FROM FOREIGN PRACTICE

INTERNATIONAL EXHIBITION OF MINING EQUIPMENT

"INTERGORMASh-67"*

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At the Moscow Exhibition a Swedish firm exhibited electric submersible Bibo pumps in five sizes (Fig. 1), chiefly intended for pumping surface water at construction sites. The capacities of these pumps are 430-970 liters/min. Their adoption has considerably simplified construction and assembly work and reduced the number of servicing personnel. The unit consists of a pump and electric motor, the impeller and rotor of which are carried on a common vertical shaft. The unit has a cast casing made of a light (usually aluminum) alloy which protects it from impact and keeps out dirt and dust. Pumps in all designs made from special steels resist aggressive waters and abrasive inclusions. The pump runner can be changed in ten minutes on site, and most of the units are rated for a ten-year life. The pumps require no suction tubes in operation and enable two or more units in sequence to work normally. Table 1 gives brief technical specifications.

The Swedish firm Atlas Copco showed two types of submersible pump, DIP-30 and DIP-60, with ratings up to 3,110 liters/min.

Powered concrete mixers, automatic mixers, concrete pumps and concrete sprays, and mix guns were exhibited by the Federal Republic of Germany and Switzerland. About 160 types of powered concrete mixers are produced in the Federal Republic of Germany, with batch volume up to 4,500 liters. The raw materials in mixers of this kind are moved along complicated trajectories inside the body. The 500 Ts cyclical mixer (with powered mixing), demonstrated at the Exhibition, has a fixed cylindrical body for batches of up to 500 liters, and a central shaft with mixing blades rotating at 27 rpm so that planetary gearing can rotate a single side shaft at a speed of 108 rpm for the additional blade work. This machine is for making mixes with aggregate particle size up to 60-80 mm, the rating is 27 m^3/h, overall dimensions (length × width × height = 3,200 × 1,790 × 2,170 mm) and continuous motor power 27 kW. Special features of this mixer include the bottom central drive shaft and rigid (without shock-absorber) attachment of blades to brackets. The mixer can be delivered stationary or mobile, weighing respectively 2,700 and 3,000 kg. The same firm also produces turbine mixers of cyclical type with batch volume 500 and 1000 liters, a fixed body and a single central rotary shaft with blades.

Wide use is made abroad of concrete mixer trucks for mixing and transporting dry and finished mixes. Two truck mixers were shown at the Exhibition, 4.5L (Fig. 2) and 5L, with drum capacity in terms of mix respectively,

*Continuation of the review of foreign equipment at the Exhibition; for previous articles, see Gidrotekhnicheskoe Stroitel'stvo, Nos. 4 and 6, 1968.

TABLE 1

Index	Bibo-1	Bibo-2	B-80MA	Bibo-3	Bibo-4	Bibo-5	B-150/200L
Maximum output, liters/min	430	1 050	1 050	1 150—1 700	1 090—2 000	2 200—6 200	5 000—9 700
Diameter of attached pressure hose, mm	38—50	76	76	76—100	100	125—150	150—200
Maximum pressure, m of water	17,5	18	26	28—21,5	36—21,5	60—35	52—30
Rating, hp	1	3	5	5	6,5	27	50—60
Overall dimensions, mm							
diameter	190	285	240	410	480	620	533
height	400	515	965	560	730	930	1 428
weight, kg	15	28	56,7	40	77	150	340—575

Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 9, pp. 50-59, September, 1968.

TABLE 2

Index	Model			
	4.5L	5L	6.5L	10L
Capacity of mixing drum, m^3				
rel. to finished concrete mix	5	6–6 5	7	10
geometric	7.86	9,1	10.4	16.2
Rating of diesel motor for drum drive, hp	45–50	60	67	100
Overall dimensions of technological equipment, mm:				
length	4 630	4 960	5 250	10 400
width	2 400	2 400	2 400	2 400
height	2 345	2 430	2 520	3 800
Weight, kg	2 700	3 100	3 350	9 700

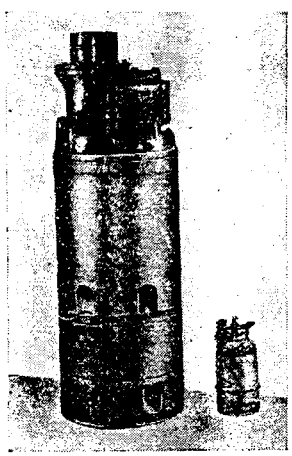

Fig. 1. B-150/200 L (on left) and Bibo-1 submersible pumps, made by Flygt International (Sweden).

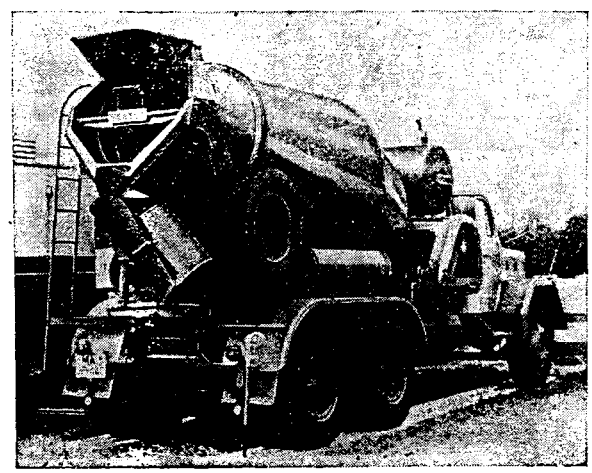

Fig. 2. 4.5L concrete mixer truck.

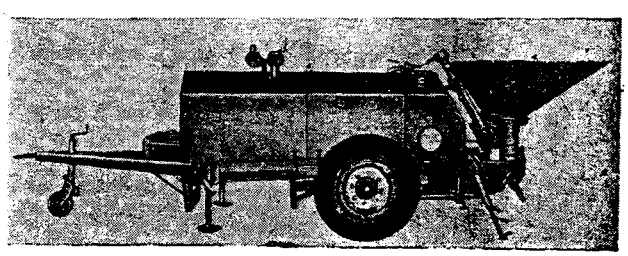

Fig. 3. PT-16FD concrete pump.

5 and 6-6.5 m^3. Table 2 gives brief technical specifications.

Technological equipment is mounted on a two-, three-, or five-axle truck chassis using speical connections. The mixture is discharged by changing the direction of rotation of the drum via a special extensible chute which can swing to the left or right of the mixer axis, through 90°.

Mixtures are usually transported along pipelines using pump or pneumatic boosters and wide use is also made of spray applicators for concrete mixtures (cement guns). Hydraulic piston pump drives are particularly popular. These are characterized by simple kinetic systems and small overall dimensions and are easy to transport. An increase in the pressure in the hydraulic system to 160 kg/cm^2 has made them more reliable and capable of transporting the mixture as far as 600 m. Practically all the concrete pumps with hydraulic drives are on pneumatic tires.

TABLE 3

Index	Model				
	PT-6E	PT-15E	PT-16FE	PK-21FE	PT-30FD
Maximum output, m^3/h	6	12	18	25	35
Maximum distance of feed, m					
horizontal	200	400	400	600	–
vertical	40	60	60	60	–
Bunker capacity, liters	300	600	450	500	350
Overall dimensions, mm					
length	2,885	4,020	6,350	6,350	6,000
width	1,505	1,610	2,250	2,250	2,150
height	1,810	2,140	1,850	1,850	1,900
Loading height of bunker, mm	1,810	2,140	1,650	1,650	1,500
Internal diameter of concrete line, mm	80-150	80-150	80-150	100-180	80-180
Power, rating kW	15*	30	45*	55	78†
Weight, kg	1,400	2,025	3,500	4,000	5,500

*The version of the pump with diesel motors has a rating of 29 and 78 hp, respectively.
†Diesel motor.

TABLE 4

Index	Firm, country, model						
	Torkret (W. Germany)				Aliva (Switzerland)		
	BO	No. 1	C-3	TM-63	300	400	600
	Sluice chamber				Sluice drum		
Maximum output in terms of consumption of dry materials druing spraying of con-mix, m^3/h	0.8	1.5	3-6	1.8	4-6	3-4	4-5
Minimum distance of feed, m							
horizontal	200	200	200	–	250	300	300
vertical	100	100	100	–	100	100	100
Maximum particle size of filler, mm	7	10	10-25	10	30	20	20-25
Hose diameter, mm	25	32	32-50	25; 32	38; 58	50; 70	50; 70
Loading height, mm	1,330	1,410	1,650	1,250	1,300	900	1,100
Motor rating, kW	1.47	1.47	2.2	2.2	6.6	2.2	4.4
Weight, kg	220	480	640	330	800	310	600
Compressed-air consumption, m^3/min	3	4.5	6-12	6	8-10	5-7	6

Torkret (Federal Republic of Germany) exhibited PT-16FD hydraulic concrete pumps (Fig. 3) with diesel motors, and PF-21FE pumps with electric motors. Table 3 gives brief technical specifications for the hydraulic concrete pumps advertised by this firm, on a tired chassis, a special feature of these being high standardization of assemblies and components. The pumps are coupled up to tractors for long hauls.

This firm also advertised a PK-21 concrete pump which has a free-floating piston in the transport cylinder and output of up to 25 m^3/h; the pump and drive unit are mounted on individual single axle pneumatic-tired bogies which are spaced 4-5 m during operation and connected up by a pressure suction hose, high-pressure sleeves and electric cabling.

Abroad, concrete pumps are frequently placed on truck chassis to make them more mobile and maneuverable. Torkret advertized a machine of this kind with an output up to 35 m^3/h. The pump output is adjusted automatically by changing the flow of the medium to the ram. The pumps are made with a conical intake hopper and no mixers

TABLE 5

Index	Firm, country, model				
	Atlas Copco	Bergman Bohr		Waacker	
	Sweden			W. Germany	
	Kobra	MB-61	BR-52	BKhF-25K	BKhF-30K
Weight, kg	23	26	28	25	30
Length, mm	615	690	730	700	700
Motor rating, hp	–	–	–	1.75	2.3
Fuel tank capacity, liters	1.5	1.9	1.9	1.7	1.7
Fuel consumption, liters/h	1.2	1.8	1.8	0.6	0.8
Maximum number of impacts/min	2,300	3,000	3,000	1,200	1,450

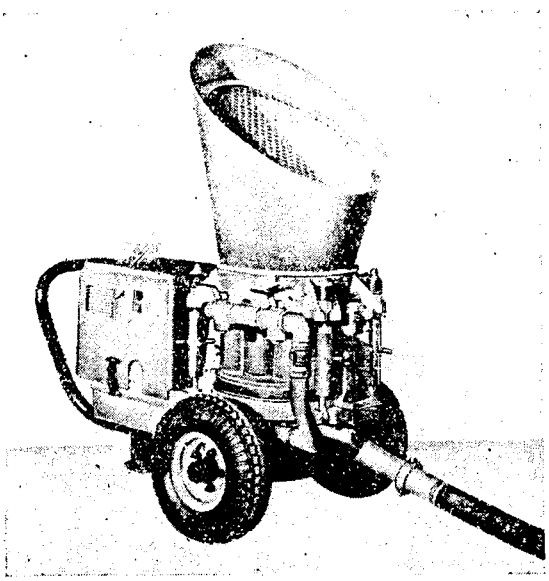

Fig. 4. Model 600 spraying a concrete mix with hose drum.

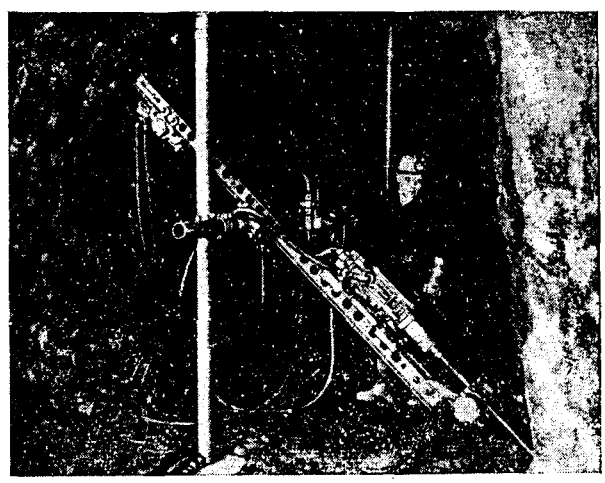

Fig. 5. S-125 drill with chain-type autofeed.

or agitators, owing to the fact that basically plastic concrete mixtures are used. Transportable mixers are also produced, having a vertical shaft and independent drive which can be placed on charge bins to suit customer requirements. In the case of concrete pipelines consisting of individual lengths and quick-acting couplings, the pipes used are generally of strong materials with an inner face coated in wearproof enamel. Water at 22 atm is used to scavenge and deplug the lines.

Spray guns for solutions and mixtures were exhibited at the W. German and Swiss stands. Guns of this kind are used widely for various types of work, including tunnel driving and facing slopes and reservoirs. The initial material is carefully mixed dry cement, sand and gravel,or rubble. Various types of ancillaries are used to get the mixture into the machine and it is then fed by compressed air (pressure 5-6 kg/cm^2) along the hose to a nozzle where it is moistened at a pressure of 1-1.5 kg/cm^2 above that of the compressed air and finally applied to the surface. In accordance with data listed, the grade of the Torkret concrete can be improved when the maximum ejection rate of the material from the nozzle is 100-125 m/sec. Also displayed were temporary units for spraying concrete solutions of mixtures. They had a sluice chamber or sluicing drum. Brief specifications are given in Table 4.

Machines operating with sluice chambers are fitted with pneumatic motors; those with sluice drums with electric motors. Machines produced by Torkret are on two-tire wheels with supporting devices, while models 1 and S-3 can also be fitted for rail travel in accordance with customer requirements. The 600 model (Fig. 4) from the Swiss

TABLE 6

Index	Firm, country, model								
	Böhler (Austria)				Tampella (Finland)	Atlas Copco (Sweden)			
	LKh-75	R-240S	TsR-250	khM-750	S-100	BBD-90V	BBTs25V	BBTs120	BBE56
Weight, kg	22.4	24.5	28	100	24	27.4	29.1	69	154.5
Length, mm	885	665	630	850	625	670	760	780	875
Air consumption, m^3/min	1.8	3.4	3.25	9	3.6	5.7	4.4	9.3	11.4
Cylinder diameter, mm	53	75	80	115	100	90	70	120	120
Piston stroke, mm	100	55	57	80	26	45	70	65	65
Number of impacts/min	1,500	2,500	2,950	1,600	–	3,200	2,100	1,900	2,200

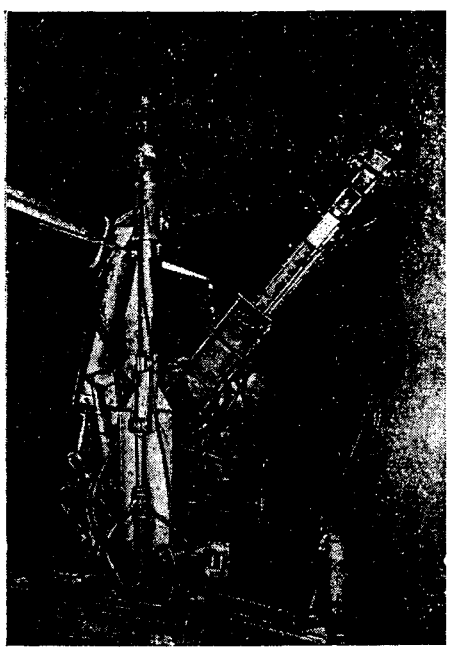

Fig. 6. Simba-11 drill carriage, made by Atlas Copco (Sweden).

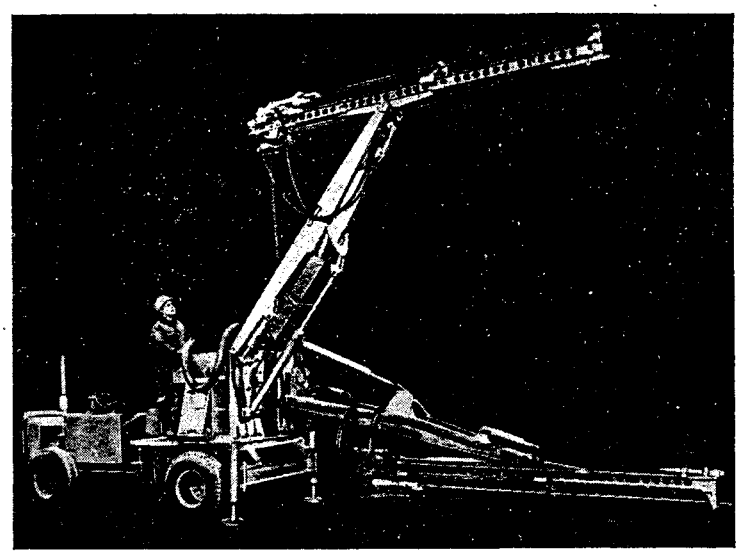

Fig. 7. RP-625 tire-mounted drill.

firm of Aliva is of the nonchamber type. A rotary sluice drum, which has vertical holes through it, is used as portioner. The dry mixture is fed into a funnel fitted with a special grid and passed through the flange of the funnel into the drum chamber; it is portioned out evenly into an air feed point and then along a hose to the nozzle. Machines of this kind mounted on a tired chassis with sluice drums are now very popular; they are portable, simple to control and just as reliable in operation as those with sluice chambers.

Equipment intended for drilling underground and in open rock was shown at the exhibition by Austria, Great Britain, Belgium, the U.S.A., Finland, France, Federal Republic of Germany, and Sweden.

Abroad, heavy manual work is mechanized by hand percussive tools: air, electric, or gas-driven picks. They are used for many types of work: for crushing oversize materials, breaking of frozen and compacting freshly exposed ground, opening up asphalt and concrete coverings, etc. The Austrian firm of Böhler advertized picks of 29 types weighing from 2.6-36 kg operating off compressed air at 4-6 atm. Atlas Copco (Sweden) makes five types of pneumatic picks weighing from 9-36 kg. Picks with individual gasoline motors are of interest here and these are particulary effective for

TABLE 7

Index	Firm, country, model			
	Seau du Tarn-Stenwig		Böhler	Holman Brazers
	France-Belgium		Austria	Britain
	BB	42	ETKD-11/35	VR-4
Hole diameter, mm	64-115	64-115	85	83-108
Drilling depth, m	30-40	50-60	60	30
Overall dimensions, mm				
length	3,250	3,250	2,800	4,705
width	1,750	2,100	1,880	1,778
height	–	–	4,600	3,530
Weight, kg	550	1,100	1,070	1,134

TABLE 8

Index	Firm, country, model				
	Böhler	Atlas Copco	Ingersoll Rand	Gardner Denver	Joy Ville Goze
	Austria	Sweden	U.S.A.		France
	TTs-110	ROts-600	TsM-150A	ATD-3100	Mustang
Hole diameter, mm	64-125	64-102	64-102	51-102	89-164
Hole depth, m	60	12	–	50	90
Overall dimensions, mm					
length	5,400	2,400	4,900	3,060	3,650
width	2,200	2,200	2,100	2,184	2,950
height	1,250	1,300	2,900	5,000	10,660
Weight, kg	3,300	3,325	4,186	3,765	8,160

working in places difficult of access. Table 5 gives some brief specifications of the contemporary percussive pick equipment which was exhibited with motors fitted with various interchangeable tooling.

These picks (except for the MB-61) can be used as hand drills for drilling shotholes and holes up to 26-100 mm in diameter by changing a few simple parts.

The BR-52 pick on the Pioneer system (from the Swedish firm of Bergman Bohr) is equipped with a single cylinder two-stroke motor with air cooling. It is designed to drill shotholes and holes of diameter 27, 29, and 34 mm to 6 m, horizontal and vertical, and also at angles of up to 45° upwards of the horizontal. Maximum drilling rates in average granites are 310, 290 and 200 mm/min. The range exhibited by the firm has various types of interchangeable tooling, including tamping plates with diameters of 125 and 200 mm.

Waacker demonstrated special motorized tampers of five types weighing 18, 52, 55, 100, and 125 kg; fitted out with independent carburetor-motors; aircooling; and ratings of 1.5, 1.7, 1.7, 2.6, and 6 hp. These machines can compact ground in beds of 25-50 cm in 2-4 passes in a single run.

Hand-held drills (hammers) are perhaps the most popular tools for drilling work. Table 6 gives brief specifications of those shown at the exhibition.

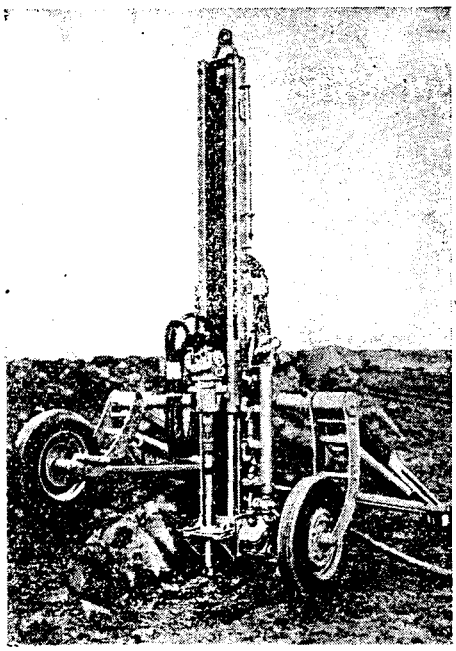

Fig. 8. Tire-mounted drill BB, made by the Franco-Belgian firm Seau du Tarn-Stenwig.

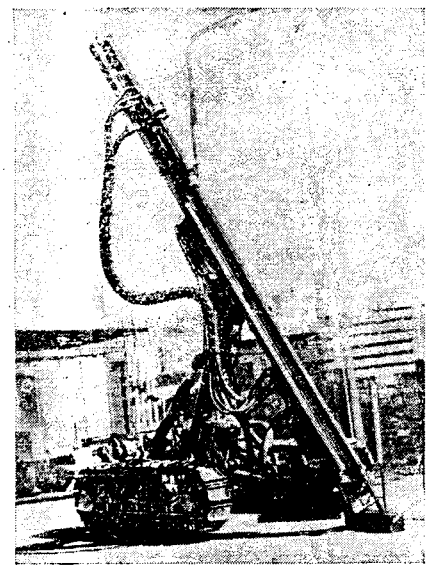

Fig. 9. ATD-3100 track-mounted drill (author's photograph).

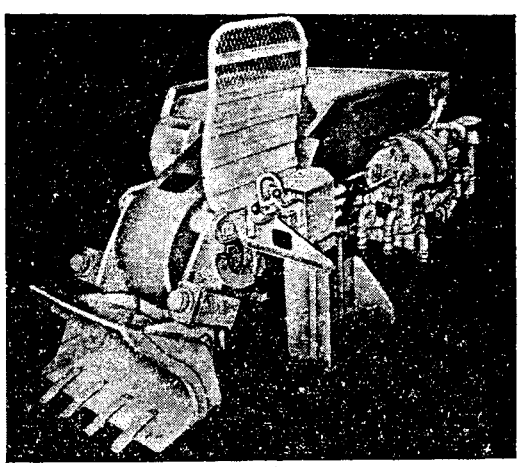

Fig. 10. Eimco (Britain) loader-feeder, model 803.

Hand drills are used chiefly with air legs of various designs weighing up to 30 kg with a feed of up to 1,700 m. Use of high-speed percussives (more than 2,000 blows per minute) is forbidden without air leg backup. Cuttings are removed from holes by compressed air or water with axial or lateral flushing. The drills are fitted with noise and vibration dampers. Core drills work with a self feed (screw, chain, and pneumatic), which can be adjusted on the legs and manipulators of the drilling carriages. The S-125 pneumatic hand-held drills shown in Fig. 5, weighing 51.5 kg with a chain feed, come from the firm of Tampella (Finland) and are used for drilling holes 33 mm in diameter to a depth of 3.2 and 4 m underground (air consumption at 6 atm with water flushing of 4.1 m^3/min). The same firm also showed an LT-2 drilling frame on skids with remote control, the arrangement consisting of two drilling hammers of the S-125 type with chain feeds intended for drilling a spread of risers within limits of 52° either way from a longitudinal axis and up to 30° from a transversal axis towards the direction of driving.

The French firm Seau du Tarn exhibited a drilling frame Super 7 fitted out with a pick and screw feed which can drill fan holes of diameter 85, 102-120, and 160 mm in any direction to a depth of 100, 180, and 150 m. The combined French and Belgian firm Seau du Tarn-Stenwig showed a similar apparatus, Super 4, which was fitted out for drilling holes of diameter 85, 100-115, 127, and 160 mm to depths of 100, 80, 60, and 30 m.

The Swedish firm of Atlas Copco makes seven types of pneumatic picks of the Simba type weighing from 992 to 6210 kg for drilling deep holes underground. The drilling carriages are served by a single operator and fitted with one or two BBTs-120 conventional drills with screw feeders and made from standarized units. By using hydraulic rams to set the jibs, output of the drill is doubled in comparison with mechanical screw manipulators. The mean drilling rate in rock of average hardness is 180m/shift. They are supplied on rail or tire tracks with or without an individual drive for the carriage. A special apparatus weighing 1600 kg of the Simba 5 type was carried

TABLE 9

Index	Firm, country, model				
	Holman Brazers		Atlas Copco	Gardner-Denver	Joy Ville Goze
	Britain		Sweden	U.S.A.	France
	RO-25P	RO-60P	PR-600Dd	SP-600	RPS-900
Throughput, m^3/min	7	16.9	17	17	25.5
Overall dimensions, mm					
length	3,378	4,064	3,830	3,696	4,100
width	1,651	1,829	1,760	1,829	2,250
height	1,676	2,146	1,760	2,134	–
Rating of diesel motor, hp	68.5	153	192	200	310
Weight, kg	1,370	4,082	2,970	4,230	5,390

TABLE 10

Index	Firm, country, model				
	Gutehoffnungshütte (W. Germany)				ANF (France)
	ST-4	ST-5A	ST-8	ST-8A	462-KhTsS
Bucket capacity, m^3	3	3.8	5.6	5.6	2.6
Overall dimensions, mm					
length	8,915	8,915	9,120	9,703	9,350
width	2,450	2,450	3,330	2,438	2,500
height	1,524	1,524	1,557	1,830	1,630
Maximum height with raised bucket, m	4,039	4,230	4,094	4,826	4,740
Loading height, m	1 688	1 730	1 710	1 830	2 160
Minimum radius of rotation, m	6.17	6.17	7.58	6.3	6.5
Rating of diesel motor, hp	130	174	174	216	130
Maximum rate of movement, km/h	39	37	33	18.5	28.7
Weight, tons	17	18.2	20.7	25.7	15

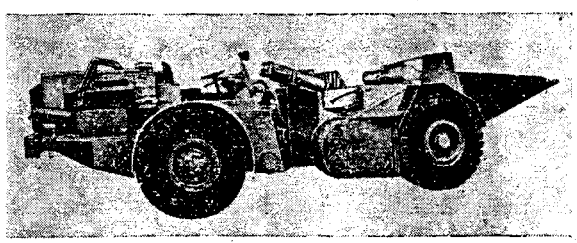

Fig. 11. TL-60 bottom-discharge loader-feeder.

on a hydraulic leg and fitted with a single BBE-56 hammer and can drill 60-mm holes over a radius of 1.7 m to a depth of 40 m and deviates from a preset direction of less than 1%. Minimum distance of the holes from the column is 430 mm, and permitted angle over the vertical for drilling 0-35°. Noteworthy is a Simba 11 single-pick drilling carriage with a track width of 750 mm (Fig. 6) with rod feed to 1220 mm and used for drilling fan risers or parallel holes of diameter 57 mm to depths as much as 40 m. The hydraulic drive of the jib ensures that this can be fixed within limits of up to 65° in a vertical plane (5° backwards of the vertical axis up to 60° forward). The carriage weight is 1600 kg, width 2500 mm, and height 2700 mm. Shift output reaches 130 linear meters. The firm offers a modified machine of this kind with rod feed to 1830 mm and, if the customer so

Fig. 12. ST-8 tire-mounted machine (W. Germany).

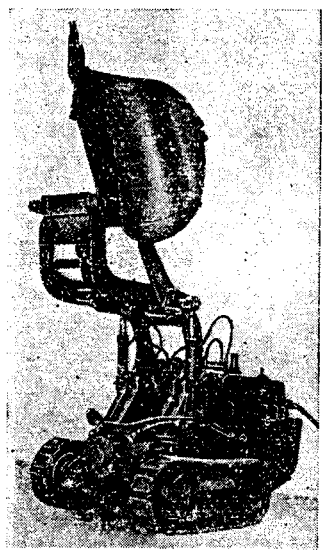

Fig. 14. 623-Kh side-discharge track-mounted loader.

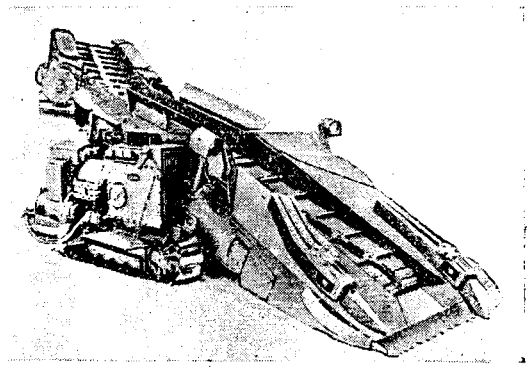

Fig. 13. 19-KhR continuous loader.

requires, it can also provide trackage with tracks of 600 and 900 mm. This firm also exhibited a drill carriage on a rail track 750 mm, the Tsaks 202 which is used for traveling up to a section of 23 m^2. The carriage weight is 3000 kg, it takes two drills of the BBD-90V type, has overall dimensions (length, width, height) of 6100 × 1410 × 1830 mm, and can drill holes up to 3.2 m without rod extension. It provides a rigidly parallel arrangement of the holes up to a height of 3.6 m and a width of 6.4 m and is controlled by a single operator from a console which is placed on a rear platform. Output reaches 300 m/holes per shift.

New tire-tracked self-propelled drilling rigs for underground work were exhibited by the Finnish firm of Tampella (Fig. 7) and by the French firm Secoma. The Tampella firm apparatus is used for drilling from a single position and can make tunnels of section from 7 to 27 m^2; it consists of a track and two manipulators of the RP-625 type. Each manipulator is a rotary jib with a pneumatic pick of the S-125 type with a chain feed and is fitted out with parallel arrangement of the holes. Normally the depth of a 33-mm hole is as much as 3.2 or 4 m without extending the rods. Movement of the jib in various directions is done by rams which are driven by their own motors. Maximum drilling area is a 6.25 m circle. Overall dimensions (length, width, height) of the equipment shown here are 9000 × 100 × 2100 mm. Manipulators RP-625 can be mounted on carriages, with a rail track, or on trucks. They make it possible to drive tunnels up to a section of 5-48 m^2 from a single position. Manipulators shown by Secoma are moved by hydraulic motors and consist of drills which are equipped to drill holes to 120 mm to a depth of 3-3.35 m with feeders. They can be mounted on tires, rails, or track. Depending on the rock hardness, the drive ensures a smooth feed of the drill on the face. The rod of each of the two manipulators in the machine model 284 is rotated with reference to the longitudinal axis towards the frame and can swing in a horizontal plane up to 23° towards the hole being worked and up to 10° towards the axis of the machine, while vertical freedom is up to 29° upward and 15° downward. The jib is fixed to the rod in such a way as to ensure forward extension by a screw arrangement up to 1.5 m and to rotate through ± 55°. The machine thus performs seven patterns of movement and can drill from a single setting a tunnel of section up to 22 m^2, without dead ground. The machine is so designed as to drive at right angles in the case where the width of workings is not less than 4.45 m. Machine 284 weighs 1800 kg and is 6760 mm long, with a width of 2210 mm and height, with horizontal manipulators,

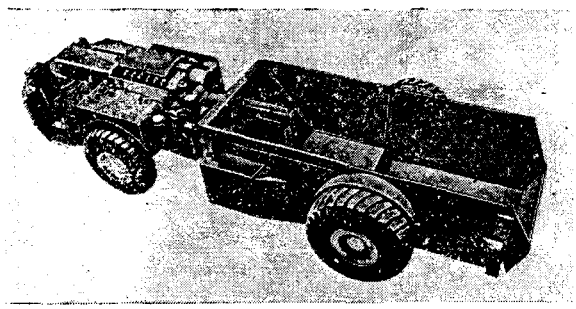

Fig. 15. 461-KhB-25 truck with tipping body.

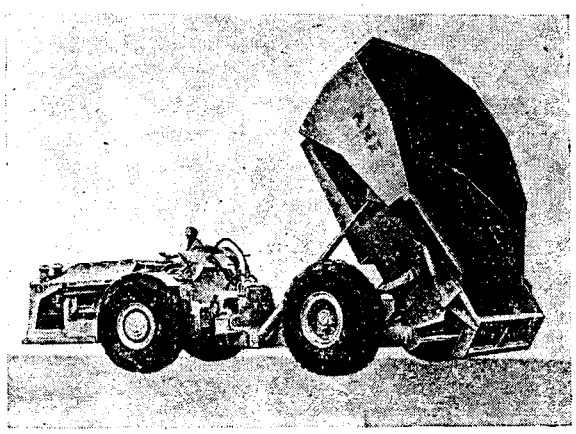

Fig. 16. MTT-423 truck with telescoping body, made by Gutehoffnungshütte (W. Germany).

of 1520 mm, and a base of 3100 mm. The main drive motor has a rating of 50 kW.

Drilling machines were also exhibited (Fig. 8) on tires or tracks and are used predominantly in opencast working and are of particular interest for hydraulic engineering. Brief specifications of drills of this kind, with air or hydraulic drives and designed to drill vertical or horizontal holes, are shown in Table 7.

The British firm of Holman Brazers also exhibited a mobile rig with chain feed for drilling holes up to 122 mm to a depth of 30 m with core or a down-the-hole drill. The drilling equipment and compressor were mounted on a tired tractor base. Atlas Copco advertized four types of drills weighing 280-1740 kg with air drive on air tires with a reversible chain feed system, and capable of drilling holes up to 50 m in depth and 102 mm in diameter. A special arrangement in some of the models of the Swedish drills makes it possible to drill holes in rock covered by soft ground without any opening-up work.

Interesting drills also exhibited on track mountings were shown by a French firm which manufactures mining equipment under license from Joy, the American firm; the Austrian firm of Böhler; and the Swedish firm Atlas Copco, in conjunction with the American firm Ingersoll Rand and Gardener Denver (the last name through the Finnish firm Vitraktor). Specifications of self-propelled drill rigs on track mounting are shown in Table 8.

Gardner Denver (U.S.A.) exhibited the ATD-3100 (Fig. 9) self-propelled rotary-percussive drill on track mounting, for drilling holes in hard rock in opencast mining. The carriage has a low center of gravity, a frame of high-grade steel and the tracks can slew in the vertical plane up to 40° so as to use the machine in very unfavorable conditions. Drive for the tracks stems from two independent motors; the jib and reversible chain feed have hydraulic control. The 5-m jib can turn round on a point of securement on the frame up to 45° upwards and 25° downwards and 57° either way from the long axis of the machine. The design of the drill makes it possible to drill downward holes at any angle. Average performance of the ATD-3100 drills (one operator) in hard rock is 100 m holes of diameter 64 mm in an eight-hour shift. Air consumption at 7 atm in dry drilling is 16 m^3/min and in flushed drilling 11.5 m^3/min. Gardner Denver also make machines of similar design for drilling holes 76-122 mm. The same firm also exhibited IR-300A which consists of a hand-held drill and reversible air leg and can drill holes 32, 35, 38, and 41 mm in diameter underground. The weight of the machine, depending on the type of leg used, is 42-50 kg.

Austria, Great Britain, the U.S.A., Finland, France, the Federal Republic of Germany, and Sweden exhibited various types of drilling tools: drill bits, cutters and bits of various type of connection, hollow drilling steels for various sections, drilling rods etc.

The firm of Christensen-Longyar (France) exhibited diamond drills. Important characteristics of diamond drilling used predominantly in extremely hard rock are the low-order curvatures and hole diameter losses involved. Distinguishing characteristics of diamond drills are their compactness, low weight, high rpm, and their ability to drill holes in any direction. This firm exhibited two models (34 and 44) of machines weighing 1200 and 2200 kg, respectively, with diesel motors rated at 36 and 40 hp (of the four made) and which can drill holes of diameter 48 mm to a depth of 426 and 1220 m, respectively. These drills can be equipped with diesel, air, or electric drive. The firm also demonstrated two equipments 300-E and 330-E with electric motors rated 1.5 kW for drilling holes of

TABLE 11

Index	Firm, country, model				
	Atlas Copco			Hugg-lunds	Eimco
	Sweden				Britain
	LM-36	LM-250	Kavo-320	ISL-7Kh	623-Kh
Bucket capacity, m^3	0.14	0.6	0.3	0.33	0.6-0.67
Overall dimensions, mm					
length	2,000	3,120	2,550	2,845	4,470
width	1,310	1,740	1,960	1,970	1,676
height	2,010	3,000	2,640	2,580	3,632
Motor rating, hp	22	50	40	57	75
Weight, kg	1,800	6,450	3,500	4,400	6,300
Mounting	rail		tire	tracked	

TABLE 12

Index	Firm, country, model				
	ANF	Joy Ville Goze	Mining transportation		
	France		Sweden		
	461-KhB-25	25-DM	K-162	K-162A	K-500
Load capacity, tons	25	25	21	25	37
Overall dimensions, mm					
length	8,500	8,610	7,420	7,120	8,725
weight	3,200	3,200	3,025	3,000	3,040
height	2,230	2,420	2,100	2,090	2,950
Angle of lift of body, deg	60	60	55	60	60
Angle of turn of tractor rel. to longitudinal axis, deg	±45	±50	±45	±31	±45
Minimum radius of turn, m	7.35	6.82	6.85	8.0	8.17
Rating of diesel motor, hp	190	180	162	162	500
Maximum rate of movement, km/h	41	25	41	41	37

diameter 25-152 mm in concrete, reinforced-concrete structures, rock, and other hard material. 300-E drills holes only in the vertical sense, while 330-E can take out fan holes in all directions in the vertical plane.

Foreign firms produce a large number of stationary and mobile compressor units for supplying pneumatic drilling equipment. The Swedish firm of Atlas Copco makes 28 models of stationary compressors with ratings from 1.7 to 34 m^3/min. At present widest use is made of the small-dimension rotary and screw mobile compressors. The most widely used at the present moment are the small rotary and screw mobile compressors. These are without any connecting piston group which halves their weight, increases their reliability, and raises their guaranteed service life to 10,000 hours.

Table 9 gives brief specifications of screw compressors exhibited at the Exhibition of interest in hydraulic engineering. Compressors are rated for up to 7 atm.

The firm of Holman Brazers exhibited screw compressors of the RO-25P type, on single-axle tired track, and RO-60T heavy type on two-axle cage, and also advertised four additional types of contemporary mobile screw compressors with ratings of 3.54 to 10.4 m^3/min (weighing 1098 to 3493 kg). The French firm manufacturing equipment under license from Joy Ville Goze advertized tow types of power wheel-mounted screw compressors, 17 and 34 m^3/min, 3560 and 57 kg, fitted with 205 and 410 hp diesel motors.

TABLE 13

Index	Firm, country, model									
	Joy Ville Goze France			Gutehoffnungshütte W. Germany						
	TsB-3	14-D2	20-D2	MTT-415	MTT-420	MTT-423	MTT-425	MTT-426	MTT-435	MTT-p40
Lift capacity, tons	14	15	22	15	20	23	25	26	35	40
Overall dimensions, mm										
length	8 590	8 720	9 870	8 530	8 530	10 515	10 240	10 290	10 310	10 415
width	3 130	2 800	3 200	2 740	2 820	2 590	2 110	2 920	3 860	3 960
height	1 590	1 760	2 200	1 880	2 010	1 905	1 850	1 960	2 540	2 438
Minimum turning radius, m	5,8	6,1	6.7	6.8	7,1	8.3	7.7	7.7	8.2	8.6
Diesel motor rating, hp	140	140	195	130	174	174	260	260	260	260
Maximum rate of travel, km/h	19	20	19	40	44	34	53	53,5	53.5	—
Weight, tons	14	14	22	17,3	18.1	23	24,4	24,8	27,1	—

The loaders and loading machines were exhibited together with transporting means of cyclical type with contemporary design of interest for hydraulic tunneling. The most typical and widely used types of plant are wheel-mounted machines with a bucket loader and a gathering, tipping bunker. Owing to working conditions, the tracking carries tires of reinforced higher grade—sometimes extremely strong types, with air pressures of 6-8 atm (cast smaller types are also used). Use is made of protective chains which increase the service life 2-3 times. The basic shortcoming of wheel mounting is the large turning radius in the new type of machine; this is eliminated by using a drive for each wheel. In braking, the wheels on one side of the machine can turn on the spot. A design of this kind is found in a loader machine of the 803 model (Fig. 10); its four ground wheels can be treated with independently hydraulic drives. The bucket capacity is 0.255 m^3 (3.58 tons) and that of the bunker with rear discharge 1.28 m^3. The overall dimensions (length, width, height) in the working position are 2934 × 1854 × 2210 mm; if the customer requires, the machine can be fitted with a 51.5 kW electric drive, or 54 hp air motor.

A similar wheel-mounted machine is seen in the 310 system of Kavo, together with bucket and bunker with capacities respectively of 0.13 and 1 m^3 and exhibited by Atlas Copco. The machine weighs 2700 kg, has an air drive of 32 hp, and moves at speeds of 1 and 1.4 km/h. The French and West German stands exhibited self-propelled loaders with a bucket bunker-type loading head. Figure 11 shows the TL-60 machine exhibited by the French associate of Joy; it has a lifting capacity of 7 tons on wheel tracking, having four driving wheels with a bucket capacity 4.6 m^3, and a diesel motor with air cooling rated at 145 hp and 2300 rpm. Maximum travel speed is 24 km/h. Working movements are controlled hydraulically. Bottom discharge of material from the bunker occurs when the shutters of the discharge trap are open (dimensions 0.81 × 147 m). The bunker is loaded in 30-40 sec and discharged in 10 sec. The machine weighs 17 tons and has an articulated frame; the possible turning circle of one part in either way with respect to the lower axis is 30°. Overall dimensions, with the bucket down, are length 8.53, width 2.9, and height 2.19 m.

The American firm of Joy makes two types of machines with bottom discharge of similar design, their capacities are 3.67 and 4.2 m^3 and another type with forward discharge as the machine moves where the body tips—this uses a bunker of 8.4 m^3 (with bucket raised, 1.5 m^3).

Another special type of machine in this group has a rotary bucket with a forward discharge. The rock can be carried in the bucket straight to the point of discharge or be transferred to other facilities. Thus these units act as loader-and-feeder machines and also as loaders. Machines of this kind on wheel tracking were exhibited by Gutehoffnungshütte (Federal Republic of Germany) which makes them under license from two American firms, and also the French firm ANF (Les Ateliers de Construction du Nord de la France). Brief specifications are given in Table 10.

A machine of this type, model ST-8 (Fig. 12), is a heavy type with independent drive and hydraulic control. All the wheels are driven; it has a small turning radius, independent suspension of rear wheels, and appreciable ground clearance (485 mm), which combine to provide high maneuverability. The machine is operated by one man who has a good view from his seat, which is placed perpendicular to the line of travel. All these types of machines are fitted with stock bins; they can carry material over long distances and are used successfully underground and on the surface.

Loaders exhibited at the Exhibition included six self-propelled items. The French associate of Joy exhibited a 19-KhR type powerful machine (from four made on a production basis) with remote control (Fig. 13); it was track mounted on a continuous basis, with a gathering arm loader and scraper conveyor. Output of the machine is 20 tons/min, weight 29 tons, and the motor rating 206 kW. The scraper discharge conveyor can turn in the down plane left or right with respect to the long axis by 45°; the load height ranges from 1.1 to 2.7 m. Britain and Sweden exhibited five types of self-propelled pneumatic loading machines of cyclical type on rail, tire, or track mounting. All the types of machines gave excellent performances and are intended for use in conjunction with transporting facilities either on a cyclical, intermittant, or continuous basis. Brief specifications are given in Table 11.

All these models (except 623-Kh) of loading machines discharge at the rear by means of linkages. The 623-Kh machines (Fig. 14) from the British firm of Eimco are fitted with remote control systems and discharge at the side with buckets swung through 45-60°. The loading height is respectively 2.55 and 2.13 m. To ensure maximum maneuverability, each caterpillar in the track system has an independent drive. To meet customer requirements, the machine can be driven with pneumatic or electric motors in flame-proof finish. The operation is hydraulic. For conjoint use with loading facilities, manufacture of various transporting facilities of cyclical and continuous type is under way. Three types of cyclical transporters were shown; they are working successfully both on the surface and in tunnels and are undoubtedly of considerable practical interest in hydraulic engineering jobs. Attention should be paid to diesel trucks on wheel mounting which discharge backwards by raising the body (Fig. 15), and tipping tubs which have a telescoping body which is discharged without lifting, at first partially by moving the front part and then ultimately by means of a special moving shutter (Fig. 16). Hydraulic control is employed throughout. Brief technical specifications of these types of tipping troughs are given in Table 12, and those with the telescoping body system in Table 13.

The truck shown in Fig. 16 with a telescoping body and a load capacity of 23 tons has four ground wheels. The spoil is loaded by belt conveyors first to the front and extensible portion of the body, which is placed at the end of the truck. Once this has been filled and the machine moved toward the tractor, the rest of the body is filled. The material is discharged in as little as 20 sec and is done in reverse order. Thus the rear end of the body is raised by two rams. For convenience of servicing, two control desks are provided and the driver's seat can swing through 180°.

Interest is also attached to equipment shown by Hagglunds (Sweden) consisting of mounted wagons of all types for rail work which are used underground. These cars are equipped with built-in chain reversible bottom conveyors driven by a pneumatic motor so that the rock which is loaded at one place gradually is distributed over the length of the body and can be discharged continuously without requiring additional hand scraping. The car bodies for carrying particularly abrasive rock can be lined with sheet alloy steel.

Loaded cars are pulled by an electric locomotive or diesel locomotive at 20 km/h. The bodies in the cars can negotiate curves up to 12-15 m in radius. The firm produces six standard types of cars with bodies ranging from 5.5 to 11.5 m^3 and length 6.7-11.2 m. The most powerful car exhibited here was the KhRS-12 type which holds 22 tons (body volume 11.5 m^3). A four-axle car weighing 11.5 tons has overall dimensions (length, width, height) of 11,200 × 1,500 × 1,700 mm, with a load height of 1,400 mm. Recently trains consisting of 2, 3 or more specially designed cars have been used to carry rock. With these cars it is possible to employ hydraulic rams which are driven by a motor to raise the discharge end of the car by 1-1.2 m, thus ensuring continuous loading. After the train has been loaded, the car bodies are lowered and passed on the discharge point. The firm produces three standard types of cars with bodies of 7.5, 9, and 11.5 m^3, respectively, and length 8.27-11.6 m. All types of cars from Hagglunds are used in workings of 4 m^2 and upwards.

The stands of the foreign firms also devoted considerable space to those types of instrument plant and apparatus for automated working and mine rescue work, and central control systems.

There was a wide exchange of background and experience between the participants during the Exhibition. Foreign experts and specialists gave eleven papers and showed ten films during the Exhibition.

The Moscow Internation Exhibition "Intergormash-67" was instrumental in providing a useful exchange of background and experience in terms of technical achievement, and in expanding and strengthening the mutually advantageous practical cooperation between various contries of the world.