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Mine Master made self-propelled drilling and bolting rigs designed for underground mining

Underground exploitation (mining) of useful minerals consists of three main stages, with the entire process starting with winning through loading and finishing with construction of the lining. Minerals are mined using explosives or mechanically by machines which are called combined cutter-loaders (cutting and loading). When rocks are hard to mine or they are abrasive, now only methods using explosives can be used as a factor destroying rock cohesion, and room or room-pillar or gallery technology may be applied as well. The application of explosives requires holes to be drilled of various length and diameter oriented spatially, manually, or mechanically. Then, self-propelled drilling rigs, loaders, self-propelled bolting rigs and haulage vehicles are applied most often in these circumstances. A set of these machines constitutes a complex for the exploitation of mined-hard and abrasive minerals, though the machines may be used with other types of rock as well. One such example are the machines made by Mine Master Sp. z o.o. designed for mining metal ores like copper, zinc, nickel ores, also rock-salts and potassium salts and bituminous shale.

Key words: room and room-pillar exploitation systems, self-propelled drilling rigs, self-propelled bolting rigs, self-propelled haulage cars, and self-propelled loaders

1. INTRODUCTION

Underground mining of useful minerals consists of three main stages when the entire process starts with winning (explosives, cutting, scaling) through loading (serial, parallel) and finishes with construction of the lining (roof bolting, roof supports). Mining of minerals is made by means of explosives or mechanically using machines called combined cutter-loaders (cutting and loading). For mined-hard or abrasive rock mass nowadays only explosives may be used as a factor destroying the rock cohesion and room or room-pillar or gallery technology may be applied. The application of explosives requires holes to be drilled of various length and diameter oriented spatially, manually, or mechanically. Then, holes may be drilled using local, remote or automatic control. Of course, these holes are most often made mechanically using self-propelled drilling rigs where a main assembly of such a rig is a boom or booms with feeders fit-

ted with various types of drills [1, 2]. Next, after blasting, the excavated material is loaded with loaders, most often front-end bucket loaders, to self-propelled haulage machines which transport it to further transport means. Excavation stability is achieved using various types of linings, most often roof bolting. Also in this case, drilling a hole to install a bolt is required. It may be done manually or mechanically using self-propelled drilling-bolting rigs [3]. Sets of these machines constitute a mechanized complex for mining minerals that are hard to be mined and abrasive, although they may also be used for mining other rocks where the decisive factor is mainly an abrasive feature of the rock mass. One such example are the machines manufactured by Mine Master Sp. z o.o. designed for mining metal ores like copper, zinc, nickel ores, also rock-salts and potassium salts and bituminous shale. These machines are used successfully also in tunneling [4] where rocks are mined by means of explosives.

Mine Master Sp. z o.o. manufactures several types of self-propelled drilling rigs [5] with combustion driving systems (diesel engine) or electric driving systems (batteries) [6], as well as self-propelled bolting rigs. New products are self-propelled rigs for spatial-oriented drilling of long holes fitted with a drill rod rack.

2. SELF-PROPELLED MACHINES

As said above, Mine Master specializes mainly in self-propelled drilling rigs and bolting rigs with combustion driving systems or electric driving systems (additional letter “E”). Self-propelled drilling rigs are marked respectively as Face Master 1.4, Face Master 1.7, Face Master 1.7K, Face Master 2.1, Face Master 2.3, and Face Master 3.0, and they are designed for drilling blast holes. And self-propelled bolting rigs are marked as Roof Master 1.4, Roof Master 1.7, Roof Master 1.8, and Roof Master 2.3, and they are designed for bolting in the excavation to ensure its stability. A self-propelled rig for spatial-oriented drilling of long holes fitted with a drill rod rack is marked as Production Master 2.3.

2.1. Self-propelled drilling rigs

A self-propelled low drilling rig – Face Master 1.4 (Fig. 1) is designed for drilling blast holes with diameters 41–76 mm and net length 3.2 m. It is an articulat-

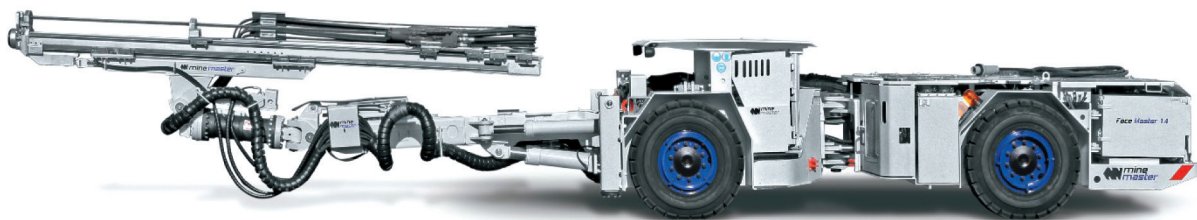


Fig. 1. Face Master 1.4 – drilling rig for low excavations



Fig. 2. Face Master 1.7K – drilling rig for low excavations with an air-conditioned cab

ed machine with a 4-wheel hydrostatic drive (motors in wheels) and dynamic brakes including a HAP (emergency-parking) brake. The rig may be used in methane-free excavations of ore mines and mineral material mines. A design of the rig allows effective drilling in excavations with heights starting from 1.6 m.

A self-propelled low drilling rig, the Face Master 1.7, is designed for drilling blast holes with diameters in the range 41–76 mm and net length 3.2 m. The rig may be used in methane-free excavations of ore mines and mineral material mines. The design of the rig allows effective drilling in excavations with heights from 2 to 4.3 m.

Face Master 1.7K (Fig. 2) is an improved version of FM 1.7. The rig is fitted with a closed and ergonomic operator's cab (capsule), raised and lowered hydraulically. The design of the cab and the (front) working platform frame are subject to dynamic tests on transfer of loads of kinetic energy 60 kJ which is acknowledged by a respective certificate. A front window panel of the operator's cab complies with requirements of class P8B according to standard EN-356. The cab is also equipped with an air-conditioning system which operates when the machine is being driven and works being powered by the 500 V mine power network, and with a cab filter. Additionally, in order to provide the best protection for the operator against gas hazards occurring in the mine excavations of the KGHM Group, the cab is equipped with a hydrogen sulfide (H_2S) filter.

In order to ensure superior traction, the rig is fitted with an articulated joint featuring two turn axes (vertical and horizontal oscillation) due to which very good stability in maneuvering and considerably reduced excavations where the rig may move have been obtained. A working unit of the rig is of a well-proven design of the B40 HD boom and the HC 109 drill made by Montabert, equipped with a water box featuring the increased resistance to aggressive flushing water.

A single-boom drilling rig of the Face Master 2.1 is designed to be operated in narrow veins. The main features of the rig are as follows:

- A working unit with a two-axis rotary actuator significantly improves the maneuverability of the feeder,
- the 360° turn of the boom in both planes allows drill bits from the operator's stand to be replaced,
- a well-proven design of swinging the main articulation to improve traction,
- an operator's canopy (FOPS & ROPS) with a raising canopy and a hydraulically controlled segment in order to improve the visibility during vertical drilling,
- drilling coverage 30 m²,
- a strong hydrostatic tramping system to drive slopes up to 14 degrees,
- an automatic articulation lock to ensure an increased stability of the rig during drilling operations.

Face Master 2.3 (Fig. 3) is a two-boom drilling rig designed for drilling blast holes with a diameter 41–76 mm, drilling coverage 67 m², and 4-wheel drive. The rig may be used in methane-free excava-

tions of ore mines and mineral material mines. The design of the rig allows effective drilling in excavations with heights from 2.5 to 6.1 m. The features of this rig are as follows:

- a hydraulic system with a direct control providing: anti-jamming of a bit in a hole, collaring, feed pressure control in order to optimize drilling parameters,
- B40L booms with 1500 mm extension,
- an aluminum feeder of F 700 series with stainless steel rails – a simple design ensuring low maintenance costs,
- a minimum tramping height of 2.3 m with an adjustable operator's seat,
- the rig width of 1.99 m allowing tramping in excavations of minimum width 4.5 m at 90-degree angles,
- the articulated design with 4-wheel drive,
- a SAHR braking system controlling the service brakes and a HASR system controlling the parking / emergency brakes,
- the rig is equipped with four floor jacks,
- the rig in its basic version is equipped with an operator's canopy (FOPS/ROPS).

The Face Master 3.0 is an articulated rig with 4-wheel drive, with the minimum tramping height of 2.9 m. Control of the 1500 mm-extension B 40L straight-line boom movements by means of a joystick ensures precise and fast relocation of the boom and the drill between successive holes to be drilled. A simple and robust design of the aluminum feeder of F 7000 series reduces costs and facilitates servicing. Hydraulic control ensures low operation costs and high performance.



Fig. 3. Face Master 2.3 – two-boom drilling rig

2.2. Self-propelled bolting rigs

The Roof Master 1.4 bolting rig is fitted with a dry drilling system (suction removal of drill chippings) or a wet drilling with a flushing system (water flushing). Drilling is carried out by means of a rotary drill. The location of the operator's stand allows for full control when bolts are installed. A working system as employed in the rig allows drilling holes with diameters

from 25 to 38 mm to install expansion and resin bolts in two stages using a possibility of drill rod string elongation.

The Roof Master 1.7 (Fig. 4) is design for making roof bolting in mine excavations with heights from 1.92 m to max. 4.0 m. Its working unit is composed of a roof bolting mast made by J.H. Fletcher including a rotary drill and a drill chippings suction removal system.



Fig. 4. Roof Master 1.7 – bolting rig

The Roof Master 2.3 self-propelled bolting rig is designed for bolting underground excavations with heights from 4 to 7 m. The rig allows the drilling of holes to install bolts, installation of cement bolts and placing the roof and side walls with mining mesh by means of a mining mesh feeder.

depending on a configuration. An easy-in-operation positioning system facilitates drilling in the required directions. The rig features very good stability, allowing its fast tramming even in hard conditions. A portable control panel allows precise drilling, and easy and safe operation.

2.3. Self-propelled rig for spatial-oriented drilling of long holes

The Production Master 2.3 (Fig. 5) is a self-propelled drilling rig for drilling parallel long holes in the roof and the floor, as well as for radial and circular drilling vertically and at a set angle. Atop-hammer system allows drilling holes in the range from 64 to 165 mm

2.4. Self-propelled drilling and bolting rigs with electric drive

The Roof Master 1.8KE (battery)electric bolting rig (Fig. 6) is designed to be operated in excavations with heights from 3.0 to 5.8 m. The rig is fitted with a bolting mast that holds 9 bolts 1.8 m long.



Fig. 5. Production Master 2.3 – rig for drilling long holes

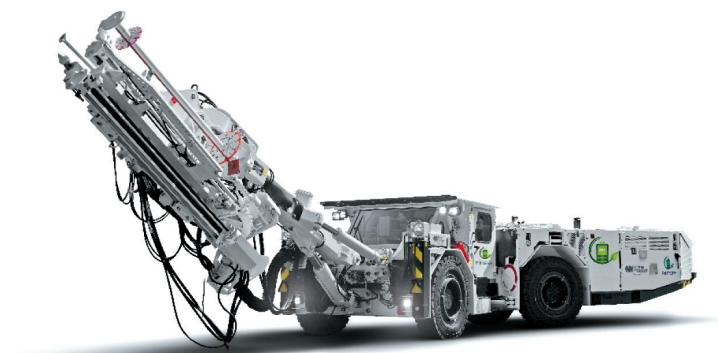


Fig. 6. Roof Master 1.8KE – battery electric bolting rig

The rig is equipped with a 120 kWh sodium-nickel battery. A characteristic feature of the BEV system applied in the both versions of battery electric machines is a possibility of recharging the battery from the existing mine power network within the voltage scope 500–1000 V using a battery charger installed on the chassis of the machine, as well as a possibility of recharging the battery during tramming when applying brakes and when driving downhill. The operator is provided an ergonomic air-conditioned cab with a cab filter.

The Face Master 1.7LE is a drilling rig designed for drilling blast holes with diameters from 41 to 76 mm, and length 3.2 m, in excavations above 1.7 m high. It is equipped with a closed, air-conditioned cab providing very good visibility for the operator. Regarding this type of drilling rig, a particular achievement is the low transporting height of the machine (1.65 m) in this class of machine, despite the fact that a battery is installed on board, and that the rig is adapted for tramming in heavy conditions of mine excavations in the room-pillar system inclined up to 15 degrees.

3. SUMMARY

Self-propelled drilling or bolting rigs are used in the mining of various minerals, most often by means of room or room-pillar systems, but also in driving dog headings where rock cohesion is destroyed by means of explosives. The machines and self-propelled rigs for spatial drilling start the process of mining and, together with loaders and self-propelled haulage vehicles, they constitute a set of machines called complexes. Such a set may not only be used for useful minerals mining but also for construction ob-

jects like tunnels, cross-cuts, culverts, discharge adits or canals. In each of the mentioned cases, machines should be arranged taking into account their technical parameters bearing in mind their place of their operation, assumed output or advance.

The self-propelled drilling and bolting rigs, or rigs drilling holes or the holes made by the Mine Master are designed for just these purposes. Their application on specific mining-geological conditions is connected with their technical parameters which allow the assumed outputs or advances to be achieved. That is why they are always dedicated to specific orders, and in many cases they meet future needs and requirements.

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