Drum hoists

The hoists in question are double-drum type with a fixed or loose drum, and also hoists of less usual concepts, such as single-drum hoists or double-drum type with both loose drums. Double-drum hoists are destined to be used mostly for double-action or single-action extraction, and transport of people and material from multiple floors of the mine. They are used for smaller, medium-sized, as well as higher depths, and they are cage-operated, or less often, skip-operated. They are manufactured in various proportions and power for payloads from 4000 kg to 25000 kg, and their transport speed up to 16 m/s. Their advantage is the possibility of repositioning of transport containers (after disconnection of the drums) to different extraction floors.
We produce hoists of winding drum diameter ranging from 2500 mm to 6500 mm. They are usually used for ground floor or underground placement in the machine hall. All drum hoists may be equipped to be used under the fully automated mode of extraction.
The drive is mostly designed as single-motored or, in case high potency is to be installed, double-motored; installed power is supplied in a wide range from 250 kW to 11000 kW (2 x 5500 kW). With the exception of the lower power-levels, in which the drive is provided by an asynchronous motor with a gear-box, and the control is provided by a frequency converter, it altogether concerns drives with direct-current, slow-running motors, which are powered by a thyristor converter and digital regulator.

Mechanical part of the double-drum hoists includes:

- Winding drums with a nominal diameter of 2,5 – 6,5 m and winding width 0,9 – 3,2 m.
- Main shaft located in the antifriction or sleeve bearings(customer-dependent)
- Electro-hydraulically (electro-pneumatically) controlled clutch of the loose drum
- Gearbox – only with the AC drives (c. up to 1500 kW)
- Torque-flexible clutch VPS – only with AC drives
- Brake pedestals fitted with brake units (alternatively, order-dependent mechanism of pneumatically controlled jaw brakes acting on the brake belts of the drums
- Hydraulic distribution (alternatively, if jaw brakes are used, pneumatic distribution including a back-up compressor)
- Electro-hydraulic system for lubrication and control of brake units (alternatively, if jaw brakes are used, electro-pneumatic microprocessor-controlled braking system Sistonic PR6B)
- Electro-hydraulic system for main bearings' lubrication

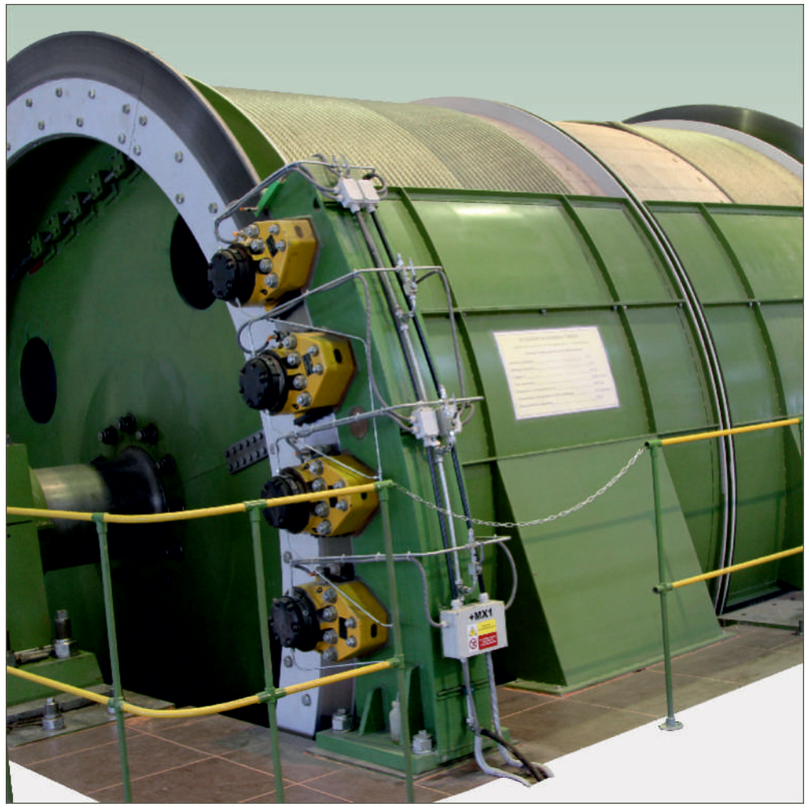
Electrical part of AC-drive hoists (up to 1500 kW)

The electrical part is compactly designed and located in solely two distributors. The +RM regulation of the drive contains a four-quadrant frequency converter with a recuperation unit and integrated network filter, communication module of the redundant network ControlNet, as well as disconnecting and safety elements, control panel for visualization of operational reports, separatory transformer for auxiliary power supplies, UPS unit for back-up power-supply of the electronic circuits, as well as supplies of auxiliary voltages for the control automatons.
The distributor +RA for control and safeguard contains a PLC for hoist and drive control, PLC for control of the electro-hydraulic braking system, PLC for safeguard and visualization, communication modules of the redundant network ControlNet, modules of the distributed system inputs-outputs, input-output relay, safety circuit of the hoist and WD safekeeping units of the control systems.
Ergonomic control panel with a visualization touch screen, signaling and monitoring components, joystick controllers, and other equipment are all placed in a sound-proof insulated cabin to ensure comfort of the operating staff. The cabin is equipped by two lockable entry doors that are abundantly glazed in (total of 5 double glazed windows) and the front part of the cabin is doubly bent for better view of the machinist.
The use of the redundant communication network increases operational safety, while decreasing the assembly and maintenance requirements. This type of hoists is usually controlled manually, but it is possible to adjust all the machines for fully automated operation.

Basic technical data on selected types of double-drum hoists

Single/double drum hoists are mostly manufactured on the basis of concrete extraction parameters and other specific requirements of the client. Power parameters of different hoists therefore vary greatly, and the difference can be registered even in two hoists of the same type (e.g. 2B3212, 2B3216, 2B6118, 2B6121, 2B6124 hoists is manufactured in many power versions). Regarding the above mentioned, it is not feasible to give detailed data to all hoists. Below mentioned table shows technical data of selected hoists in order to give an overview of production scope. Nevertheless, INCO engineering is able to produce a hoist of basically any power parameters or technical solution.

Hoist type	---	**2B2510**	**2B3212**	**2K3216**	**2B4015**	**2B6118**	**2B6121**	**2B6124**
Maximum static overbalance	kN	65	120	155	250	350	375	465
Nominal speed	m/s	6	8	12	16	16	16	16
Nominal drum diameter	mm	2500	3200	3200	4000	6100	6100	6100
Nominal winding width	mm	1000	1200	1600	1500	1800	2100	2400
Maximum rope diameter	mm	30	40	40	50	67	67	67÷73
Number of hoisting motors	---	1	1	1	1	1	1	1
Nominal motor power	kW	500	1500	1800	2500	4000	4500	5000
Number of brake units	---	4 ÷ 24						
Working pressure of the braking apparatus	bar	145						



INCO engineering s.r.o.
Thámova 13
186 00 Praha 8
Czech Republic
sale@incoengineering.cz
www.incoengineering.cz

- Drives of the sensors
- Frames, covers, anchorages
- Air-conditioned machinist cabin for the control panel placement

Electrical part of the DC-drive double-drum hoists includes:

- Slow-speed DC motor
- Distributor of high voltage +VN
- Converter transformer
- Excitation transformer
- High-speed switch and suppressor
- Thyristor converter with a regulation and converter set
- +RM distributor of auxiliary drives
- +RA distributor for control and safeguard
- +RB2 distributor of the electrical part of the electro-hydraulic brake system
- Control panel of the machinist +RT with a digital depth-gauge, control and inspection elements and a central visualization system of operational and faulty conditions in the air-conditioned cabin).

Electrical part of the AC-drive double-drum hoists includes:

- AC motor of the drive (c. up to 1500 kW)
- Distributor for drive regulation with a four-quadrant frequency converter, recuperation unit, and network filter.
- +RA distributor for the control and safeguard containing a set of programmable automatons and other equipment
- Control panel of the machinist +RT with a digital depth-gauge, control and inspection elements and a central visualization system of operational and faulty conditions (in the air-conditioned cabin).

Mechanical part

All the manufactured single or double-drum hoists exhibit a similar structural design of mechanical parts, and also principles of design and structure, as well as preparation and proper technology of production are similar. At the beginning, the function of machines being designed is tested through a mathematical model of a hoist, which the company developed for its own needs, and on which correctness of designed concept of a designed winding plant is checked, and its behavior in particular operational and emergency modes (starts, braking, security braking in the most adverse cases, breakage of a winding rope, etc.).

Winding drums are designed as split welded constructions. Welding is executed in protective atmosphere, and all weldments are annealed after welding with the view of inner stress relief, and are subjected to extensive material tests, by which the quality of welds is proved. The compliance of the mechanical characteristics and chemical structure of the material contained both in the construction documentation and the material used manufacture, are attested and subjected to materiological tests that confirm the homogeneity of the material and eliminate possible hidden flaws. Active space of the winding drums is lined with alcamide blocks, in which a rope helix is recessed. The drums are equipped with guiding wedges in order to enable fluent transition between wound layers of the rope.

Jaw clutch is used for fixation of the loose drum. The electro-hydraulic (alternatively, electro-pneumatic) drive of the clutch is remote-controlled from the machinist post. The mechanism of the clutch is fitted with sensors which check the state (location) of the clutch; the sensors are input in the safety system of the hoist.

Brake disks are structurally designed as divided with respect to the technology of production, and especially with respect to the highest operational warming, whereas each of the winding drums consists of six, or in the case of smaller diameters, of four segments.

The segments are screwed to thickened side plates of winding drums, using the analogous technology as that used with connecting frictional winding drum halves (hydraulically tightened screws with defined axial pre-stress). Mutual location of individual segments is stabilized by the help of locks of groove and tongue type. To every brake disk, sensors automatically checking the extent of its axial run-out are installed on mounting. The sensors signal possible deviation of the disk or its segment. Moreover, every disk is fitted with an infrared sensor, which checks possible overheating of the disk over the permissible limit. In case the pneumatically controlled jaw brakes are used (order-dependent), the winding drums are fitted with braking belts that are welded to the drum coating.

The main shafts are manufactured as shaped, with connectable flanges. For rotor placement we use flange connection, or more often the rotor is placed directly on the main shaft.

Bearings are mostly anti-frictional double-row inclinable spherical roller-bearings. Their lubrication is ensured with the aid of an autonomous microprocessor-controlled system Tribonic III. At customer's request (also during modernizations of older hoists) we use the well-tried sleeve bearings with two-part or four-part bearing basin that are circulatory-lubricated by grease with the aid of an autonomous lubrication system Tribonik MKL. The bearing pedestals are fitted with pressure sensors, or alternatively flow sensors, and thermometers with a remote signaling and marginal contact. Placement of the loose drum on the main shaft is carried out with the aid of sliding covers that are lubricated with grease filling.

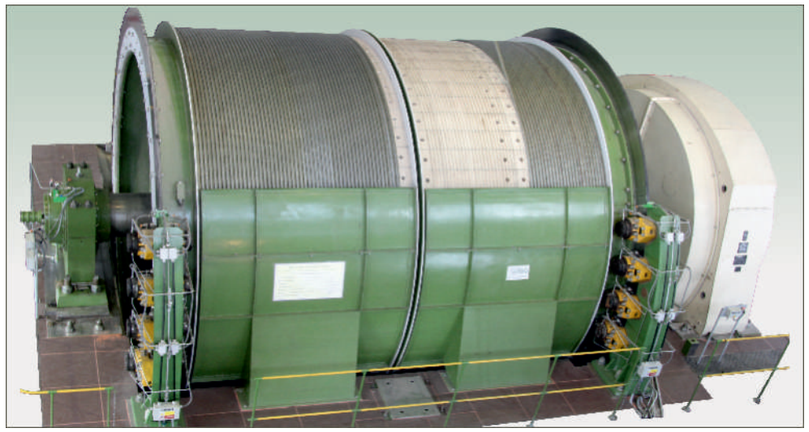
Braking apparatus is formed by modular brake units which are placed on brake pedestals in the necessary amount, acting on usually 2 brake discs. Control of their braking power is hydraulic, and is ensured by any of our electro-hydraulic braking systems types HR9K, HR13K (with a constant braking momentum under the safety-brake mode), Frenomatic HR11K, Reprimatic HR17K.

The last two types, thanks to their highly sophisticated hydraulics and electronics, ensure Constant Retardation under the safety brake mode. Electro-hydraulic systems for supply and control of braking units are addressed on a separate catalogue sheet, including the used braking units. In case the hoist is designed and supplied custom made with jaw brakes, their control is pneumatic (combined with a gravity safety brake). In such a case the supply and control of the braking apparatus is ensured by the electro-pneumatic system Sistonic PR6B (see a separate sheet). This modern microprocessor-controlled electro-pneumatic system finds broad and successful use during modernizations and reconstructions of older hoists, which are more and more in demand.

Electric part of the DC-drive hoists (from 750 to 2 x 5500 kW)

A converter is used for power supply of the DC motor. A twelve-pulse reversal connection for armature of direct current motor (converter set VARIANT) with a non-reversal six-pulse reversal converter (converter and regulation set MODULEX) for actuation of direct current motor is used. The converters for armature circuits of the motors are designed in modular arrangement VARIANT, enabling fast exchange of component blocks in case of need. The component block contains a semiconductor element (thyristor) in the pellet design with coolers on a principle of heat pipes, fuses for protection of thyristor, signaling circuits indicating working conditions of thyristor, and converters of switching pulses.

The component blocks are arranged in VARIANT boxes in layers by three blocks. One layer thus contains a complete three-phase bridge. Cooling of the component blocks is provided by a ventilator located on the top side of the box. Cooling air is sucked through the rear wall of the box through an input filter, blown over cooling ribs of the heat pipes of the component blocks, and exhausted by a ventilator through the top side above the set. The rear part of VARIANT set is accessible after opening the rear door with the air input filter. In this room, strip heavy-current distributions with current sensors are located. The lower part of the front door covers the compartment with auxiliary devices (circuit breakers, power supplies, terminal blocks), and separate the compartment from the power supply circuits of the converter. In the case of another requirement for connection of the converter set Variant to the cable distribution, other construction arrangements may be carried out. Converter sets VARIANT may be installed by placing sidewalls next to each other.



The converters for actuating circuits of direct current motors are designed in modular arrangement of MODULEX sets. The sets contain a modular component block with converter of actuation made up of potential-free thyristor modules, including over-voltage protection, current sensors, converters of switching pulses, and protective fuses. Air cooling of the component block is provided by its own ventilator located inside the box. Cooling air is sucked through the rear wall of the box through an input filter, and blown out through a grid located in the lower part of the front door.

Further, converter set MODULEX contains microprocessor-controlled regulator EMADYN, including software providing all necessary functions of the drive.

A part of the regulator function may also be a possible control of primary high-voltage switches of supply transformers of individual drives, if they are equipped with closing, trip and under-voltage coil (high-voltage switches themselves are not a part of the supply). Microprocessor-controlled regulator EMADYN is adapted for external communication with the superior control system by means of serial line RS485, protocol MODBUS. By the help of this communication, it is possible to control microprocessor regulator EMADYN from the superior control system of the hoist, or to read selected parameters for "statistics" of the winding process. Microprocessor-controlled regulator EMADYN is equipped with an internal block for "post-mort" function, providing cyclic sensing of set parameters for diagnostics (analysis) of faulty actions. Part of the supply of the microprocessor-controlled regulator EMADYN is also simulation program SIMPA, enabling full control of the regulator from PC. The control panel with controllers and indicating lamps for basic control of the drive is located on the front door of the converter and regulation set MODULEX. Apart from the anchorage reversal we can provide field reversal as well.

Other components of the individual drives – supply transformers for armature converters, direct current air inductors, direct current quick-break switches – are without cover (protection IP00) in internal design with natural air cooling. The supply transformers for converters of actuation are in a cover (protection IP23) in internal design with natural air cooling. Five-field HV distributor is included in the supply, 3rd field of which is fully equipped for connection of filtration-compensatory device. Filtration-compensatory device itself is not a part of the supply, but it can be included in a separate order. Superior control of the hoist, as well as control of hydraulic brake system, and of system of control of bearing lubrication, is carried out by a set of four microprocessor control systems (produce of Allen Bradley, alternatively Tecomat), which are interconnected one to another by a duplicate redundant net. It enables exchange and sharing of selected parameters for the individual control systems, and at the same time, it also assures a very high level of the safeguard system of the hoist. The control panel of the machinist is equipped with a digital depth gauge and speedometer, joystick control of brakes and drive and, in addition to other check-up and control elements, it has inbuilt two large-screen touch operated displays serving for visualization of operational and faulty conditions. The machinist console is located in a noise and heat insulated cabin with integrated air-conditioning system.