to Metal Strength	2 Deficiencies in Rail Section and Fastenings	3 Deficiencies of Maintenance of Track	4 Due to Motion of Rolling Stock	5 Impact and other Mechanical Damage	6 Technology of Welding	7 Technology of Heat Treatment	8 Technology of Weld Build-up and Fastening	9 Other Causes
Head	1 Lamination and shelling of metal on the surface of Rail Head	10 1-2	11.1-2			14.1-2			17.1-2		
	2 Transverse Cracks in the Head and Breaks due to them	20.1-2	21 1-2			24.1-2	25.1-2	26.3-8	27.1-2		
	3 Longitudinal cracks in Rail Head	30r 1-2, 30s 1-2								38.1	
	4 Flow and Uneven Wear of Rail Head	40 1-2	41 1-2		43.1-2	44 2		46 3-8	47 1		49.1-2
Web	5 Defects and Damage to the Web.	50.1-2		52 1-2	53.1-2		55.1-2	56.3-8			59.1-2
Base	6 Defect and Damage to the Base.	60 1-2		62.1-2			65.1-2	66 3-8			69 1-2
Complete Section	7 Complete Break in Rail	70.1-2				74.1-2					
	8 Bending of Rail						85.1-2	86 3-8			
	9 Other Defects and Damage.										

Third digit of identification: 1 Defect in the Joint; 2 " outside "; 3-8 " IN weld area; 3 Butt weld; 4 High speed Thermic; 5 Regular "; 6 Gas weld with pressure; 7 " " by melting; 8 Arc weld

Figure 56. Rail Defect Classification Chart

measurements are made mechanically and transferred to recording charts by means of pen recorders.

Records are made on 2 identical charts of gauge (except gauge through turnouts), alignment and surface of right rail, alignment and surface of left rail, superelevation and speed. The measuring frame, similar to but smaller than that used by Amsler, is also equipped with smaller sensors. These are retractable while going through switch points. One set of record charts is given to the roadmaster, the other kept on the car for use by track-rating experts.

Maximum operating speed of this car is 120 klm/hr (72mph), its equipment is overhauled after each 25,000 klm of operation. New cars being developed to include computer analysis of the records will provide digital output and immediate rating of the track.

ADDITIONAL AND GENERAL OBSERVATIONS

During its visit, two other developments warranting mention were shown to the delegation. One concerns plans for high-speed (200 klm per hour) [125 mph] operation on the October Railroad between Leningrad and Moscow.

High-Speed Operation

Several track modifications have been introduced in preparation for high-speed intercity transport:

1. Some of the curves have been reduced, new grade separations have been built, and protection walls are being built on both sides of the right-of-way to keep animals off the track.
2. Modification designed to strengthen track structure had to be accomplished. For this purpose, ballast has been added, and at cross-overs, switches replaced with new ones to produce continuity of track, eliminating the discontinuities inherent in conventional turnout feature design. The latter was accomplished by installing movable point frogs and strengthening the switch mechanism. Figures 57 and 58 show a new movable point switch in operation and detail of its switching mechanism, respectively.
3. Another means of lessening maintenance, developed on the October Railroad and now widely used, is reduction in track gauge from

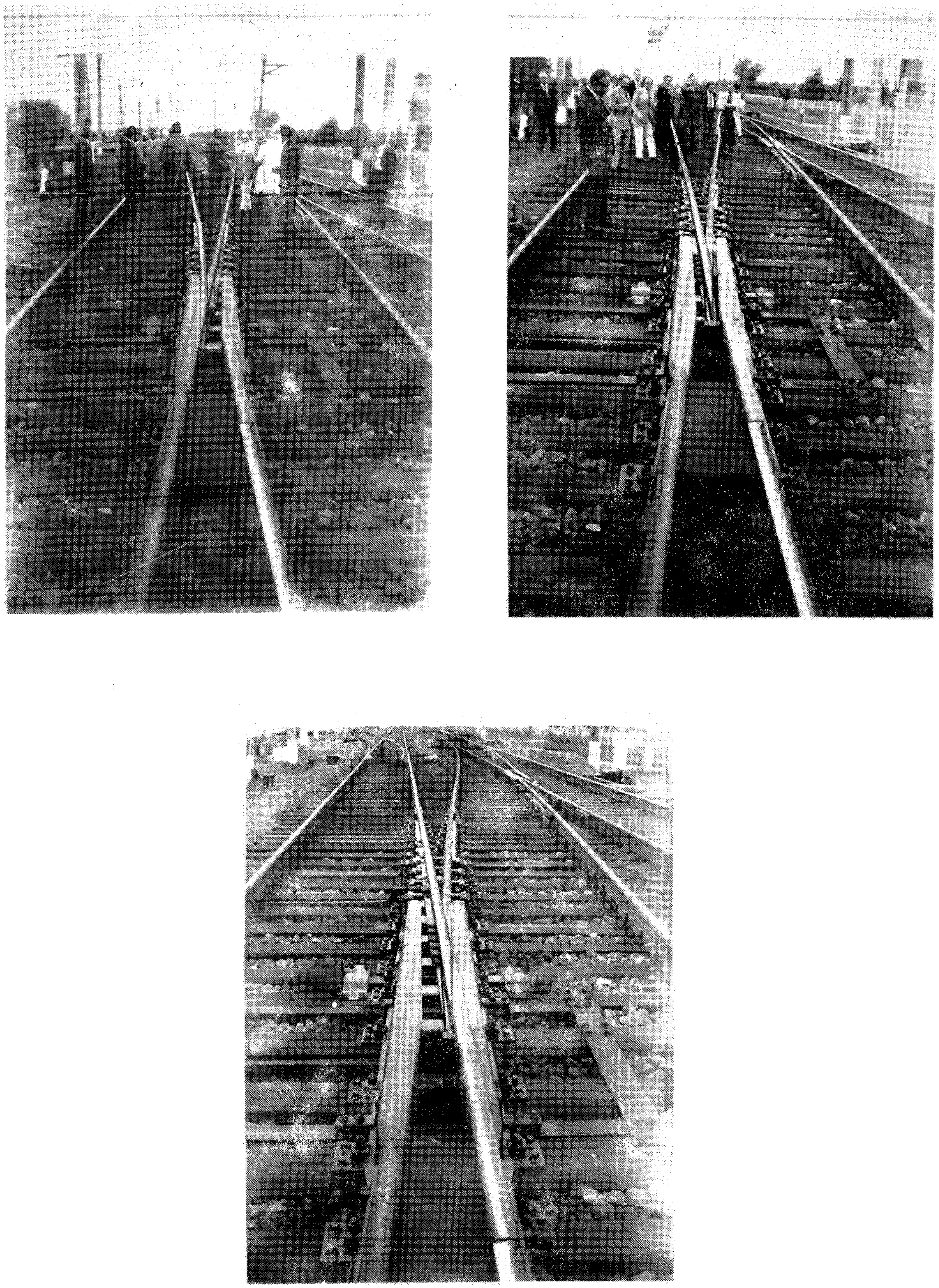
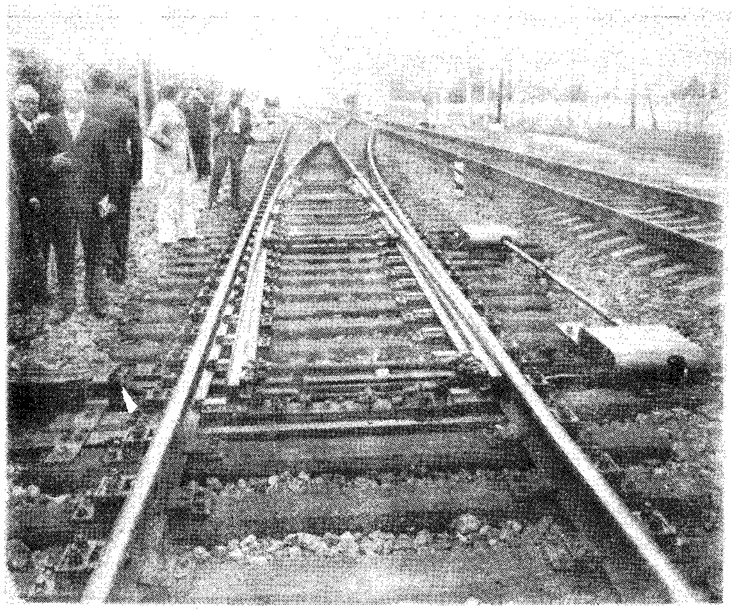


Figure 57. Operation of Movable Point High Speed Crossover, Mark I/II



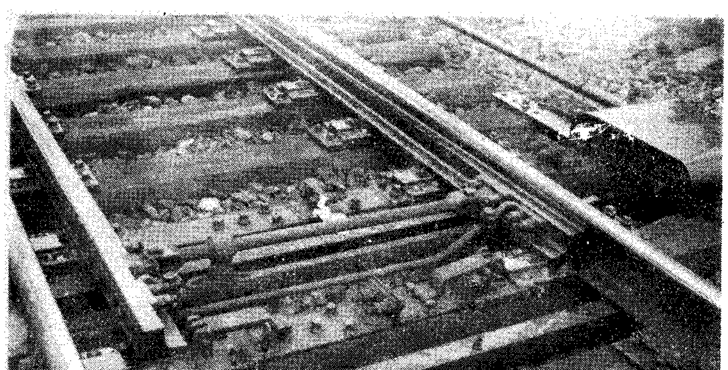


Figure 58. Detail of Operating Mechanism, Mark I/II Crossover

1524mm to 1520mm. The delegation was told that due to this change track maintenance costs have been reduced by 25 percent.

In-Track Welding

The other development of interest was the in-track rail weldor Model PRCM-3, observed at a station outside Moscow. This machine is mounted on a special rig on the front of a diesel locomotive converted for such use. The diesel driven generator car provides power to either traction motors or the weldor. The weldor mount provides enough adjustment to weld the rail as normally located or as if laid half way off center.

The unit contained two weldors. While these can work together they must be started in sequence with about 50 seconds lag. To accomplish welding, two items of preparation must be undertaken. First, the joint at the opposite end of the rail must be loosened and a ditch must be dug underneath the joint to be welded. Second, room must be provided for the welding head and later provided again to remove the upset produced by the welding process.

On this unit, developed by The Paton Welding Institute, removal of the upset is quite laborious as it has to be chiseled first and then ground, but the new heads have means to shear the upset immediately after the weld is completed. Holland Company in the U. S. is negotiating with Soviet officials for distribution rights pertaining to this improved version of the equipment presently offered.

Figure 59 shows the loosening of a joint to permit the weldor to pull the rail; Figure 60 shows the in-place welding operation; Figure 61 shows grinding of upset; and Figure 62 shows a completed weld. Figure 63 and 64 show the several arrangements and suspension of the welding heads on the diesel locomotive.

The major use for this machine is in repair of continuous welded rail strings, when it is necessary to remove a short piece from the middle of a string; insert a short section of rail and weld in place with the in-track welder. Another application involves welding short strings of rail, e.g., 300 meters each, into standard 800 meter lengths.

General Observations

The delegation is of the opinion that the general condition of track in the USSR is very similar to that in the US. This conclusion was reached on the basis of ride quality experienced during our several rail trips and from out-of-window observation. Many track gangs were observed, their personnel including women as well as men.

Although many features of the USSR railroads are quite similar to those of the US, one of the most important differences is the low axle loading, 24 metric tons for locomotives and 20 for freight cars. Soviet engineers stated that there is pressure to increase wheel loading, and that their problems would vastly increase if this occurs (as previously indicated, 23 and 25 ton axle loadings are being tested at the experimental ring).

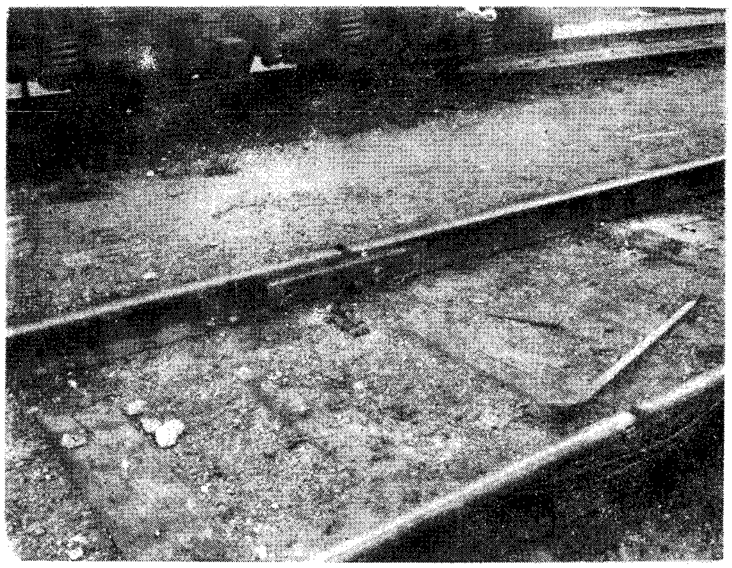


Figure 59. Track Welding: Joint Loosening

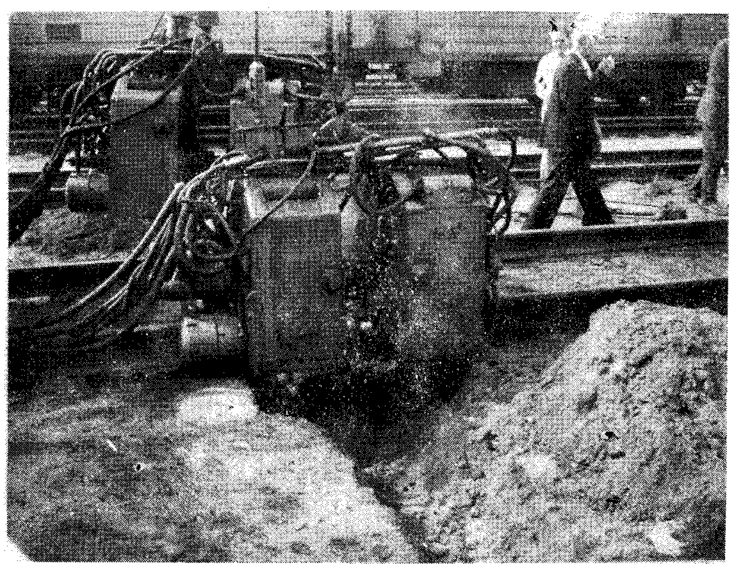


Figure 60. Track Welding: Welding Operation

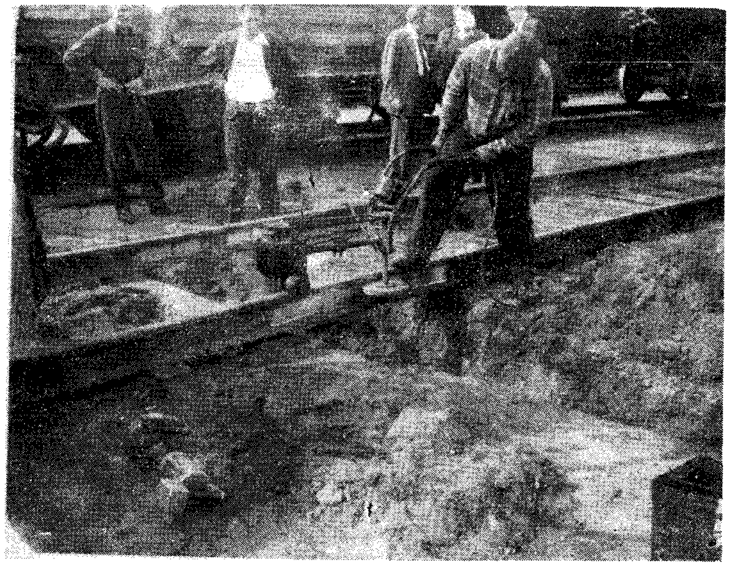
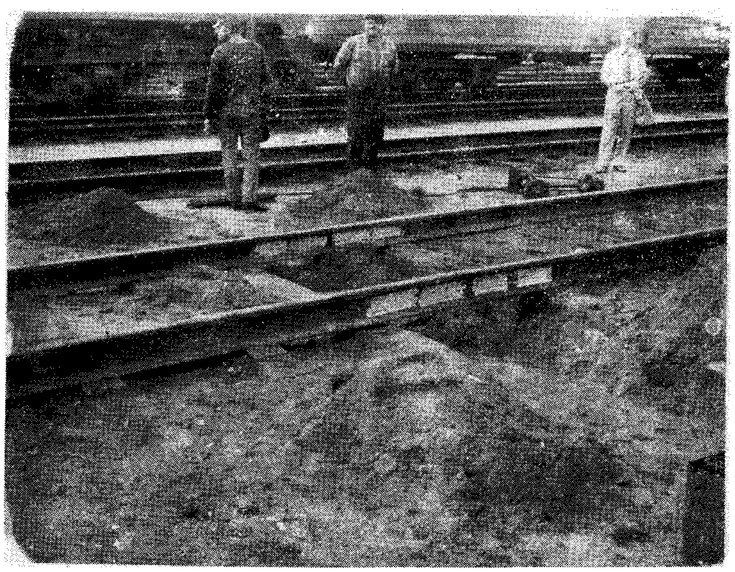


Figure 61. Track Welding: Removal of Weld Upset

Before Grinding



After Grinding

Figure 62. Track Welding: Completed Weld

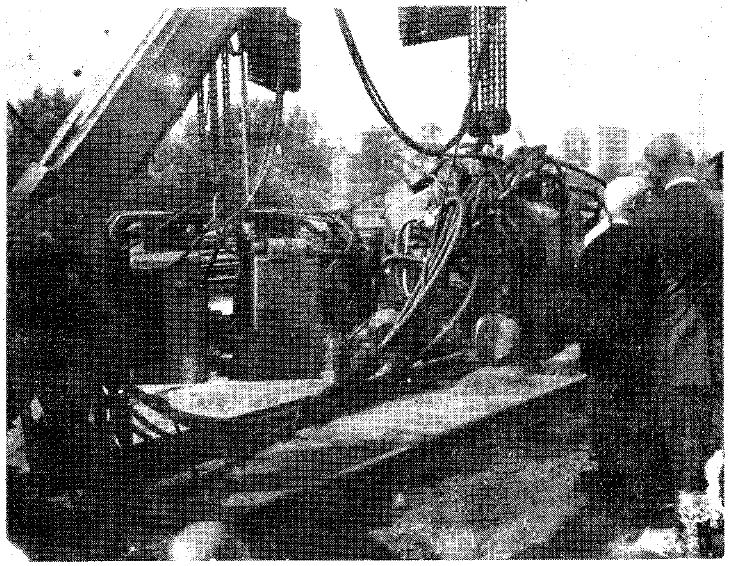


Figure 63. Welding Heads Mounted on Diesel Switcher

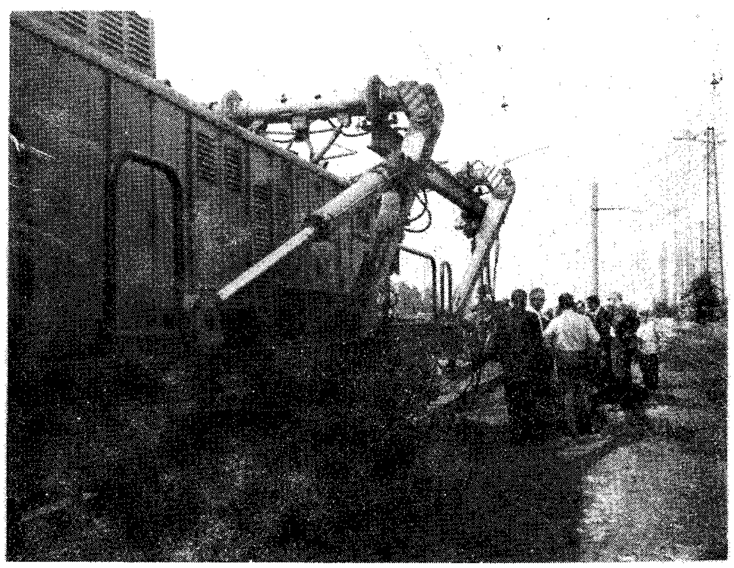


Figure 64. Suspension System for Welding Heads

As to lateral forces on the rail, the Soviet engineers believe that speed of operation has more effect than wheel loads. Increasing speeds from 80 klm/hr. to 100 klm/hr. will increase lateral forces by 30 percent. In part, this increase of lateral force is attributed to truck hunting. It is believed by Soviet experts that this contribution to accelerated wear can be controlled by diminishing the gauge standard. Consequently, target gauge, as mentioned above, has been reduced from 1524mm. to 1520mm.

APPENDIX A

USSR RAILROAD PERSONNEL INTERVIEWED

Moscow - July 1st

V. A. Samokhvalov - Chairman, USSR, Railroad Working Group

V. V. Bassilov - Chief Engineer, Track Directorate, M.P.S.

L. V. Malashko - Deputy Director, Directorate of Inter. Comm., MPS

V. N. Albrekht - Chief, Department of Track, CNII

G. S. Belov - Transportation Expert, Directorate of Inter. Communications

B. Y. Lukov - Senior Engineer, Directorate of International Comm.

Experimental Ring

N. A. Phouphrinaski - Deputy Director, CNII

Professor Alex Karetnikov - Director, CNII

V. N. Albrekht - Chief, Department of Track, CNII

N. G. Pustovoiy - Chief, Experimental Ring

Leningrad - July 2nd - October Railroad

V. V. Chubarov - Head, October Railroad

Leopold L. Rumsha - Chief Engineer

G. V. Melikov - Chief, Track Services Section

G. D. Yatsook - Chief, External Communications

Nadejda Tselnikova - Assistant to Chief, External Communications (Interpreter)

July 4th and 5th

South - Western Railroad

I. F. Chernata - Chief Engineer

V. I. Goude, Deputy Engineer of Track

F. N. Gvoznenko - Chief of Track Services Section

P. Kavalenko - Head of Machine Station Number 121

Donetsk Railroad

Slaviansk - Krasmyi Liman

July 6th

I. M. Zhoukov - Chief Engineer

V. I. Belun - Chief, Track Services Section

K. X. Sassiev - Division Superintendent

V. D. Konchenenko - Chief, Rail Train Station

Krasmyi Liman

S. M. Lavrick - Head of Track Machine Station Number 10

Krasmyi Liman - July 7th

V. V. Priklonski - Head of Donetsk Railroad

V. Ilushenko - Chief Engineer, October Coal Mine

Moscow - July 8th

S. I. Fadeev - Chief of Department of Track Welding

Moscow - July 10th

V. C. Gavrilov - First Deputy Minister, Ministry of Railroad Transportation

APPENDIX C

HEAVY MAINTENANCE EQUIPMENT SPECIFICATIONS

MECHANICAL TRACK LAYER

УК-25

The УК-25 track layer is designed for laying into the track complete rail lengths preassembled in a depot. It can also be used for dismantling old track at the same time.

Owing to their versatility, high rate of work and efficiency, mechanical track layers of Soviet make have gained general recognition among construction and track maintenance gangs both at home and in other countries. They pay for themselves before long.

The УК-25 mechanical track layer comprises a set of machines and mechanisms as follows:

a УК-12.5/Д track-laying crane (cranes of the type УК-25/9 or УК-25/21 can also be used);

a ПКД loading crane;

a МПД self-propelled rail car;

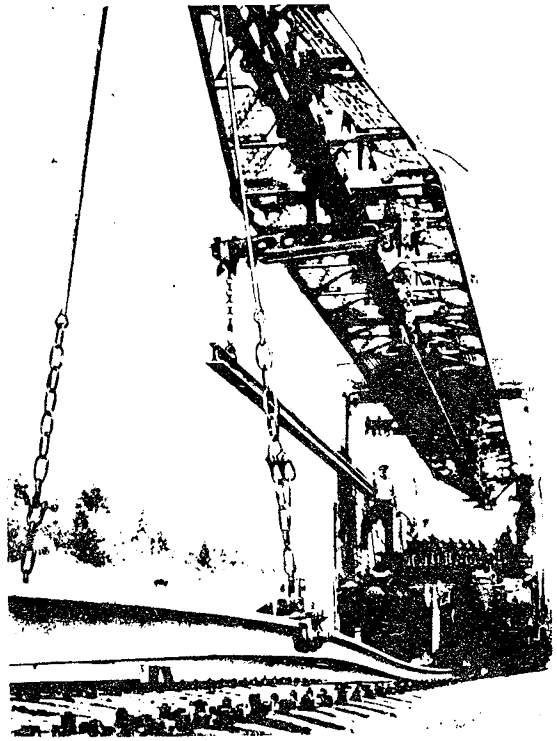
seven trailer flat cars fitted with specially designed removable or fixed equipment.

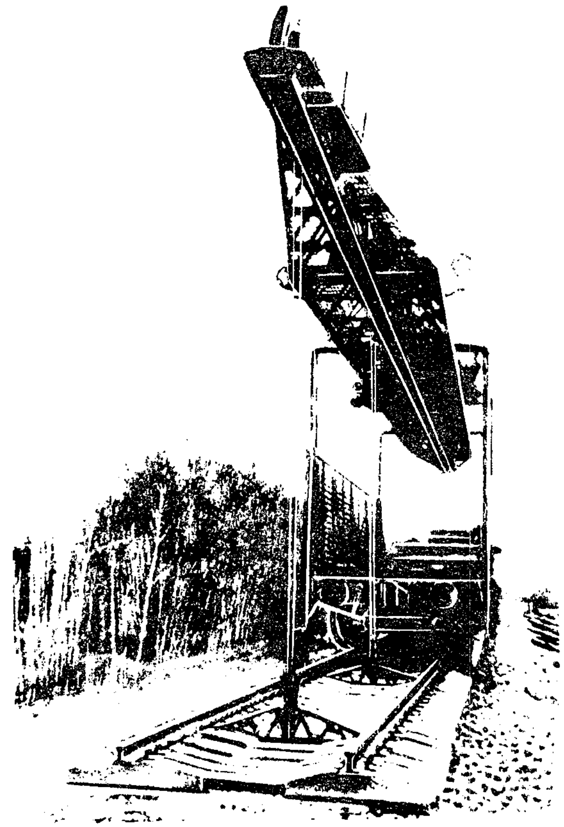
In maintenance-of-way work, two track laying cranes are used as a rule, one for dismantling the old track and loading the rails of flat cars, and the second for laying new rails. In construction jobs, only one track-laying crane is employed.

The items of equipment comprising the track layer may vary in number depending on the scope of work and the time available for the job.

TRACK-LAYING CRANE

УК-25/9





The УК-25/9 track-laying crane is designed for laying new rails up to 12.5 and 25 metres in length and dismantling worn out tracks. Used complete rail lengths are loaded on specially equipped eight-wheel rail cars and delivered to the nearest track assembly depot where they are taken apart and some of its elements (rails, ties, etc.) are reconditioned.

The track-laying crane is mounted on a specially designed self-propelled body (deck) which is a frame of welded construction with automatic couplers. The frame is supported by two six-wheel trucks with a single suspension and longitudinal equilizers. The body is equipped with an independent air brake and a hand brake. The body accommodates two Diesel generating sets, the crane with load-handling equipment, a roller conveyor, and the control desks.

The Diesel generating sets supply power for the traction motors and the load-handling equipment.

The crane essentially consists of four portals with carriers which give support to the boom. The portals are so arranged that the boom can be raised into its upper working position, leaving below ample space to accommodate several packets of complete rail lengths each consisting of 8 to 10 units. On finishing the work, the portals lower the boom into its lower transport position without interfering with clearance limitation. When the track is being laid on curves, a special arrangement enables the boom to rotate through a certain angle. Lifting and lowering of the boom is effected by means of a hydraulic system consisting of pumps, hydraulic cylinders and other mechanisms.

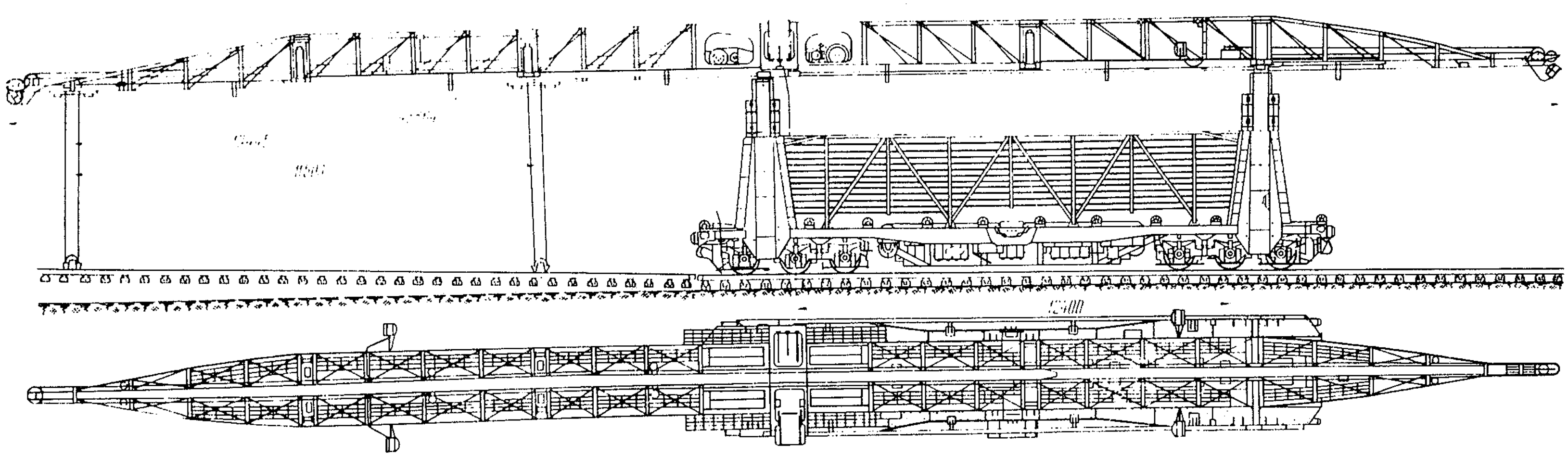
Hoisting, hauling, and lowering of rail lengths into the track is made with the help of load-handling equipment consisting of hoisting units, hoisting and trolley winches, and pulling winches. The trolley winch powered by a reversible electric motor serves to move the hoisting units along the boom. The hoisting winch is equipped with two rope drums of different diameters so that the rail end closer to the track layer is lowered more rapidly than the opposite end, facilitating thereby joining of rail lengths. An overload release automatically cuts out the motor if the winch load exceeds 9 tons.

The trolley and hoisting winches are of identical design, differing only in the rope and brake drum diameters. Both winches are powered by separate electric motors.

The pulling winches for handling the stacked rail lengths are of simple and reliable design, ensuring smooth conveying of the packets along the train and onto the deck of the track-laying crane. The winches can operate simultaneously and individually.

The track-laying operations are controlled from two control desks, an upper and a lower one, the former being arranged in the driver's cab and the latter in the operator's cab. The lower control desk is the main desk which is equipped with traction engine controls (the crane has two traction engines) and all the instruments. Other controls for starting the engines, adjusting the generator terminal voltage and engine output, applying the brakes, and operating the pulling winches are also concentrated on the lower control desk. Being of the portable type, this desk can be removed from the cab and installed either on the left or right-hand side of the crane so as to control the operations in the most efficient way.

Unlike the lower control desk, the upper one serves the purpose of controlling the operations of the load-handling equipment, including the hoisting and trolley winches. The VK-25/9 track-laying crane has made replacememt of relay rails by rail strings a practical possibility, provided the strings have been placed inside the track preparatory to the replacement.



TECHNICAL DATA

Gauge, *mm*	1524 and 1435
Rate of work, running metres per hour	1000
Type of crane	self-propelled
Tractive effort at starting, *t*	10
Maximum capacity, *t*	9
Maximum travel speed when moving, *km/hr*	50
Maximum travel speed when working, *km/hr*	5
Drive	electric
Number of driving axles	4
Load carrying capacity of crane body (deck), *t*	40
Fuel tank capacity, *l*	980
Overall dimensions, *mm:*	
length of body	18030
total length of crane	43864
width of crane	3250
height in transport position	5285
height in working position	6825
Weight, *t*	78.0

Power Generating Plant

Engine	Diesel
Number of engines	2
Engine power output, *hp*	150
Rpm	1500
Weight of engine, *kg*	1300
Generator	type ПН-750
Number of generators	2
Kind of current	d.c.
Voltage, *V*	230
Current, *A*	435
Generator rating, *kW*	100
Rpm	1470
Weight of generator, *kg*	1300
Traction motor	type ДК-309 A
Number of traction motors	4
Traction motor power, *kW*	43
Rpm	3100
Weight of traction motor, *kg*	465

Hoisting Unit

Capacity, *t*	5
Hoisting speed, *m/sec*	0.3
Trolley travel speed, *m/sec*	1.5

Hoisting Winch

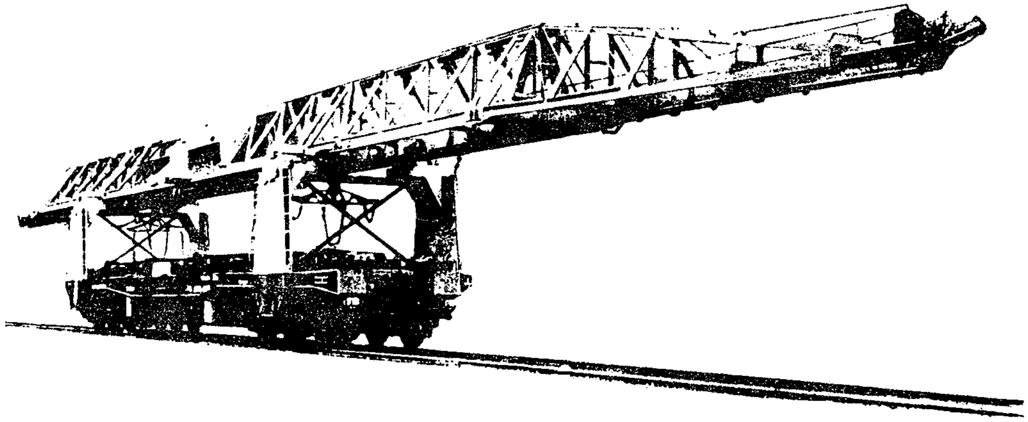
Type	double-drum with magnetic brake
Capacity, *kg*	9000
Rope load, *kg*	2250
Rope diameter, *mm*	19.5
Motor rating, *kW*	23

Trolley Winch

Type	double-drum with magnetic brake
Load on rope, *kg*	1200
Rope diameter, *mm*	13
Motor rating, *kW*	23

Hydraulic System

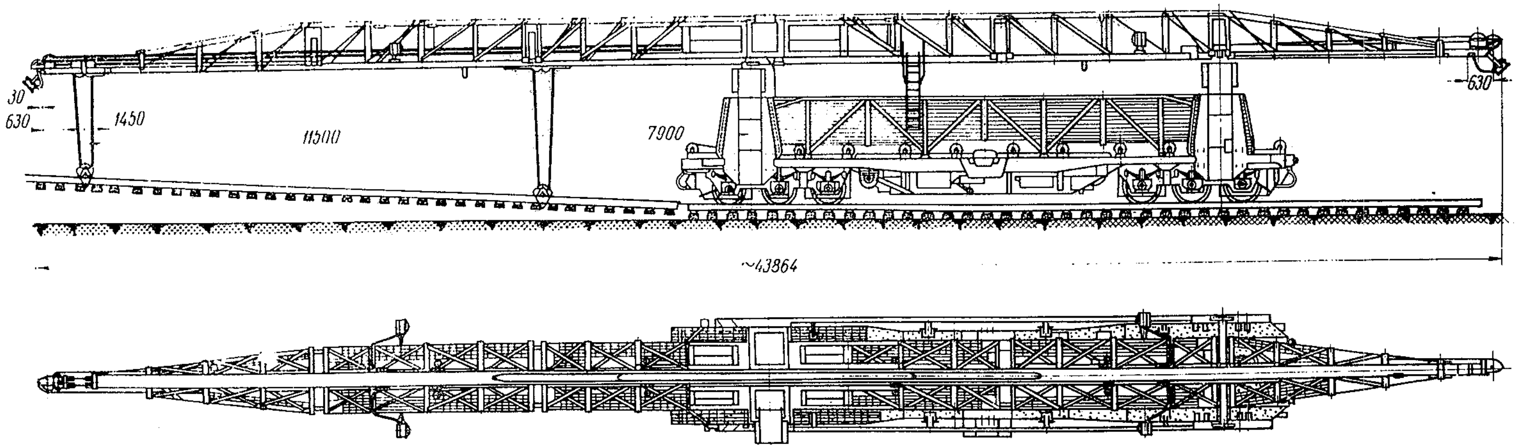
Pump	plunger
Delivery, *l/min*	18
Pressure, *kg (f)/cm*^{2}	95
Number of pumps	2
Pump drive	from pulling winch motor
Number of lift cylinders	12
Lift cylinder stroke, *mm*	1540



TRACK-LAYING CRANE

УКэ-25

The УКэ-25 track-laying crane is a 1435-*mm* gauge export model designed to meet the West-European clearance limitations and supplied into countries of the temperate zone. The crane has the same outfit as the УК-25/1 model.



TECHNICAL DATA

Gauge, *mm*	1435
Length of crane deck over buffers, *mm*	18580
Total length of crane, *mm*	43864
Width of crane, *mm*	3130
Height in transport position, *mm*	4635
Height in working position, *mm*	5855
Clearance in transport position (driver's seat excluding) according to ГОСТ 9238 59	02-Т
Number of complete rail length in each packet	4 6
Lift cylinder stroke, *mm*	1220
Control desk	in removable driver's cab

Other leading particulars of the crane are identical with the УК-25/9 type.

TRACK-LAYING CRANE

УК-25/21

The УК-25/21 crane is designed for laying complete 25-metre rail lengths in new railway projects or track renewal programmes. It can also be used for dismantling old track and loading the rail lengths on flat cars of the track-laying train.

Recently modernized, this model has a lifting capacity which is more than twice that of other cranes. This feature enables the crane to handle not only rails with wooden ties but also those with reinforced concrete ties with a total weight of 21 tons.

The УК-25/21 model consists of a self-propelled body mounted on two six-wheel trucks. The body carries two power generating plants each consisting of a 1Д6 150-*hp* Diesel engine and a ПН-750 generator rated for 100 *kW* at 230 *V*.

Props erected on the body give support to a latticed boom of welded construction which is equipped with various load-handling devices (hoisting units, winches, etc.).

The crane is fitted with lifting tongs which automatically grab a complete rail lengths from a packet for putting it on the bed and a specially designed contrivance for bending rails a small amount before laying them on curves.

The flat cars used with the crane are equipped with roller conveyors and removable equipment used to pull rail packets along the cars to the place where they are laid.

Operation of the crane is controlled from the upper and lower control positions.

TECHNICAL DATA

Lifting capacity, *t*	21
Hoisting speed, *m/sec*	0.3
Trolley travel speed, *m/sec*	1.3
Crane travel speed when moving, *km/hr*	50
Clearance in transport position	1-B
Overall dimensions, *mm:*	
length	43864
width	3250
height in transport position	5285
height in working position	6825
Weight, *t*	92.6
Personnel	2

Body

Type	12-wheel, self-propelled, truck-supported
Gauge, *mm*	1524
Number of driving axles	4
Number of trucks	2
Wheelbase, *mm*	12400
Length over couplers, *mm*	18030

Diesel Engine

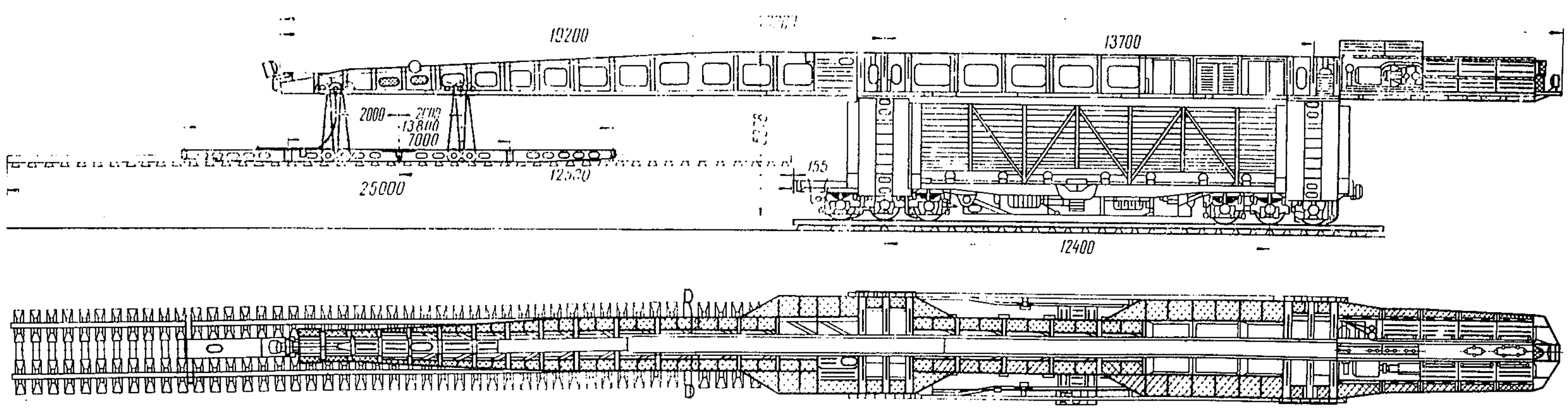
Type	1Д6
Number of engines	2
Engine power output, *hp*	2×150
Rpm	1500

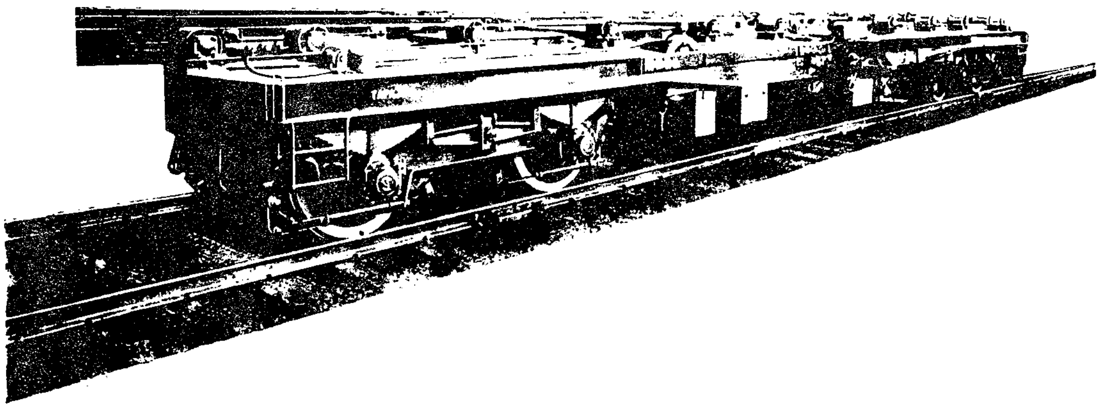
Generator

Type	ПН-750
Number of generators	2
Kind of current	d.c.
Rating, *kW*	2×100
Rpm	1470
Current, *A*	435
Voltage, *V*	230

Traction Motor

Type	ДП-309 А
Number of motors	4
Maximum power (hourly), *kW*	4×43
Current, *A:*	
maximum power	260
rated power	210
Rpm	960
Reduction gear unit	two-stage, spur-gear type

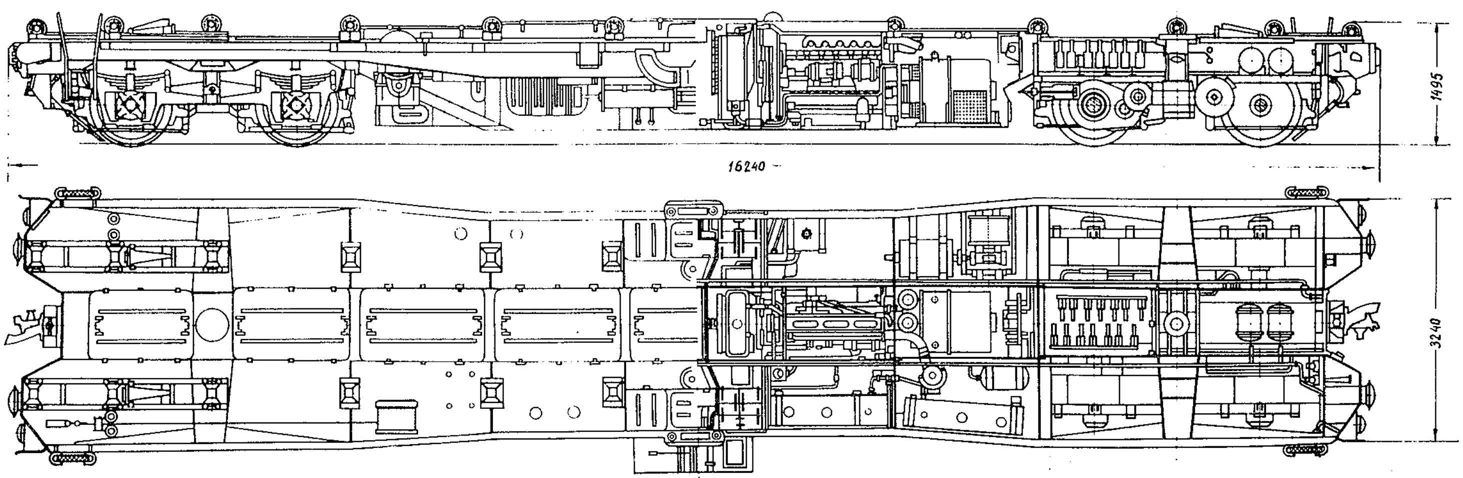




SELF-PROPELLED RAIL CAR
МПД

The МПД model is a self-propelled traction unit used in track-laying work for pulling complete rail lengths packets from the rail train to the track-laying crane deck and hauling the packets of removed rails along the flat cars of the rail train. The rail car can also be employed in shunting jobs both when laying a new track of dismantling the old one.

The car is equipped basically with the same mechanisms as the track-laying crane. The body consists of a welded frame supported by two four-wheel trucks and provided with couplers. The frame accommodates two Diesel-generating sets, compressors, two pulling winches, roller conveyor, and other gear.



The trucks are of the same design as the trucks of the track-laying crane.

The Diesel-generating sets supply power for both propelling the loaded train and pulling the rail packets along the flat cars and putting them on the track-laying crane deck by means of winches.

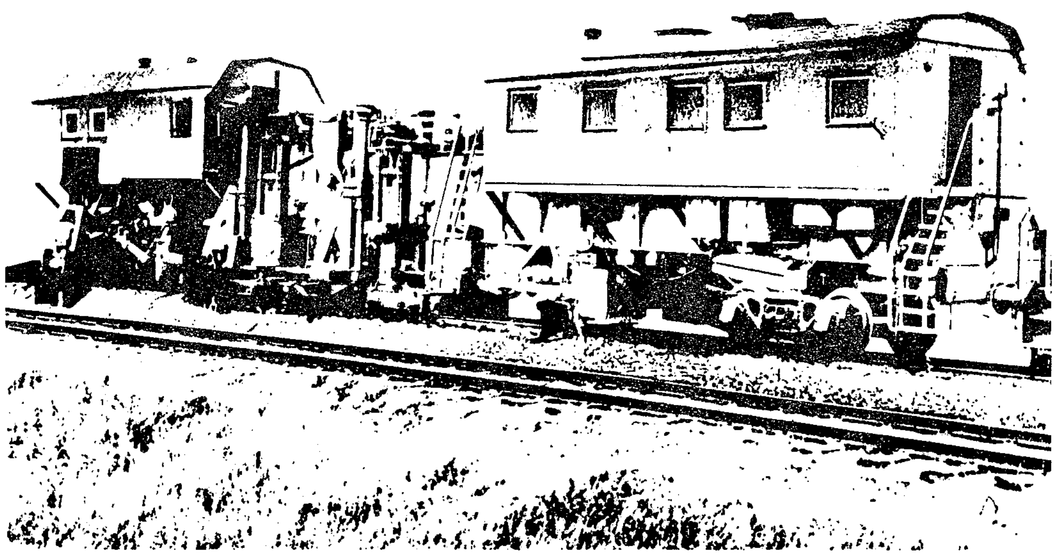
The horsepower produced by the engines and the tractive effort developed by the car are high enough to move a train loaded with complete rail lengths with a total length of 1 *km* without being aided by another locomotive. The tractive engines are designed to cope with a rail train delivering rail lengths with a total weight of 250 tons on.

The rail car is fitted with straight air brake controlled from the driver's cab. In addition, two automatic brake valves, known as Kazantsev brake, are provided for braking the train when the rail car is used as a traction unit.

All controls are concentrated in the driver's cab which is designed for maximum operational comfort and strength. The cab can be removed and placed on either side of the car. On completing the work, the cab is removed and placed on the deck of the car.

TECHNICAL DATA

Type	8-wheel, self-propelled, truck supported	Number of driving axles	4
		Design speed, *km/hr*	50
Loading capacity, *t*	40	Maximum tractive effort at drawbar, *kg*	10000
Gauge, *mm*	1524 or 1435	Weight, *t*	37



CONTINUOUSLY-OPERATING TRACK RAISING, TAMPING AND DRESSING MACHINE

ВПО-3000

The ВПО-3000 track surfacing machine employes a new method of tamping the ballast by a vibratory action, the tamping blades being lowered under the ties at their ends.

The machine is a modern multi-purpose unit capable of lifting, tamping, lining, and boxing up in various track maintenance schemes and new railway projects. It is reputed for high rate of work and workmanship.

Special arrangements on the machine enable it to bring the track to correct surface, line, and superelevation. The machine consists essentially of a single-span truss mounted on which are the units which ensure continuous and intensive tamping of the entire ballast section by vibratory action. This method of ballast handling ensures:

– compaction of the ballast section, cribs and ballast shoulder including;

– settling of the ballast section from top to bottom to a degree which considerably reduces the amount of surfacing operations in routine maintenance-of-way work;

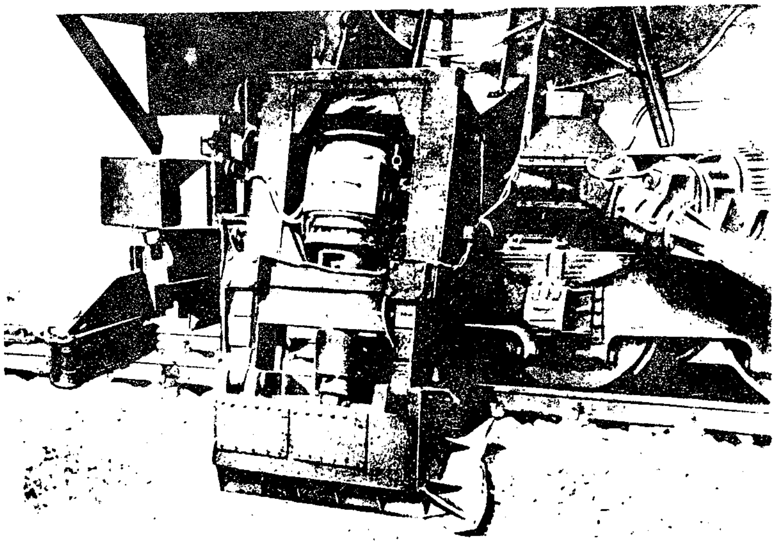
– high rate of work;

– adaptability of the machine to working track of any type with wooden or reinforced concrete ties, including track of all-concrete construction;

– completing all operations in a single pass of the machine without any special work organization and equipment routing.

The machine essentially consists of a ballast distribuitor, rail sweeper, coarse and fine track raising and shifting jacks, vibrator tamper workheads, shaper blade, ballast shoulder vibrator tamper, and tie sweeper.

A 230-*kW* generating plant of the machine provides power for the motors. The machine can be hauled by a locomotive developing a tractive effort of 20 tons at the coupler.



TECHNICAL DATA

Maximum axle load in transport position, *t*:	
front truck	18
rear truck	21.7
Maximum travel speed, *km/hr*:	
when spreading ballast	15
when raising track	5
when tamping	3
Clearance	1-T
Length over couplers, *mm*	27870
Wheelbase, *mm*	20350
Weight, *t*	112

Ballast Distributor

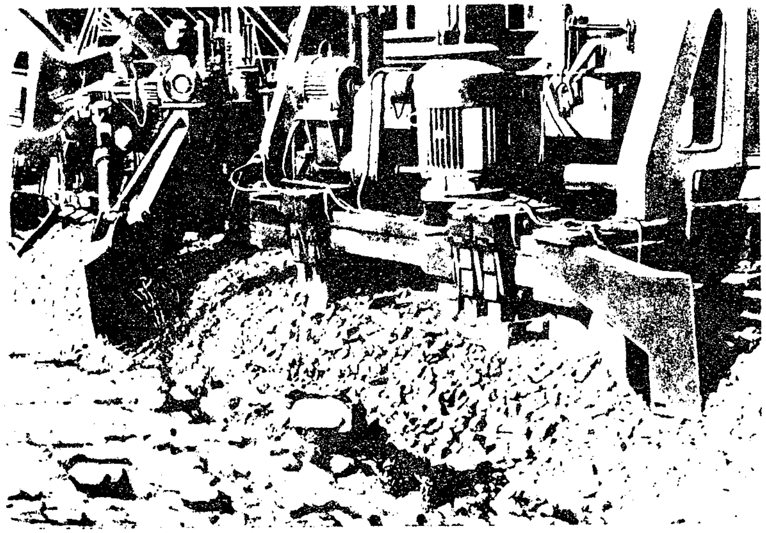
Maximum height of front plough above rail top, *mm*	250
Maximum depth of front plough below rail top, *mm*:	
with reinforced concrete ties	200
with wooden ties	150
Front plough raising and lowering speed, *cm/sec*	0.556
Front plough motor:	
type	AO-41-4Ш2
power, *kW*	1.7
rpm	1410
Number of wings	2
Wing spread, *m*	5.6
Maximum depth of wing below rail top, *mm*	1050
Maximum height of wing top above wing base, *mm*	400
Speed of wing inclination, *cm/sec*	0.745
Wing inclination motor:	
type	AO-51-6Ф2
power, *kW*	2.8
rpm	950
Number of rotating mechanisms	2
Angle of rotation, *deg*	45
Speed of rotation (by screw), *cm/sec*	0.753
Wing rotating motor:	
type	AO-51-6Ф2
power, *kW*	2.8
rpm	950

Rail Sweeper

Number of brooms	1
Pressure on rail head exerted by broom at either end, *t*	1
Speed of broom lifting and lowering, *cm/sec*	1.112
Electric motor:	
type	AO-32-4Ш2
power, *kW*	1
rpm	1410

The First Track Raising and Shifting Jack

Number of jacks	2
Lifting capacity, *t*	20
Maximum track lift, *mm*:	
P-50 rails	140
P-65 rails	120
P-75 rails	100
Number of lifting magnet subassemblies	2
Throw, *mm*	±450
Shifting speed, *cm/sec*	0.365
Superelevation, either side, *mm*	±150
Shifting motor:	
type	AO-51-6Ш2
power, *kW*	2.8
rpm	950



The Second Track Raising and Shifting Jack

Number of lifting jacks	2
Lifting capacity, *t*	12
Number of lifting magnet subassemblies	2
Lift, *mm*:	
below rail top	50
above rail top	670
Lifting speed, *cm/sec*	0.503
Lifting motor:	
type	AO-51-6Щ2
power, *kW*	2.8
rpm	950
Number of shifting jacks	1
Pull, *t*	13.6
Throw, *mm*	±300
Speed of shift, *cm/sec*	0.201
Lifting motor:	
type	AO-51-6Щ2
power, *kW*	2.8
rpm	950
Superelevation, either side, *mm*	±150

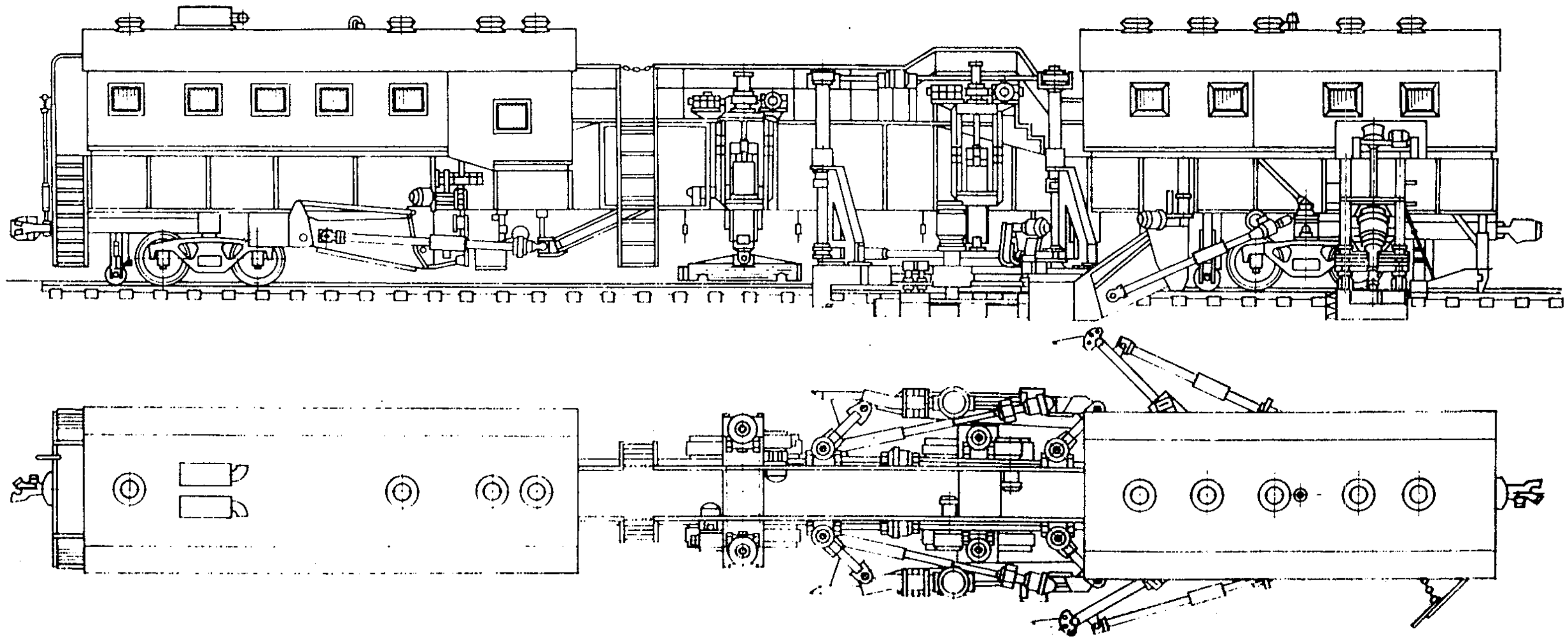
Shifting motor:	
type	AO-42-6
power, *kW*	1.7
rpm	930

Vibrator Tamper Workheads

Number of workheads	2
Impact force, *t*	20
Length of workhead, *m*	4.03
Number of tamping blades per workhead	8
Tamping blade amplitude, *mm*	40
Speed of tamping, *strokes/min*	1430
Workhead drive motor:	
type	AO-82-4B3
total pover, *kW*	40
Workhead shift, *mm*	300
Speed of shift, *cm/sec*	0.324
Shifting motor:	
type	AO-52-6Щ2
power, *kW*	4.5
rpm	950
Maximum lift, *mm*	1130
Lifting speed, *cm/sec*	0.565
Lifting motor:	
type	AO-52-4Щ2
power, *kW*	7
rpm	1400
Number of tapered sleeves	1
Diameter of sleeve, *mm*	16—20

Shaper Blade

Maximum height of blade base above rail top, *mm*	550
Number of lifting mechanisms	2
Lifting speed, *cm/sec*	0.556
Lifting motor:	
type	AO-41-4Щ2
power, *kW*	1.7
rpm	1420
Number of wings	2
Wing spread, *m*	5.6
Maximum depth of wing below rail top, *mm*	1050
Speed of wing inclination, *cm/sec*	0.745
Number of rotating mechanisms	2
Angle of rotation, *deg*	45
Speed of rotation (by screw), *cm/sec*	0.753



Wing rotating motor:

type	AO-51-6Ш2
power, *kW*	2.8
rpm	950

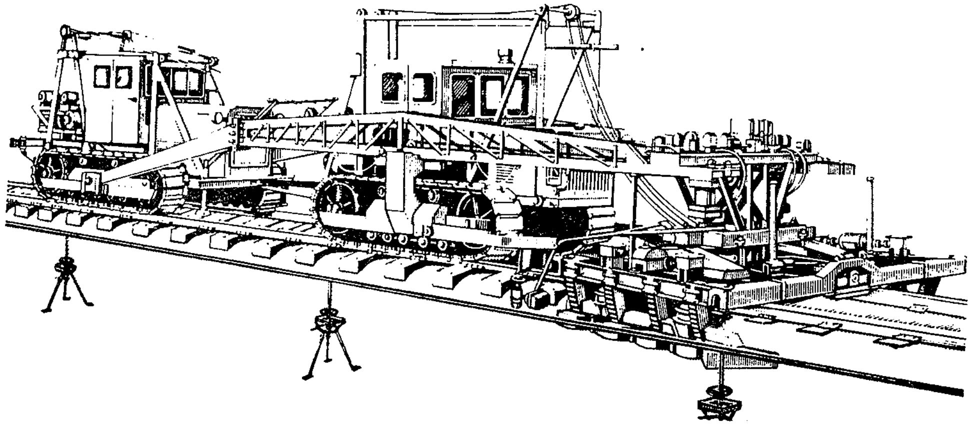
Ballast Shoulder Vibrator Tamper

Number of workheads	2
Impact force, *t*	10
Length of workhead, *m*	1.5
Speed of tamping, *strokes/min*	1450
Vibrator drive motor:	
type	AO-78-4B3
power, *kW*	20
rpm	1450

Number of lifting mechanisms	2
Lifting motor:	
type	AO-51-6Ш2
power, *kW*	2.8
rpm	950

Tie Sweeper

Number of brooms	1
Width of broom, *m*	2.8
Lifting speed, *m/sec*	0.12
Motor:	
type	AO-32-4Ш2
power, *kW*	1
rpm	1410



TRACK SURFACING EQUIPMENT

This equipment serves the purpose of bringing track with wooden ties to correct line and surface in addition to tamping the ties at the same time. It is used with success in new railway project and maintenance-of-way schemes, being adapted to handle ballast section of standard shape. The equipment cannot be used with frozen ballast.

The equipment is carried by two C-100 tractors hitched one to the other by means of a rigid drawbar and provided with an arrangement for travelling along the rails.

The main working mechanisms are a surfacing unit and a vibrator for tamping the ballast. They are automatically controlled by an operator at a remote control desk.

The equipment can operate at four different rates of work (370, 590, 840, and 1210 *m/hr*) depending on the circumstances so as to provide for maximum efficiency.

The manpower requirement of a surfacing and tamping job is 3 men-day per kilometre of track.

BALLAST CLEANING AND TRACK SURFACING MACHINE

ЩОМ-ДО

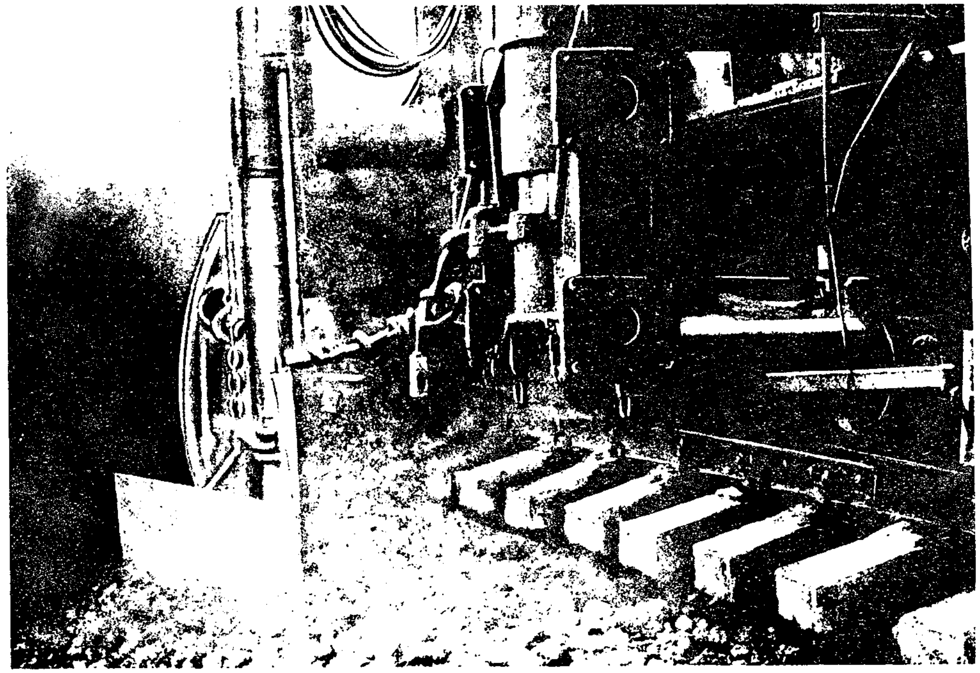
The machine, mounted on a Dragavtsev simple-span truss, is designed to clean crushed stone ballast or remove sand ballast, equalize the ballast, raise the track, and dress the ballast section.

The machine is mounted on a specially simple-span metal truss of welded construction, all items of the equipment being conveniently arranged inside the truss.

This feature increases the capacity of working mechanisms, adds to the versatility of the machine as a whole, improves its economical performance and quality of the work.

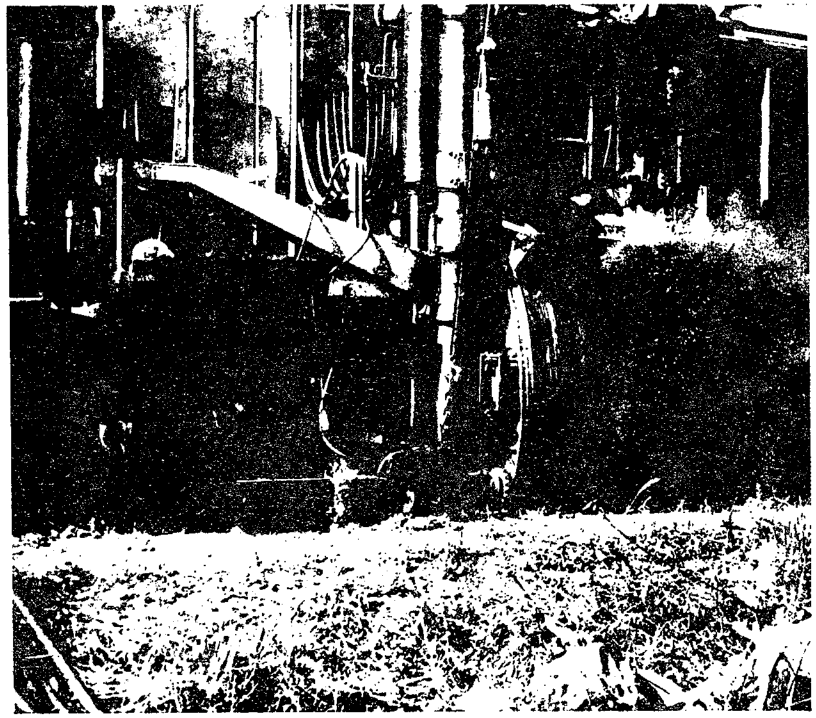
The ЩОМ-ДО unit is capable of cleaning the ballast section to a depth between 400 and 450 *mm* from shoulder to shoulder. Simultaneously with cleaning the ballast, the machine collects the waste material from the belt and dumps it on another belt conveyor for loading into special cars behind the machine or flat cars on a parallel track.

The ЩОМ-ДО ballast cleaner features considerable improvements both in design and performance over earlier models, the ЩОМ-Д ballast cleaner of the ЭЛБ-1 electric ballaster including. It is a heavy-duty and reliable machine of great potentialities capable of coping with large-scale track maintenance schemes in minimum time.



TECHNICAL DATA

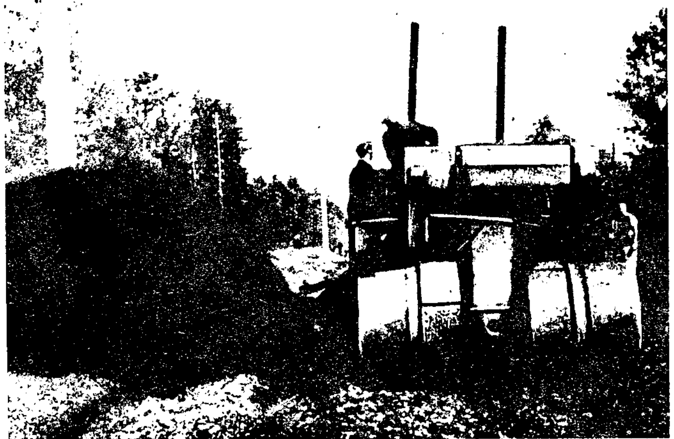
Wheelbase, *m*	28.0	Tractive effort in working position, *t*	30
Length over couplers, *m*	34.0	Rate of ballast cleaning work, m^3/hr	3000
Clearance in transport position	1-B	Maximum track lift (P-75 rails), *mm*	250
Clearance after "possession" is obtained	2-B	Maximum throw, *mm*	550
Number of trucks	2	Lifting magnet capacity, *t*	50
Number of wheels	8	Power of ballast cleaning belt drive motor, *kW*	310
Weight, *t*	80	Belt speed, *m/sec*	10–12
Travel speed when moving, *km/hr*	70	Cleaning width, *m*	3.2–5



Maximum cleaning depth below bottom of tie, *mm*	0 350
Capacity of main waste belt conveyor, m^3/hr	1000
Main belt conveyor speed, *m/sec*	2.5
Motor power, *kW*	29
Capacity of swivel-mounted waste belt conveyor, m^3/hr	1000
Swivel-mounted belt conveyor speed, *m/sec*	3
Slew angle, *deg*	360
Motor power, *kW*	29
Capacity of belt conveyor for dumping clean ballast back into cribs, m^3/hr	600
Speed of belt conveyor for dumping clean ballast back into cribs, *m/sec*	2.8
Angle of inclination, *deg*	15
Motor power, *kW*	20

BALLAST CLEANER

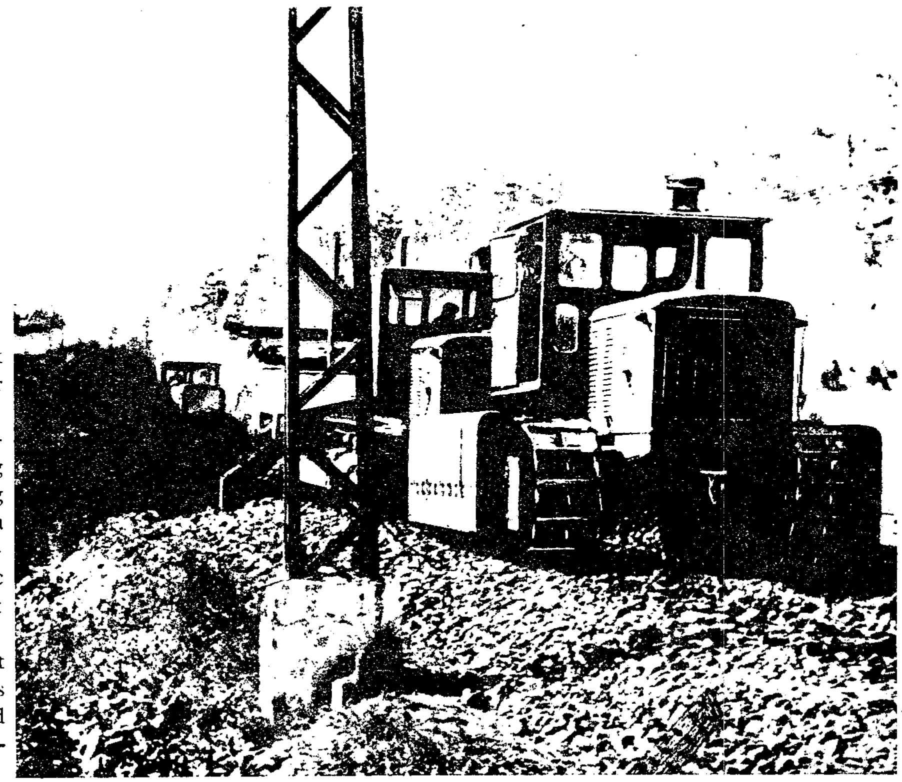
БМУ

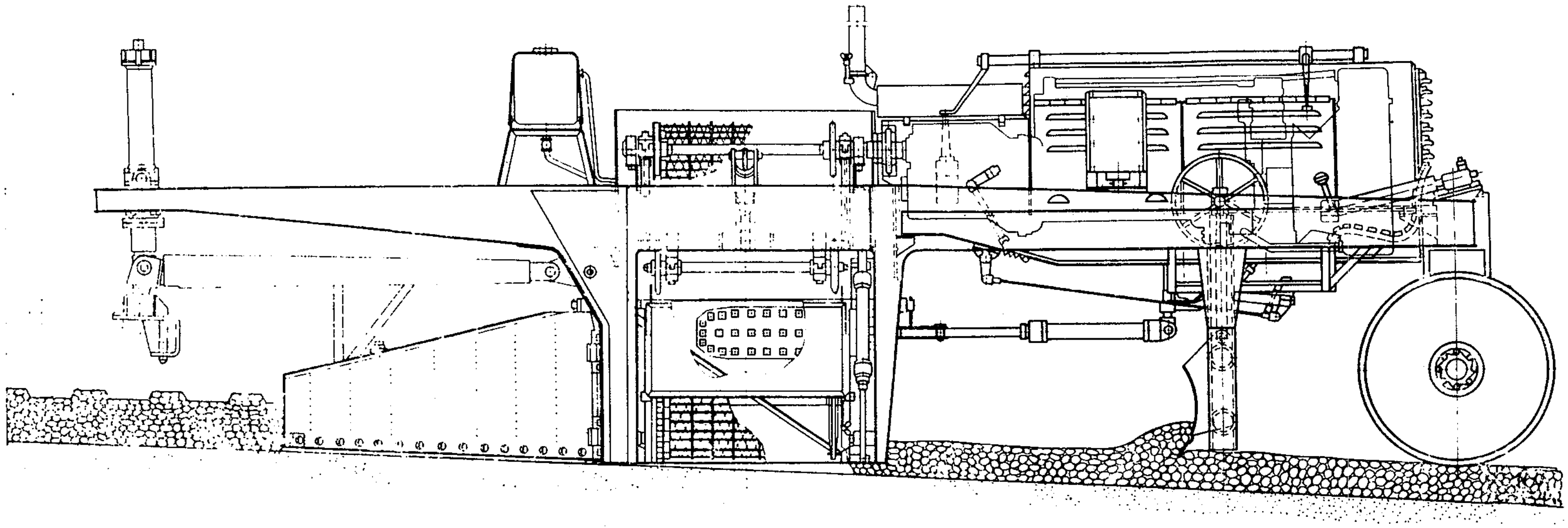


This is a heavy-duty machine designed to clean stone ballast to the entire depth of the ballast section from shoulder to shoulder after the track structure has been removed.

The machine is a trailer with a frame of welded construction carrying the power plant and working mechanisms including supporting rollers, spreading blade, ballast-cleaning belt, cutting blade, wings, and ball-and-socket bearing. The power plant is a 300-*hp* Diesel engine which drives the perforated belt and a vane-type hydraulic pump. The oil from the pump is fed into hydraulic rams to raise and lower the cutting blade and control the amount of ballast forced on the belt for cleaning.

Cleaning is by the centrifugal action of the perforated belt which picks up a layer of ballast so that the waste material drops through the perforations and the clean material flows over the end of the belt and is returned to the track. The spreading blade equalizes then the ballast and the rear rollers compact it.





The wings, when extended, serve to force the ballast from the shoulders to the belt for cleaning. The machine is moved along the ballast section by means of two HC-100M crawler tractors.

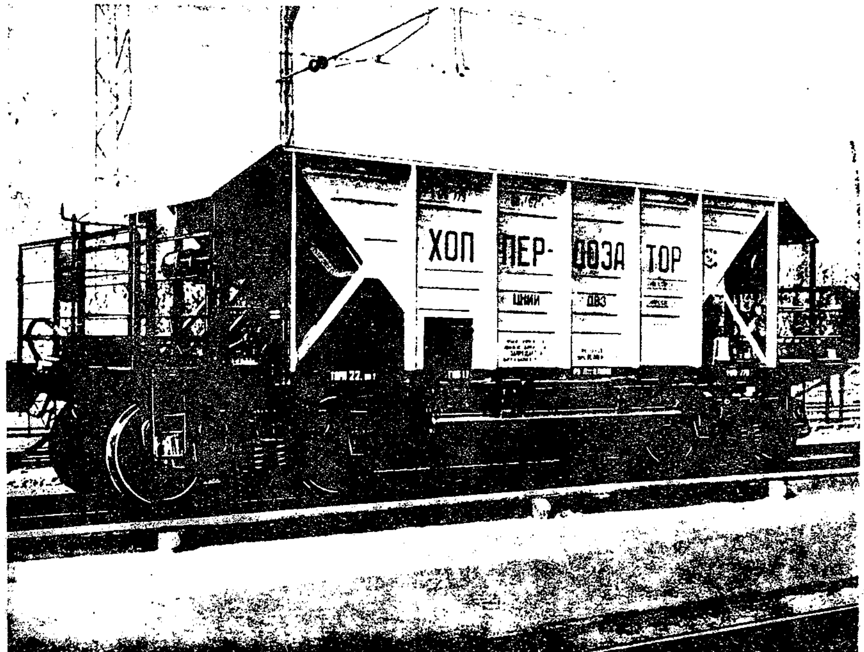
The support rollers are fitted with hydraulic rams which can turn them about the vertical axis.

TECHNICAL DATA

Rate of work, m^3/hr	1000
Maximum depth of cutting blade below top of ballast section, *m*	350
Cleaning width, *mm:*	
wings folded	23800
wings extended	4100–5000

Overall dimensions, *mm:*	
length	8870
width	2820
height	2300
Weight, *t*	13

HOPPER CAR
ЦНИИ-ДВЗ



The hopper car is specially designed for hauling and dumping ballast as well as filling in the cribs and spreading the surplus material in connection with new railway projects and maintenance-of-way work of all kind, such as out-of-face renewal, spot renewal or track raising.

The hopper car is an all-metal gondola of welded construction consisting of two four-wheel trucks, a frame, a body a ballast box, hatch controls, ballast box raising and lowering mechanism, ballast discharge controls, and running gear.

The hatch controls and the ballast box raising and lowering mechanisms are operated pneumatically through a system of shafts and levers. The ballast box is a rectangular frame adjustable for pre-set height by means of a special scale and suspended from the body.

The hatches of the car are fitted each with two covers, an inner and an outer one. Hopper cars are available in two modifications (with and without brakes).

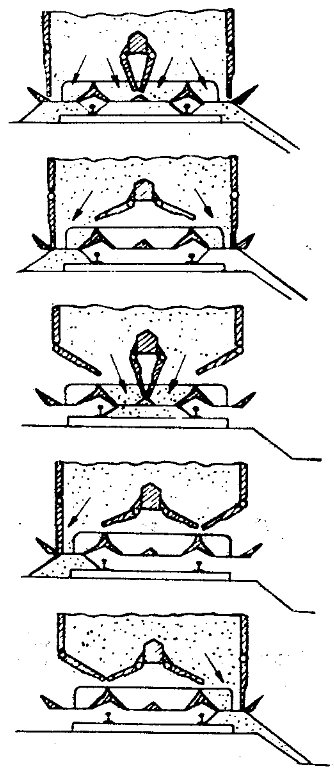


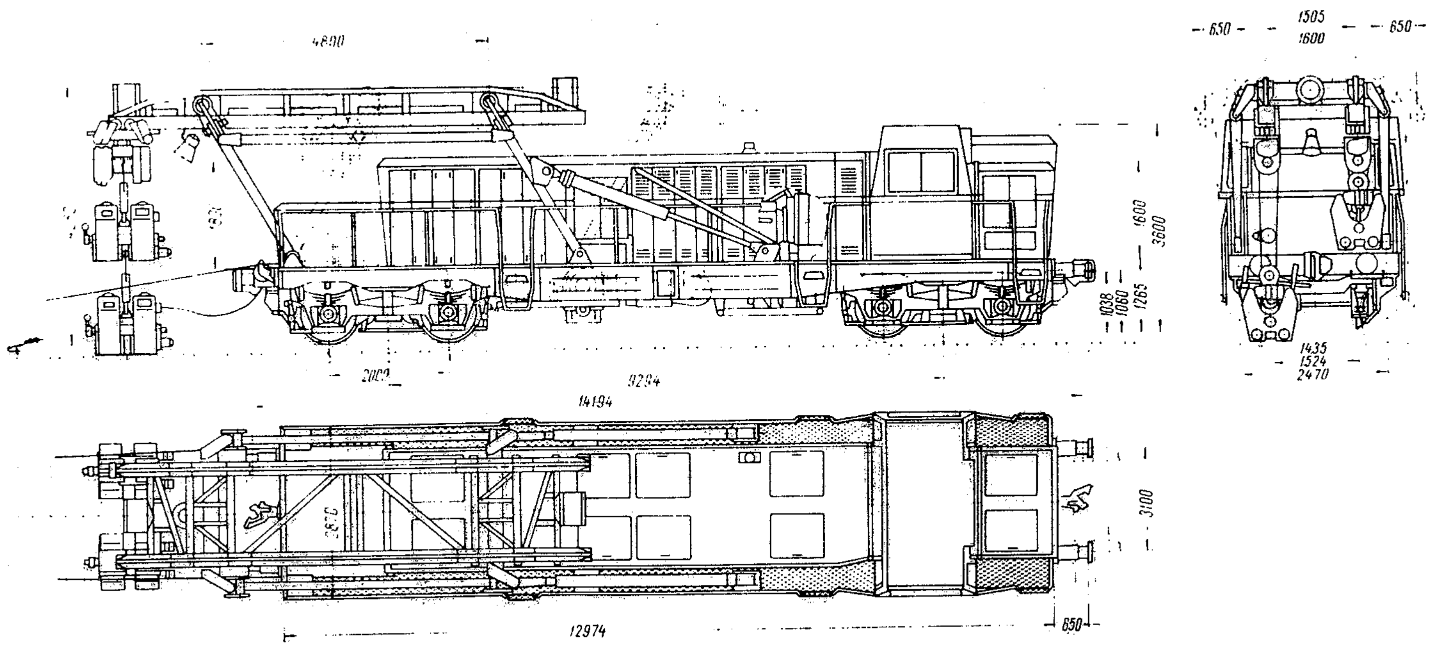
Diagram of unloading of Hopper-Car
ЦНИИ-ДВЗ

TECHNICAL DATA

Gauge, *mm*	1524
Loading capacity, *t*	60
Tare weight, *t*:	
with brake platform	22.77
without brake platform	22.6
Overall dimensions, *mm*:	
length of frame	9650
length over couplers	10870
width	3206
height above rail top	3167
Cubic capacity, m^3:	
standard car	32.4
car with extended top	40
Number of hatches	2+2
Weight, *t*:	
with brake platform	82.77
without brake platform	82.60

SELF-PROPELLED WELDING MACHINE

ПРСМ-3



ПРСМ-1 welding machines, widely employed on Soviet rail roads, have proved their efficiency and gained general recognition among experts both at home and abroad.

At present, a new model of the welding machine has been designed and marketed. Its construction and principle of operation are similar with those of the ПРСМ-1 model but featuring a self-contained power plant the new ПРСМ-3 machine is capable of travelling on track under own power.

TECHNICAL DATA

Gauge, *mm*	1524 and 1435
Weld time, double butt, *min*	12
Travel speed, *km/hr:*	
when working	2.5
when moving under own power	50
when moving as part of train	80

Overall dimensions, *mm:*	
length over couplers	14194
width	3100
height	4280
Weight, *t*	61