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JPRS L/10682

23 July 1982

# USSR Report

## TRANSPORTATION

(FOUO 6/82)

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AIR

UDC 625.717(083.75)

NEW RULES OF AIRPORT CONSTRUCTION SPECIFICATIONS

Moscow STROITEL'NYYE NORMY I PRAVILA: PRAVILA PROIZVODSTVA I PRIYEMKI RABOT; AERODROMY in Russian 1981 (signed to press 9 Apr 81) inside front cover, pp 1-2

[Annotation and table of contents of book "Construction Norms and Rules; Rules for Performing and Accepting Work; Airfields", "Stroyizdat", 34,000 copies, 112 pages]

[Text] Annotation

This booklet was developed by the State All-Union Scientific Research Institute of Roads (Soyuzdornii) of the Ministry of Transportation Construction with participation by the Aeroproyekt Planning-Surveying and Scientific Research Institute of the Ministry of Civil Aviation.

With the introduction of the present chapter into effect the Instruction on Performance and Acceptance of Airfield Construction Work (SN 121-73) loses its force.

The booklet is intended for engineering-technical employees of construction and planning organizations. The editors of the booklet were engineer V. I. Seregina (USSR Gosstroy) and candidates of technical sciences B. S. Maryshev and A. M. Sheynin (Soyuzdornii) and E. N. Smirnov (Aeroproyekt).

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MISCELLANEOUS

## MEANS OF INCREASING EFFICIENCY OF ENERGY USE IN TRANSPORTATION DISCUSSED

Moscow IZVESTIYA AKADEMII NAUK SSSR in Russian No 1, Jan-Feb 82, pp 77-85

[Article by Molyarchuk, V.S.: "Ways to Increase the Efficiency of Energy Use in Transport"]

[Text] The greatest importance is currently attached to the problems of the development of the fuel and energy complex and an energy conservation policy. In the solution of these problems a great role is played by transport, which is one of the basic consumers of the energy resources, using as it does about 12 percent of the total amount of these resources expended in the national economy.

The proportion of the expenditure of fuel and energy by the transport means is in our country somewhat lower than it is in the other industrially developed countries. For example, in the United States the expenditures comprise 17 percent of the energy resources, in France 16.7 percent and in England 15 percent. This is due to the higher level of the use in these countries' transport systems of the most energy-intensive motor vehicle shipments, which handle 80 percent of the total volume of work in the United States, about 70 percent in France and about 50 percent in England.

In the 1960's, with steam traction, the ratio of transport to the amount of consumption of the country's energy resources amounted to more than 20 percent.

With a nearly 50 percent reduction in the proportion of transport in the balance sheet of the national economy the 2.7 increase in turnover of goods of all types was primarily the result of the remodeling of the transport means on the basis of replacement of the reciprocating steam engine of the traction facilities and power installations with internal combustion and electric engines.

In the past the construction of the country's fuel and energy balance sheet was dependent chiefly on the availability of resources and the level of development of the technology, the interests of which have also been subordinated to the energy policy. At present, and this will be even more true in the future, the resources, trends and strategies relevant to the development



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of the fuel and energy base in many respects determine the basic directions of the technical progress of the country's productive forces.

It is this latter circumstance, along with the high level of domestic machine building, which has enabled us to effect a technical restructuring of transport, including the supplying of it with up-to-date equipment and the provision of the appropriate energy resources.

One of the basic trends in world economics in the last 10 years has been the widespread use of oil and gas in the fuel balance sheets of all the countries of the world and the gradual supplanting of solid fuels.

This trend also operated in the economics of the Soviet Union, which were characterized by even higher rates than those in world economics. Thus, in the period from 1950 to 1975 the world's oil extraction increased five-fold but the USSR's increased 15-fold, extraction of gas increased 6.7-fold and 47.4-fold respectively, and extraction of mineral coal increased 1.3-fold in the world and 2.4-fold in USSR.

The facts of the so-called energy crisis exacerbated in the countries of the West the problem of cutting down the expenditure of liquid organic fuel.

Table 1.

| Type of Transport | Expenditure of Conventional Fuel, kg/1000 ton/km | | | | |
|---|---|---|---|---|---|
| | 1960 | 1965 | 1970 | 1975 | 1980 |
| Railroad | 35.64 | 18.0 | 11.45 | 8.94 | 8.50 |
| National Economy Truck Transport | 237.0 | 243.7 | 202.3 | 173.1 | 143.8 |
| Maritime | 18.35 | 12.30 | 11.10 | 11.34 | 10.0 |
| River | 29.60 | 18.90 | 15.40 | 12.70 | 11.3 |

Despite the fact that the USSR is the world's only industrially developed country fully provided with fuel resources, this problem is also a very pressing one for Soviet economics. Even at present the rates of increase of the felt needs of all the types of transport for crude oil-converted oil fuel are approximately double the rates of increase of extraction of this product.

Consequently, whereas in 1975 transport consumed about one-third of the extracted oil (crude oil-converted), if the evolved norms for fuel utilization are retained, then the transport consumption proportion will reach 40 percent and even more, resulting in a considerably strained situation in respect to the balance sheet of the country and transport.

Thus, a first-priority task in the future will be the organization of energy use in transport. The role of this activity will grow and will consist of all possible reduction of the expenditure of liquid petroleum fuels.



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However, the urgency of the matter of economical expenditure of fuel involves not only economy in the use of the various types of fuel. The importance of this problem is determined by the ever increasing scales of the consumption of energy resources. This engenders a state problem with respect to the conservation of these resources, a problem which is clearly indicated in the "Basic Directions of the Country's Economic and Social Development in the 1981-1985 Period and in the Long-Term up to 1990."

In his speech at the November (1979) plenum of the CPSU Central Committee Comrade L. I. Brezhnev pointed out that the difficulties in the supplying of fuel stem primarily from the sharp increase in the expenditure of the fuel. This process, the result of the rapid growth of the volumes of production, may at the same time be associated with the increase in the relative (per unit of output) energy consumption.

The technical restructuring of transport, which determined the transition to more powerful, progressive and economical power installations employing liquid fuel and electric energy, enabled us at the same time to effect a considerable reduction in the energy intensiveness of the transport output (See Table 1).

In 20 years--from 1960 to 1980--the relative expenditures of energy resources for shipping work fell off by 86.2 percent in railroad transport work, including 76 percent resulting from technical progress. In maritime transport of a total reduction of 45.5 percent 42.5 percent was obtained by remodeling of the power installations; in river transport the figures were 61.8 and 44.5 percent respectively; in motor vehicle transport, with a total reduction of 38.5 percent, nearly 10 percent resulted from the introduction of diesel engines.

A sharp increase in the capacity of the energy installations of transport has enabled us to improve all the indicators and to step up the economical qualities of the transport process as a whole.

The primary development was a substantial increase in the freight capacity of the rolling stock of railroad, motor vehicle, maritime and river transport, i.e., a buildup of one of the basic factors which determine the efficiency, the fuel conservation potential, and the lowering of the cost of the transport process.



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Table 2

| Type of Transport Means | Change in Consumption of Energy Resources, % | |
|---|---|---|
| | 1960-1970 | 1970-1980 |
| Electric locomotives | -14.2 | - 4.3 |
| Diesel locomotives | - 0.2 | + 8.0 |
| Motor ships | - 3 | - 2.8 |
| Steam vessels | -53.7 | -31.5 |
| Freight trucks | -14.5 | -16.9 |

There has also been a fundamental improvement in other indicators for the transport process. The engineering and routing speed of movement has been increased; a reduction has been made in the layovers of trains and ships for the complex and labor-intensive servicing by the steam power stations; there has been an increase in the extent of utilization of the rolling stock and tonnage of the fleet; etc.

Successful work has been done to reduce the resistance in the movement of the rolling stock in all the types of transport.

In railroad transport this was achieved by converting from the use of gliding bearings to roller bearings for the car fleet. This has enabled us to effect a 7-10 percent reduction in the resistance in the movement (the number of cars with these bearings has already reached 50 percent of their total number), and also by increasing the stability of the track roadbed through conversion to reinforced concrete ties and seamless track, etc.

In motor vehicle transport the average resistance in movement was reduced by virtue of an increase from 21.6 to 55 percent in the proportion of roads with a firm covering.

In water transport further improvement of the hydrodynamic qualities of the ships has continued along with the introduction of deflectors and special nozzles for the screw propellers. In river transport there has been a reduction of the resistance in movement and, in addition, a deepening of the waterway and the use of pushed instead of towed units.

Improvement of the equipment and organization pertaining to the loading and unloading operations along with the introduction of container carriers and ships with the horizontal means of carrying out freight operations have enabled us to effect additional economizing of fuel in cutting down the layover of ships with operating auxiliary mechanisms.



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Analysis of the consumption of fuel and electric energy, the prospects for further technical progress, and the requirements for operation of operation of all the types of transport--this analysis has shown that the 1975 completion of the mass renovation of the electric power stations of transport exhausted the reserves for the radical increase of energy conservation in the transport process, an increase which took place in the 1960-1970 period.

Further reduction of the consumption of fuel is primarily the result of improvement and modernization of the now new transport means which operate on a new power basis; also a factor in this connection is improvement of the indicators for the use of these transport facilities. And the rates of reduction of this fuel consumption have been appreciably less, a fact which is supported by the Table 2 data which describes the change in expenditures of energy resources according to the types of energy-consuming transport means (i.e., not counting the change in the structure of the fleet of traction units).

When we examine the various consolidated directions for further reduction of the relative expenditures of energy resources, we can point to the following changes in the conditions of operation of the transport equipment.

There will be some diminution of the increase of the rates of further reduction of the relative expenditures of electric energy and fuel as a result of increasing the weight of the trains and the freight capacity of the rolling stock. For example, in railroad transport the increase is expected to be only 9-10 percent as compared to 30 percent in the last five-year period; in maritime transport instead of a two-fold increase in the average freight capacity of ships, as happened in the 1960-1975 period, this increase is expected to be only 30 percent; in motor vehicle transport the increase in the freight capacity of the truck has been to all intents and purposes quite negligible.

Remaining substantial will be the impact of organizational and technical factors, i.e., improvement of the conditions of operation as a whole, measures for reducing the resistance in movement, the most significant of which is apparently the construction of hard-surface motor roads, the use of more efficient designs of truck tires, further equipping of the railroad cars with roller bearings, the change to eight-axle cars which have 12-15 percent less resistance than the four-axle cars currently in use, further remodeling of the railroad track, etc.

Considerable effect can be obtained from the measures for further increase of the propulsion coefficient of the ships, increasing the proportion of the work done by ships which are not self-propelled, etc.

The most important aspect of the work for stepping up the level of the energy utilization is improvement of the existing power stations and the search for new, more economical ones as well as improvement of the propelling and energy complexes as a whole.



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The following principal directions will apparently be the basis for further modernization of the power stations for the transport means and rolling stock; this modernization will provide for curtailment of the energy capacity in use. The directions are the following:

The development of new high-powered traction facilities and power stations which make for more economical fuel utilization processes based on four-cycle diesels of progressive designs with improved pressure feed characteristics and combustion chambers of the appropriate designs to provide for pipe conveyance of the charge and improvement of its ignition and combustion;

Increase of the degree of compression in carburetor motors, the use of electronics for control of the fuel inspection systems (Tables 1 and 2), increase of the power and duration of the electric sparkplugs (Table 3), and the jet ignition process in motor vehicles which use gasoline fuels;

Broadening of the scope of use of diesels in motor vehicle transport by reducing the lower level of the freight capacity of motor vehicles from the current six tons to 2.6 tons and also by installing diesels on all buses of medium and higher passenger capacity and on truck tractors in the process of being built;

Reduction of the power level of the auxiliary machines of the transport power systems; this power is considerably greater than or analagous foreign models; automation of the regulation of their operating schedules in accordance with the heat status of the chief machines and the traction motors and transmissions and in particular automatic regulation and switching off of the motor vehicle ventilators with provision for high-temperature cooling of the motors;

Improvement of the transmissions and motor complexes, the use of specialized nozzles for ship propellers, and the use of propellers of variable pitch, coaxial propellers and other systems which produce an increase in the propulsion coefficient of the ships (Table 4);

Use of rolling stock which provides for the consolidation of items shipped by means of increased freight capacity of the transport means; through increase of the proportion of rolling stock of higher freight capacity, particularly motor vehicles of large freight capacity, eight-axle railroad cars, large-tonnage ships, etc.; the preparation of measures for widespread introduction of advanced experience in the use of motor vehicle trains and pushed units in water transport;

The use of such scientifically substantiated methods of control of the transport process as will insure operation of the traction facilities with maximum utilization of their capacities and traction forces, minimum layovers while in operating condition and runs without load, and rationalization of all the auxiliary operations in the form of all possible consolidation of them.



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Table 3

| Type of Transport | Consumption of Conventional Fuel (kg/1000 ton-km) 1960 | 1970 | 1980 |
|---|---|---|---|
| Railroad | 35.64 | 11.43 | 8.3 |
| Maritime | 18.35 | 11.32 | 10.3 |
| River | 29.60 | 15.40 | 11.4 |
| Truck | 237.0 | 202.30 | 144.1 |
| Gas pipe line | 41.25 | 57.90 | 66.5 |
| Oil pipe line | 7.06 | 5.01 | 5.5 |

Table 4

| Type of Transport | Proportion of Total Energy Consumption, % 1960 | 1965 | 1970 | 1975 | 1980 |
|---|---|---|---|---|---|
| Railroad | 63.6 | 43.2 | 31.2 | 25.9 | 21.3 |
| Maritime | 3.9 | 6.6 | 6.4 | 5.5 | 4.5 |
| River | 3.3 | 3.4 | 3.0 | 2.3 | 1.9 |
| Motor Vehicle (Railroad Economy) | 24.6 | 35.6 | 43.8 | 43.3 | 39.7 |
| Oil pipe line | 0.3 | 0.7 | 1.0 | 1.7 | 2.8 |
| Gas pipe line | 0.7 | 3.3 | 5.5 | 11.3 | 19.7 |
| Other types of transport | 3.6 | 6.3 | 9.1 | 10.1 | 10.1 |



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Table 5

| Reason for Change in Expenditures of Energy Resources | Change in Expenditure of Conventional Fuel, millions of tons, in the 1960-1980 Period |
|---|---|
| In all | 497.6 |
| Including change resulting from increase in the volume of work | +260.5 |
| Change in the structure of the transport | 61.0 |
| Technical progress | -180 |
| Organizational and technical measures | - 44.0 |

Table 3 presents the actual relative expenditures.of conventional fuel in shipments carried out by the various types of transport delineated to allow for the implementation of the relevant measures.

The change in the energy consumption of the shipments by the various types of transport and in the structure of the shipments leads to a curtailment of their shared participation in the overall energy consumption of the transport system. Evidence of this is furnished by Table 4, which sets forth the data on the participation of each the types of transport in the overall energy consumption, counting the expenditures for auxiliary needs.

The change in the structure of the work is very strikingly reflected in the overall consumption in the energy resources of the transport system as a whole for the accomplishment of the shipments. Analysis proves that with a 3.5 increase in the shipment by all the types of mainline land transport in the period from 1960 to 1980, the overall consumption of energy resources converted for the expenditure of conventional fuel went from 101.3 to 198.9 million tons, i.e., only 1.96-fold. The structure of the change is delineated in Table 5. Thus, were it not for the fact that the transport work has been changed with an increase of the relative weight of the most energy-intensive types, then technical remodeling and implementation of the organizational and technical measures for increasing the efficiency of the energy utilization would compensate for virtually 85 percent of the increase of expenditure of conventional fuel stemming from the increased amount of transport.

However, the continued surpassing increase of the most energy-intensive types of transport, particularly motor vehicle and air, and the increase in the volume of work of gas line transport, will in the future generate energy consumption growth of such dimensions that it will be impossible to cover them by means of the predicted measures for improving the efficiency of the energy consumption.



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Thus, when there is the amount of growth of the transport system's consumption of energy resources by virtue of increased volume of work as assumed on the basis of the retrospective data, when this ensues there takes place a simultaneous increase in the expenditure of these resources as a result of the continuous change in the structure of the shipments in transport, a change of 36-38 percent with a possible reduction of the consumption of fuel and electric power by virtue of a 30-35 percent increase in the efficiency of the use of these resources. Thus, even all possible increase of the efficiency of the energy utilization cannot compensate for the negative consequences of the redistribution of the shipments among the types of transport we are examining.

This circumstance generates the third strategic direction of the work for reduction of the transport system's energy intensiveness--all possible rationalization of the structure of the shipments, i.e., achievement of the optimum distribution of the work among the types of transport and the transport means with due consideration for the efficiency in the use of the energy resources and their consumption of the types of fuel in short supply.

The following can be cited under the measures which promote the solution of the overall problem of reduction of the energy intensiveness of the transport means:

1. Concentration of the material and financial resources to provide for a reduction of the expenditure of fuel particularly by motor vehicle transport which is characterized as having the greatest energy intensiveness among all the types of land transport. In this regard the most effective measures are the most widespread introduction of diesels, modernization of the motors, improvement of the structure of the transport fleets and increase of the extent of participation of public transport.

2. A substantial increase of the fuel economy of air transport by the introduction of wide-fuselage aircraft of large passenger capacity and the use of motors with a high degree of dual contour capacity.

3. On parallel routes which have a length up to 1000 kilometers and expend about 90 kilograms of conventional fuel per 1,000 passenger-kilometers partial replacement of air transport with high-speed railroad transport (consumption 14 kilograms of conventional fuel); the establishment of optimum favorable conditions of operation and comfort for public urban transport for the purpose of cutting down the travel of personal motor vehicles within the cities (public transport consumes 1/2 to 2/5 of the fuel per passenger in comparison with personal motor vehicles).

4. Expansion of the electrification of the traction facilities of all the types of transport; this will enable us not only to replace the scarce oil fuel but also to economize on the primary energy resources through a reduction of expenditures for fuel for the production of a kilowatt-hour of electric energy. The electrification work can take on the following directions:



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The development of electrified traction in railroad transport to replace a part of the diesel locomotive traction and the development of electrified switching traction facilities. The figures show that further electrification of the railroads will enable us in the very near future to save over and above the 1980 level 2.2 million tons of conventional fuel and to reduce the expenditure of energy resources converted from conventional fuel by nearly one million tons and more and in the distant future to achieve an even greater saving of energy resources.as a whole (counting the necessary outlays of electric energy);

The use of electromobiles; at present in our country and especially abroad (United States, England, France, Japan and FRG) they have developed research, planning and design, and experimental work for the establishment of efficient chemical current sources which possess a high energy capacity and do not require the use of scarce materials. The future current sources of this type include sodium sulfur sources and sources similar to them, which possess a relative energy capacity of 100-150 watt hours per kilogram, and a service life of 1000-1500 cycles and provide an electromobile current reserve of 200 kilometers and more instead of the 40-45 kilometers for electromobiles based on lead and ferrous-nickel chemical current sources (energy capacity of 20-26 and 30-35 watt-hours per kilogram respectively) (Bibliography Items 5 and 6).

We are now already providing for the development and manufacture of electromobiles and electrobuses and we are also providing for the organization of experimental operation of them in Moscow (for the time being on the basis of lead and ferrous-nickel current sources).

The widespread introduction of efficient current sources and special electromobile designs will enable us in the near future to save about 3 million tons and more of gasoline and in the distant future up to 17 million tons;

For the traffic capacity of the street network and the conditions of ongoing construction the replacement of bus transport with trolley bus and high-speed tramway where this is possible will enable us to save about 1.5-2.00 million tons of gasoline;

Reduction of the expenditure of petroleum fuels can be achieved in the more distant future by the use of substitutes (Bibliography Item 7), as for example synthetic liquid fuels obtained on the basis of coal, lignite and combustible shales, natural and side-recovery gases in condensed and liquefied form, alcohols, hydrogen, etc. It is believed that improvement of certain methods of gasification of coal, lignite and combustible shales with subsequent obtaining of methanol and motor fuel based on it will enable us to begin using this group of substitutes in 1990.

Liquid fuel derived from coal products can be obtained by the hydrogenation methods employed rather extensively in prewar Germany and now in Arabia. In the United States they expect by 1985 to bring the production of liquid fuel derived from combustible shales to 2 million tons and by the year 2,000 to 40 million tons a year.



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Among the direct gasoline substitutes we can also list methanol, the production of which has reached 4 million tons a year in the United States. The countries of western Europe predict that they will bring the volume of production of methanol to 170 million tons by the 1985-1990 period. Methanol will apparently be used in a mixture with gasoline.

Work is now in progress for the use in internal combustion engines of hydrogen both in liquid form and in the form of metal hydrides. However, practical extensive use of hydrogen as a fuel will only be possible on the basis of the development of atomic energy.

The problem of conserving energy resources in transport is a matter of great national economic importance and for its solution requires the development of fundamental scientific, theoretical and experimental-design work in the following directions: The working out of theoretical principles for improvement of the thermodynamic cycle and the designing of traditional diesel and steam turbine power installations for the purpose of stepping up the K.F.D. [efficiency factor], including this factor in the partial load regimes;

The development of highly economical nonstationary turbine units using very sturdy heat-resistant materials for the vanes of the stators and rotors of the gas turbines, materials geared for continuous operation in a working element temperature of 1100-1200 degrees Celsius;

The development of highly economical transport installations (power) on nuclear fuel with a capacity of 10-40 megawatts;

Investigation of the extent of improvement of the process of combustion of the fuel of the internal combustion transport engines and preparation of the appropriate measures (layer ignition, jet combustion, intensification of the electric discharge ignition, etc.),

Development for the electromobiles of new electrochemical current sources with a high electrical capacity and a long service life, current sources based on the use of materials not in short supply;

For extensive application in the transport facilities the development of fuel elements based on the use of atmospheric oxygen;

Investigation of the possibilities of using new types of fuel in internal combustion transport engines (hydrogen in the form of an addition to the gasoline and air working mixture and in pure form, methanol, etc). Also, the use of metal hydrides and their combinations for the transportation of hydrogen on board the motor vehicles when using the heat of the motor exhaust gases for extracting hydrogen;

The development of stabilizers for the compounds of the mixtures of petroleum fuels and methanol and other possible types of fuels;

Prediction of the optimum fuel and energy provision for transport in combination with the overall development of the country's fuel and energy complex;



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Study of the negative effects of each of the types of transport on the environment and the working out of measures which require the accomplishment of fundamental research;

Theoretical research to determine the movement resistance of the rolling stock, including noncontact transport (on air cushion and on magnetic suspension).

Conclusions: 1. Transport is a large consumer of the energy resources of the national economy and it is therefore a problem of state importance to pursue a well-planned energy-saving policy in this transport.

2. Analysis of the basic trends in the development of transport and its power installations as well as its national economic requirements in respect to rationalization of the use of the fuel and energy resources suggests that the most important tasks are those pertaining to a substantial reduction of the relative expenditure of fuel by each of the types of transport with a maximum economy of liquid organic fuel, particularly by replacing it with other energy carriers and by the fullest possible optimization of the structure of the shipments so as to take advantage of the energy capacity of each type of transport.

3. Further increase of the efficiency of the use of energy resources requires the widespread introduction of diesels in motor transport, increase of the extent of dual-contour gas turbine aircraft engines, electrification of the transport means, the supplying of more economical units, improvement of the auxiliary installations, and modernization of the power stations and the propelling systems.

More economical use of fuel and electric energy will be achieved as a result of further measures for reduction of the movement resistance of the rolling stock of all the types of transport by improvement of its aerodynamic and hydrodynamic qualities and by improvement of the road conditions, particularly expansion of the scale of motor road construction, increased use of the stability of the railroad track, improvement of the waterway of the water mainlines, etc.

5. Economizing on energy resources is also the result of improvement of the organization of the transport process in the direction of the fullest possible use of the traction means and power stations in accordance with their capacity and time of operation (increase of the carrying capacity of the rolling stock, the weight of the trains and motor vehicle trains, the barge units, and the coefficients for full use of the freight capacity, the time of productive transport work, etc.).

The problem of increasing the efficiency in the use of the fuel and energy resources in transport is a matter of extreme urgency for the national economy, is quite urgent in a scientific-technical regard, requires further fundamental scientific and planning design exploration and for a rapid and effective solution deserves to be included among the most important national economic problems.



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Received in the Editorial Office
3 March 1981

Moscow

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MISCELLANEOUS

NEW TYPES OF MANIPULATORS EXHIBITED IN MOSCOW

Moscow PROMYSHLENNY TRANSPORT in Russian No 3, 1982 pp 25-26

[Article: "Hoisting-Transport Manipulators"]

[Text] Several models of new machines that will be of interest to specialists in industrial transportation have been displayed in the permanent exhibit "Automatic Manipulator" in the "Machine Building" pavilion of the Exhibition of the Achievements of the USSR Economy.

The Kompleks Science-Production Association (40085, Volgograd, Prospekt V. I. Lenina, 98) is exhibiting the KSh63 manipulator with automatic load balancing. This manipulator has a load capacity of 63 kilograms and is designed for interoperation, assembly, loading-unloading, and warehouse jobs. Its operating zone is 1,600 millimeters high with a radius of 300-3,000 millimeters. The force of displacement of parts on the vertical is 50 newton and 20 newton on the horizontal. Air pressure in the pneumatic system is at least 0.35 megapascal. The weight of the unit proper is 324 kilograms and its dimensions are 2,655 × 600 × 3,006 millimeters.

The same association also exhibited the similar KSh-160M1 manipulator with a load capacity of 125 kilograms. With the same service zone the force required to move a part with this manipulation is 40 newton on the horizontal and 60 newton on the vertical. The air pressure fed from the compressor to the manipulator is 0.45-0.63 megapascal. The manipulator itself weighs 465 kilograms and its dimensions are 3,870 × 2,735 × 720 millimeters.

Fully turning series MP 100 balanced-type loading manipulators with electromechanical action are also displayed at the exhibit (address to request documentation is 107005, Volna Central Scientific Technical Institute). These manipulators have a load capacity of 100 kilograms in detachable grapples.

The MP 100-1 loading manipulator can be mounted on the floor, on a column, or overhanging arm attached to the wall or ceiling of a production area. Its service zone is 1,500 millimeters on the vertical and horizontal, with a rate of vertical displacement of 200 millimeters per second. The area of the loading trolley is 1,260 × 1,050 millimeters, and the weight of the unit without the trolley is 200 kilograms. The annual economic impact from introduction of one manipulator is 2,500 rubles.



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The MP 100-8 overhead loading manipulator has a rate of vertical displacement of the detachable grappling element of 250 millimeters a second and a rate of horizontal, longitudinal displacement along a suspended beam of 500 millimeters a second. The weight of the mobile part of the manipulator proper is 600 kilograms. Its dimensions are 8,000 × 6,000 × 5,100 millimeters. The annual economic impact from its introduction is 4,000 rubles.

The overhead transportation system with a manipulator based on a monorail is especially interesting (see photograph [not reproduced] on the inside cover of this issue of the journal). It was developed by one of the Moscow scientific-research institutes. The system can operate as a subsystem of a shop automated control system for industrial processes or as a self-contained automated transportation-storage system. This consists of a manipulator and a set of devices that carry out centralized control of movement. The manipulator has a load capacity of 25 kilograms and a precision of positioning of ±10 millimeters. The maximum number of control manipulators on an overhead track is 32 with a maximum number of service points of 512. The dimensions of the manipulator are 5,000 × 4,500 × 2,700 millimeters. The elements of the overhead line are made of lightened tubular shaped metal pieces. The annual economic impact from introduction of the manipulator is 115,000 rubles.

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