

2e/nne; f907n

4 Method for carrying out material from a pressure chamber
 and conveyor device

Description

6 The invention relates to a method for carrying out material
 from a pressure chamber according to the precharacterising
8 part of claim 1 as well as to a conveyor device for carrying
 out said method.

10 From the area of tunnel construction - for example from hy-
 dro shields - it is known to carry out muck (excavation),
12 which has been stripped in-situ in the stripping chamber,
 out of the stripping chamber through pipe conduits with the
14 help of the liquid supporting the working face and to haul
 it away by pumps. This method suffers from the drawback that
16 along with the muck huge amounts of liquid have to be trans-
 ported and separated thereafter from the muck. The support-
18 ing liquid is recuperated. This calls for large separation
 plants. The soil extracted by the separation process still
20 contains a high content of support liquid and is unfit for
 short-term soil-mechanical processing. This soil causes fur-
22 ther costs for its shipping away and dumping. The disposal
 of the stripped muck and the support liquid comprised
24 therein is thus very costly with shields working with sup-
 porting the working face by a liquid.

26 With EPB-shields (EPB = Earth Pressure Balanced) stripped
 soil, which is adequately impermeable by nature and condi-
28 tioned by suitable agents, such as foams, is used for sup-
 porting the working face. So far, this soil has been trans-
30 ported away from the stripping chamber by screw conveyors.

The compacted column of soil in the screw conveyor during the conveying process acts as a seal against the pressure in the stripping chamber and as a lock to the unpressurized rear shield space. The larger the permeability of the soil the larger has to be the length of the sealing column of soil and correspondingly the screw of the conveyor. The effectiveness of the stopper formed by the soil as a pressure seal for the chamber has its limits at a soil with a k -value greater than 10^{-5} m/s and at a support pressure above about 2 bar.

Soils with too great a permeability can no longer withstand the pore pressure in the soil stopper, thus making necessary a lock for material arranged at the end of the screw conveyor. Such locks for material are in a wider sense pumps, such as piston pumps, hose pumps and centrifugal pumps, as well as drawer-like and rotating lift-locks. They comprise rotating and moving parts which are subject to high wear. They normally require a system-related conditioning of the muck to be carried out which contradicts the object of achieving an extract as dry as possible. Their extraction capacity in relation to the hauling capacity of the shield is small. To increase the extraction capacity large constructions are necessary which can be accommodated in the shield space only at large tunnel cross-sections. This means that the yield capacity of the shield can not fully be utilized. Therefore, such excavation equipment considerably reduces the economy of a heading machine.

From DE-A-36 272 70 an EPB-shield is known where the loosened soil is transported out of the stripping chamber with a screw conveyor. The screw of the conveyor presses the stripped soil out of the pressure chamber towards a closable sliding valve outlet in the inner space of the shield, and from said outlet of the sliding valve the soil is carried

away on a conveyor belt arranged below said outlet in the
2 area of atmospheric pressure. As explained above, such a
conveyor plant is unable to hold back the higher pressure in
4 the pressure chamber if the soil is permeable. With perme-
able soils the sliding valve has to be closed and the exca-
6 vation of soil has to be stopped.

The invention aims at developing a method and a device for
8 carrying out material from a pressure chamber of the kind
according to the introductory part of claim 1 and 4, respec-
10 tively, which also allow the excavation of soils with a per-
meability $k > 10^{-5}$ m/s in a simple, wear-proof, space-saving
12 and reliable manner.

To achieve this aim the invention suggests a method as de-
14 scribed by the features of the characterizing part of claim
1, and a conveyor device as described by the features of the
16 characterizing part of claim 4.

According to the method of claim 1 the excavation of muck
18 from a pressure chamber is achieved by using, in a surpris-
ingly simple manner, the energy stored in a compressed
20 medium - such as a gas, a gas mixture, foam or foamed sus-
pension - in the pores in the muck at the moment of depres-
22 surisation. This method is preferably developed for tunnel
construction. The same method could be used in analogue man-
24 ner in other industries, where muck-like substances are to
be carried out of pressurized containers, for example in
26 primary matter industries, the chemical industry, garbage
dressing and garbage disposal.

28 The method according to the invention is principally inde-
pendent of a conveyor device, such as a pump or a screw con-
30 veyor, connected in front of the conveyor chamber. The con-
veyor chamber is a simple cell which only serves to form a

2 closable space, and it comprises no rotating parts or me-
chanical drives. Thus, the conveyor chamber is very in-
sensitive under operation. It requires little space and may
4 accommodated in the shield space in a simple manner.

6 The times needed for charging and discharging the conveyor
chamber are short, thus enabling a fast cycle sequence and a
large throughput. Thus, the conveyor device according to the
8 invention is most adapted to satisfy the excavation demands
of a shield heading machine.

10 The material to be carried out may be conditioned with very
little water, thus yielding favourable conditions for an
12 economic excavation and simple re-storage.

14 In tunnel construction often varying layers of different
kinds of soil have to be excavated, which can not homoge-
nously be mixed or conditioned. When inhomogenous mixtures
16 of pore-poor, largely impervious soils and highly gas and
water pervious soils have to be excavated under holding the
18 pressure, it may occur that the change of the kinds of soil
during excavation results in a situation where the muck to
20 be excavated exhibits such a small porosity that the expan-
sion energy stored in the muck is not sufficient to bring
22 about a complete and sufficiently fast extraction. This ten-
dency is enhanced by a moderate pressure gradient.

24 In order to enable a reliable use of the method suggested
also under these conditions an accumulator for pressurized
26 gas is alternatively arranged at the inlet area of the con-
veyor chamber which, if necessary, provides additionally re-
28 quired expansion energy and which may become connected if
inhomogenous soil mixtures of different cohesion or soils
30 with a small expansion energy have to be excavated.

2 The invention will be explained with reference to the Fig-
ures 1 to 3.

4 Figure 1A-E show a schematic illustration of the different
phases of a working cycle of the method according
to the invention,

6 Figures 2A-E show a schematic illustration of the method ac-
cording to the invention according to Figures 1A-E
8 supplemented with an accumulator for pressurized
gas,

10 Figure 3 shows an example of an application of a conveyor
chamber according to the invention in an EPB-
12 shield.

14 Figures 1A-E illustrate the mode of operation of the con-
veyor chamber 2 according to the invention. The conveyor
chamber is arranged between a pressure chamber 1, in which
16 high pressure prevails, and a carry-out element 3 in the
area of lower pressure. The conveyor chamber is closable
18 against the pressure chamber 1 by a sliding valve 4 and
against the low-pressure area 3 by the sliding valve 5.

20 During phase Figure 1A the pressurized material 6, which is
to be carried out of the pressure chamber 1, extends to the
22 sliding valve 4, which is in its closed position 4/1. The
sliding valve 5 is still in its opened position 5/2 follow-
24 ing the preceded discharge of the conveyor chamber. In phase
Figure 1B the sliding valve 5 is moved to its closed posi-
26 tion 5/1. Low pressure prevails in the empty conveyor cham-
ber 2. Thereafter, in phase Figure 1C the sliding valve 4 is
28 moved to its open position 4/2. The over-pressure in the
pressure space 1 presses the muck (excavation) 6 into the
30 empty conveyor chamber 2. In phase Figure 1D the sliding
valve 4 is moved to its closed position 4/1. In the conveyor

chamber 2 there is a separated muck volume 7 loaded with over-pressure in its pores. In phase Figure 1E the sliding valve 5 is abruptly brought to its open position 5/2.

The pore over-pressure in the muck 7, which pressure is larger than the pressure in the low-pressure space 3, presses the muck volume 7 out of the conveyor chamber 2 and the depressurized muck 8 exits in the low-pressure area. Thus, the state of phase Figure 1A has been regained, and a new excavation cycle may start.

In Figure 2 the conveyor chamber 2 is provided with an accumulator for pressurized gas 9 in its inlet area. The operation sequence of the phases Figure 2A to 2C correspond to those of Figures 1A to 1C. In phase Figure 2D the sliding valve 4 is moved to its closed position 4/1. In the conveyor chamber 2 there is a separated muck volume 7 which is subjected to pore over-pressure. The accumulator for pressurized gas 9 is loaded with the pressure which is higher than the pore over-pressure. By opening the connection valve between the accumulator 9 and the conveyor chamber 2 the pore over-pressure in the closed conveyor chamber 2 will increase. In phase Figure 2E the sliding valve 5 is abruptly brought into its open position 5/2. Simultaneously with or immediately after the opening of the sliding valve 5 the accumulator for pressurized gas 9 ejects a further pulse of pressurized gas into the inlet area of the conveyor chamber 2. The expansion pressure of the gas pulse and the increased pore over-pressure in the muck 7 vis-a-vis the low-pressure space 3 press the muck volume 7 out of the conveyor chamber 2, and the depressurized muck 8 exits into the area of low pressure. Thus, the situation of phase Figure 2A has been regained, and a new excavation cycle may start.

Figure 3 illustrates an example for an application of the conveyor device according to the invention in an EPB-shield heading machine 10. The pressure space 12 arranged at the head of the shield 11 is closed at its rear end by the funnel-shaped rear wall of the stripping chamber, which exerts pressure against the working face 14 with its cutting edge 13 and thus seals the pressure space at the front side. A cutting wheel 15 strips the soil at the working face. The soil supports the working face by means of the driving of the shield and the pressure of the foam which is pressed through conduit 16 against the working face 14 and into the stripping chamber 12 and which is mixed into the stripped muck in the stripping chamber by the rotational movement of the cutting wheel.

The muck 17 is pressed into the screw conveyor 18 which is suitably installed between the stripping chamber 12 and the conveyor device 19 in order to achieve a continuous supply of muck to the conveyor device 19 according to the invention. The conveyor device 19 discharges on a conveyor belt 20. The conveyor device consists of an inlet portion 21, which substantially is subjected to the pressure in chamber 12, the conveyor chamber 22 and an outlet element 23. The sliding valve 24 is arranged between the inlet portion 21 and the conveyor chamber, and the sliding valve 25 is arranged between the conveyor chamber and the outlet element 23. To extract the muck from the pressure chamber 12 the same steps as described with regard to Figure 1 or 2 take place in the conveyor device 19.

2 Method for carrying out material from a pressure chamber and
conveyor device

4 C L A I M S

1. Method for carrying out material from a pressure chamber,
6 preferably for carrying out muck from the pressure chamber
of earth pressure shields, in which pressure chamber the
8 muck is stored mixed with a compressible gaseous medium and
from where the muck is transported away by means of a con-
10 veyor device, such as a screw conveyor, which at the same
time acts as a pressure lock, wherein the muck mixed with
12 said compressible medium is pressed through an opened slid-
ing valve opening by the force of a pressure in the pressure
14 chamber and/or in the conveyor device which pressure is
larger than a smaller, normally atmospheric, pressure pre-
16 vailing in the back space, c h a r a c t e r i z e d
in that the muck is pressed through said opened inlet open-
18 ing of the sliding valve (4,24) into a conveyor chamber
(2,22) which is limited by said inlet sliding valve and by a
20 closed outlet sliding valve opening (5,25) against the back
space (3,23) which is subjected to said smaller pressure,
22 and that the ejection of the muck out of the conveyor cham-
ber after closing of the inlet sliding valve opening (4,24)
24 is brought about by an abrupt opening of the outlet sliding
valve opening (5,25) causing sudden expansion of the com-
26 pressed gaseous medium.

2. Method according to claim 1, c h a r a c t e r i z e d
28 in that the ejection energy in the conveyor chamber (2,22)
is increased by additional gas introduced into the closed
30 conveyor chamber filled with muck (7), which additional gas
has a pressure larger than the pore over-pressure of the
32 muck in the conveyor chamber.



3. Method according to claims 1 and 2, c h a r a c t e r -
i z e d in that the muck, (6,17) is conditioned by the ad-
dition of agents, for example foaming agents, in such a way
that the permeability of the muck is decreased to a level at
which the expansion of the compressible gaseous medium is
retarded against the time required for opening the outlet
sliding valve (5,25).

4. Conveyor device for carrying out material from a pressure
chamber, preferably for carrying out muck from the pressure
chamber of earth pressure shields, which conveyor device is
adapted to press out the muck through an opened sliding
valve opening by means of a pressure in the pressure chamber
which pressure is larger than the smaller, normally atmo-
spheric, pressure prevailing in the back space or by means
of a conveyor, such as a screw conveyor, for carrying out
the method according to any of the claims 1 to 3, c h a -
r a c t e r i z e d in that in the extraction line between
the pressure chamber (1,12) or the conveyor device (18) and
the space (3,23) is provided an empty pipe-like conveyor
chamber (2,22) with smooth walls which is limited by an in-
let sliding valve (4,24) against the pressure chamber (1,21)
and by a outlet sliding valve (5,25), adapted to be quickly
opened, against the space (3,23), and that the sliding
valves (4,5;24,25) are controllable such that one sliding
valve can be opened only when the other sliding valve is
closed.

5. Conveyor device according to claim 4, c h a r a c t e r -
i z e d in that it is provided with an accumulator (9) for
pressurized gas, which enables the injection of gas into the
closed conveyor chamber (2) which gas has a higher pressure
than the gas in the pores of the muck (7) in the conveyor
chamber (2).



6. Conveyor device according to claims 4 and 5, c h a-
2 r a c t e r i z e d in that the movement of the sliding
valves (4;5;24,25) and/or the addition of gas from the accu-
4 mulator (9) for pressurized gas into the conveyor chamber
(2) is electronically program-controlled.

