United States Patent [19]

Stoltefuss et al.

[11] **3,873,157**

[45] **Mar. 25, 1975**

[54] **MOBILE MINE TUNNELLING MACHINE HAVING COOPERABLE CUTTER, TROUGH, LOADER AND CONVEYORS**

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[22] Filed: **Dec. 6, 1972**

[21] Appl. No.: **312,526**

[30] **Foreign Application Priority Data**

Dec. 7, 1971	Germany	2160643
May 13, 1972	Germany	2217765
Aug. 19, 1972	Germany	2240873

[52] **U.S. Cl.** **299/31**, 198/10, 299/64, 299/75

[51] **Int. Cl.** **E21c 27/24**, E21c 35/20

[58] **Field of Search** 299/18, 56, 57, 64–68, 299/75, 31; 198/9, 10, 11

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[57] **ABSTRACT**

A machine for use in tunnelling or mining installations and having a beam carrying a cutting device for acting on a working face. The beam is supported by a displaceable chassis for movement upwardly and downwardly and transversally.

An inclined trough is disposed beneath the beam to receive material detached from the face. A scraper-chain conveyor is rigidly connected to each side of the trough and a loading plate is used to transfer material from the trough to the conveyors. Each conveyor has an inclined section extending alongside the trough and adjoining an elevated horizontal section supported by support means enabling the conveyor to pivot at least about an axis extending laterally of the longitudinal axis of the conveyor to allow the trough to be raised and lowered.

29 Claims, 5 Drawing Figures

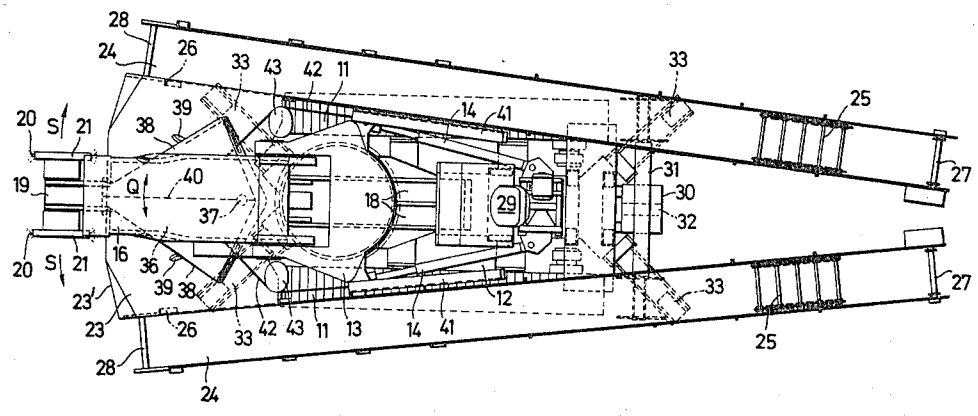
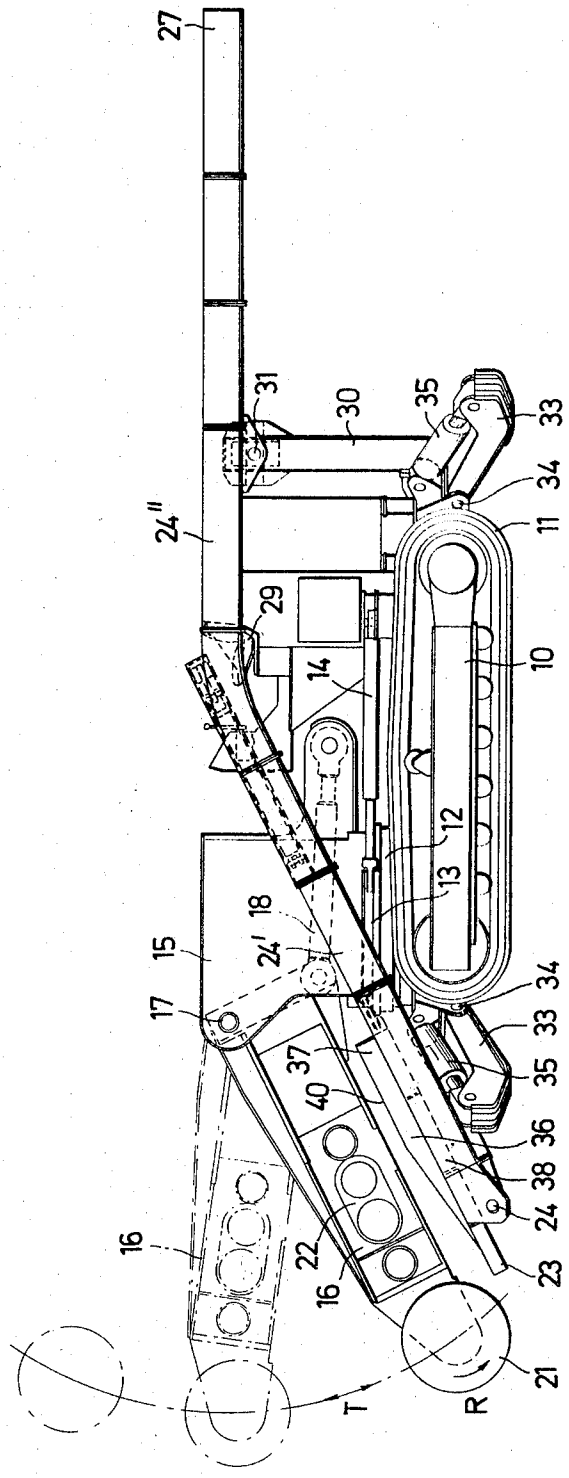


FIG. 1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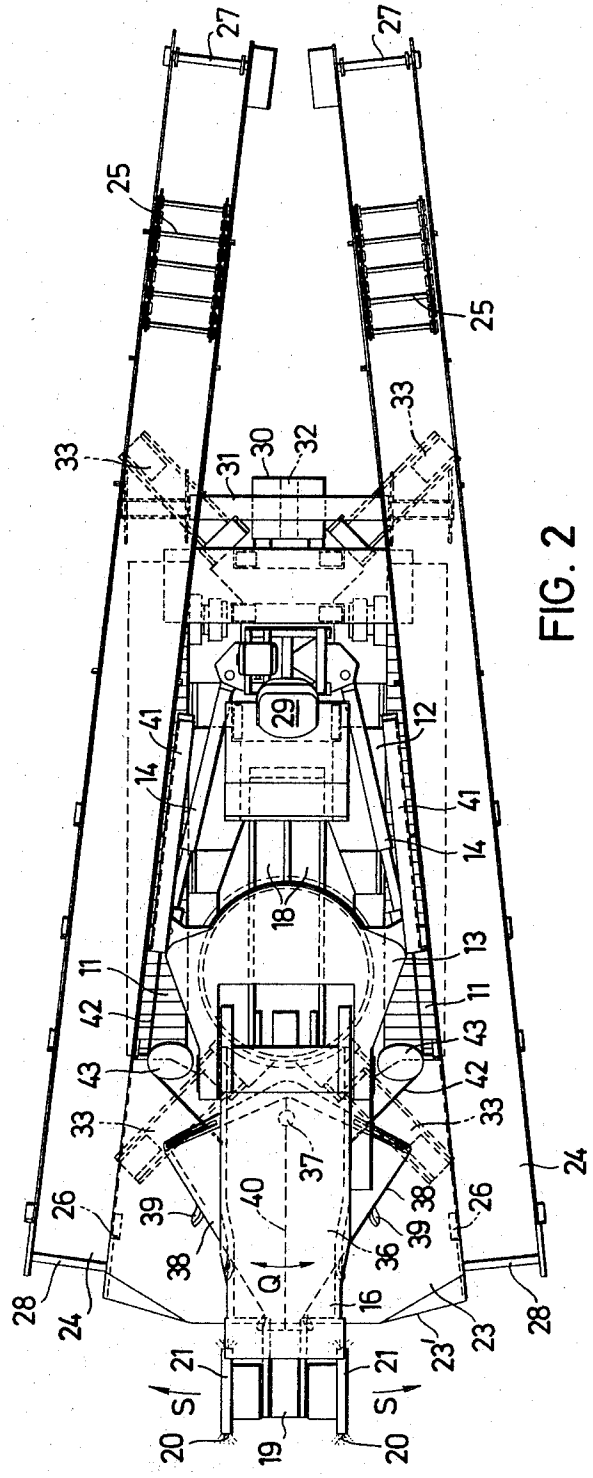
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FIG. 2

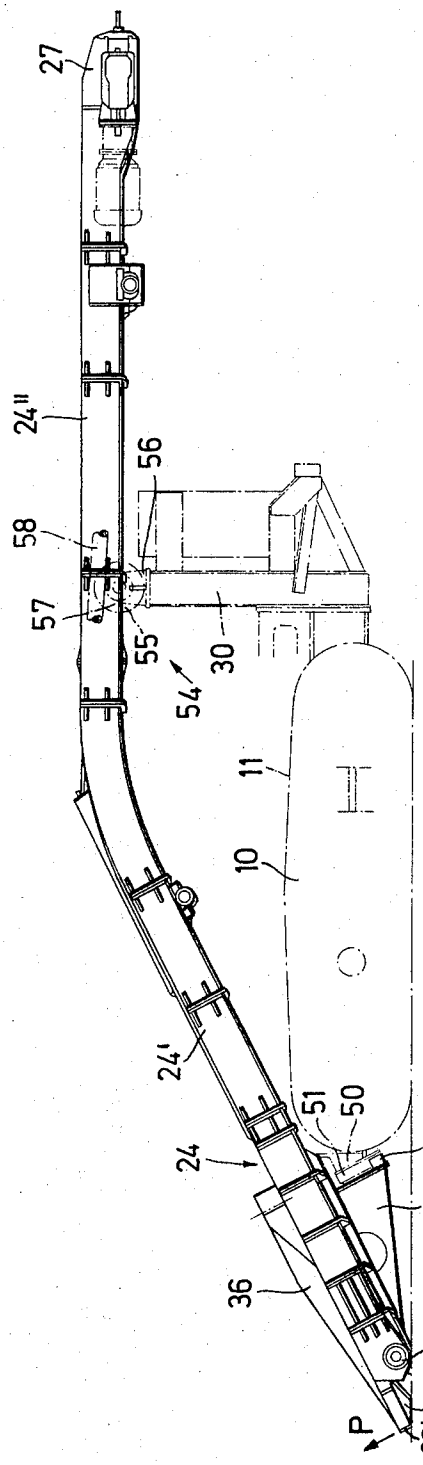

FIG. 3

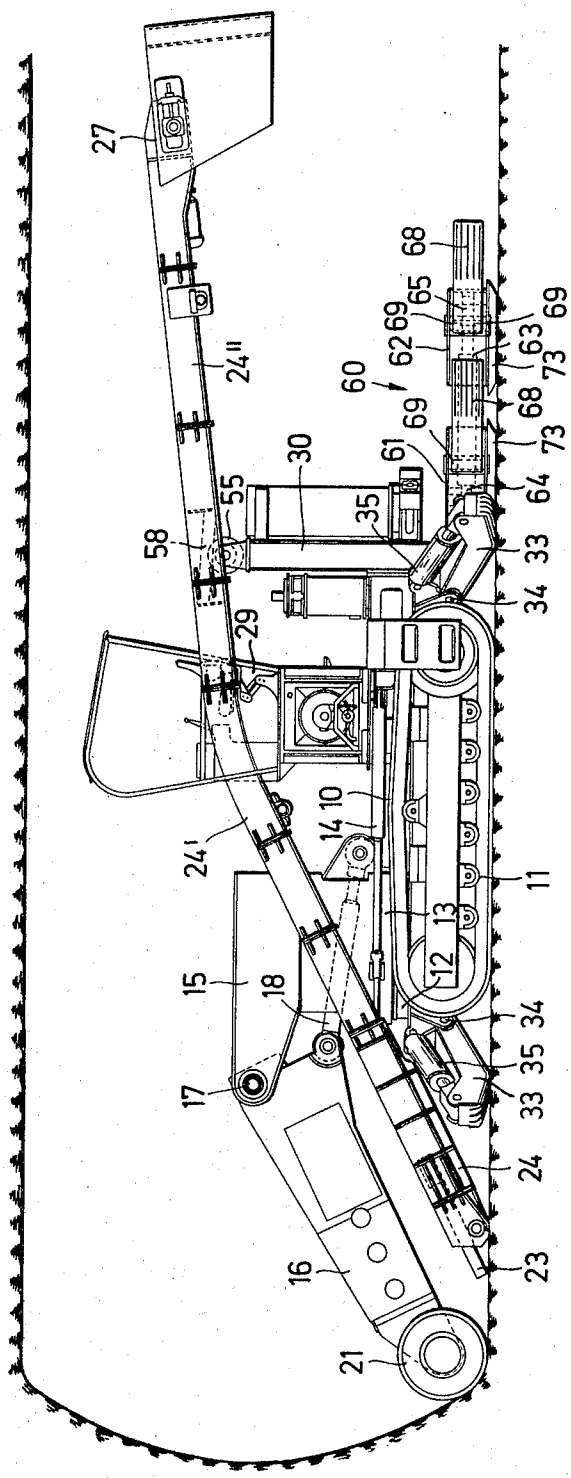
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FIG. 4

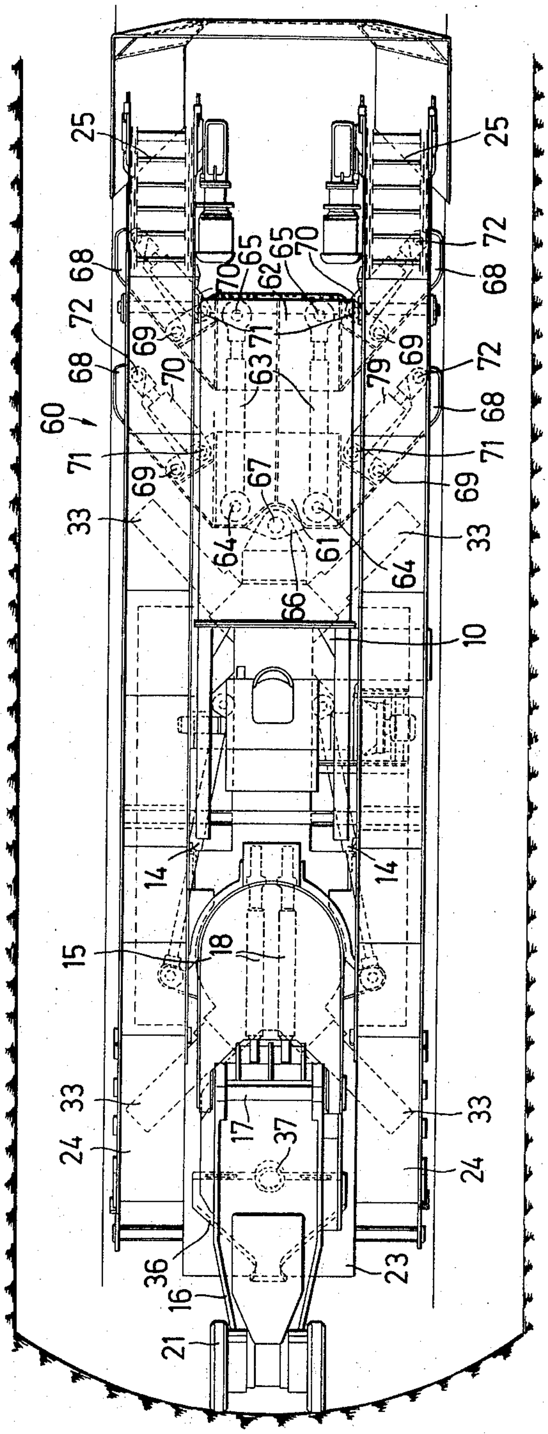
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FIG. 5

MOBILE MINE TUNNELLING MACHINE HAVING COOPERABLE CUTTER, TROUGH, LOADER AND CONVEYORS

BACKGROUND TO THE INVENTION

The present invention relates to a machine for use in mining or tunnelling installations.

Machines having a chassis carried by wheels or endless tracks which supports a beam which can be raised, lowered and pivoted sideways are well known in the mining of minerals or ores, e.g. clay or gypsum, and for the driving of tunnels, galleries and other roadways. The beam has a cutting device such as a bladed roller which acts on a working face. The material removed from the face can be conveyed to the rear of the machine by a scraper-chain conveyor incorporated on the beam and discharged onto a further conveyor.

In the known machines it is difficult to effect efficient removal of the material. This applies particularly when the material has to be taken up by scrapers moving around the roller and which have an overall height less than that of the blades mounted on the roller. In this case no appreciable loading and removal of material can take place whilst the cutting device is operative and usually the loading and removal of material is performed alternately with the cutting work and this, of course, is inefficient per se. Another problem encountered with these known machines is that a layer of material will accumulate on the floor of the working and this layer cannot be removed by the scraper-chain conveyor. Owing to these difficulties it has often in practice proved necessary to use the mining machine simply to detach the material from the face and then to use special loading and conveying devices, such as scoop-type loaders to load and remove the detached material.

A general object of this invention is to provide an improved form of machine.

SUMMARY OF THE INVENTION

According to the invention there is provided a machine for use in tunnelling or mining; said machine comprising means for detaching material from a working face, a trough for receiving such material, a conveyor located at one side of the trough for conveying the material rearwardly from said face and a loading device for transferring material from said trough to said conveyor.

The machine may have a chassis borne on wheels or tracks and the detaching means may be in the form of a beam pivotable and raisable and lowerable in relation to the chassis and supporting a cutting device.

It is advisable for the cutting device to be in the form of a bladed roller operating at the bottom of the face since this enables the machine to run much more smoothly and the driving power available for the roller can be utilized much more satisfactorily. It has been found in tests that with a roller operating at the bottom the material is mainly detached in the lower zone, of the working face, so that the roller performs not only cutting work but to a great extent breaking work likewise. This results in a great improvement of efficiency and in the production of considerably larger pieces of material.

With a machine made in accordance with the invention it should be possible for virtually the whole of the material to be loaded and conveyed away during the actual detaching operation.

The cutting roller can be provided with cutting tools over its entire outer surface. A more suitable device, however, is one in which two cutting wheels with cutting bits are mounted on the end of the beam and are combined to form a drum or roller. This device can thus penetrate forward into the working face as well as cutting into the face laterally.

Preferably one conveyor is affixed to each side of the loading trough. The trough is preferably inclined upwardly in a direction away from the working face.

It is also advisable to arrange the conveyors in such a way that they are inclined in accordance with the inclination of the trough. More preferably each conveyor has an inclined section at the front of the machine adjoining a horizontal section projecting rearwardly of the chassis of the machine. The horizontal sections of the conveyors are preferably carried by support means permitting mobility of the conveyors and one common support for both conveyors can be provided on the machine. This support means may effectively form a universal joint providing the aforesaid mobility. The two conveyors are preferably so arranged that they converge towards the rear of the machine, i.e. away from the working face, in plan view.

The conveyors preferably consist of scraper-chain conveyors of which some of the conveyor channel sections are rigidly connected, at the sides of the loading trough so that the trough and the conveyors form a constructional unit which can be pivoted in a vertical sense, and for preference transversally as well, in respect of the machine chassis. The machine is preferably fitted with some form of lifting means for raising and lowering the loading trough and the conveyors rigidly connected thereto. A particularly simple construction is provided if the unit is raised and lowered by means of floor-engageable support members which are provided on the chassis and which can be raised and lowered by means of piston and cylinder units.

In another preferred feature of the invention the unit consisting of the loading trough and the conveyors is connected to the chassis via a thrust-bearing adapted to permit raising and lowering and pivoting of the trough. It is advantageous then to ensure that in the rear zone of the machine chassis the conveyors are pivotable in a vertical plane and displaceable in their longitudinal direction so as to cope with any lifting of the trough. In this case the forces acting on the trough when the machine is fed forward are transmitted directly via the thrust bearing to the machine chassis, while the conveyors connected with the loading trough and also the rear support means for the conveyors are relieved of these forces. It is particularly notable that the rear support means does not need to absorb any forces directed longitudinally of the machine and the conveyor. The thrust bearing and the support means would be so constructed as to allow the lifting movement of the loading trough and the associated pivoting movement of the conveyors. The thrust bearing is preferably in the form of a pin carried by the trough and engaging in an apertured linkage attached to the chassis. The pin is preferably inclined more or less perpendicularly in respect of the upper working surface of the loading trough. The thrust bearing can advantageously occupy an approximately central position between the conveyors, on the lower side of the loading trough, so that the forces occurring when the latter is fed forward towards the

working face are transmitted in the direction of the central longitudinal axis of the machine chassis.

When a thrust bearing of this kind is provided it is also preferable that the constructional unit consisting of the loading trough and the conveyors can perform slight pivoting movements about their longitudinal axes.

A particularly simple and advantageous construction for the supporting means is to provide a rotatable roller having a peripheral groove in which an elongate member connected to the conveyors is located. In this way the conveyors can pivot about the axis of the roller and about the axis of the elongate member and moreover the conveyors can be displaced in their longitudinal direction. It may be desirable to construct or arrange the elongate member in such a way that it is slightly inclined towards the rear of the machine so that the support means forms a fulcrum and the trough and the conveyors at the forward side of the support means is counter-balanced. The loading trough may thus lightly rest on the floor of the working and if required special lifting devices can be provided, to hold the loading trough firmly against the floor during the loading operation.

According to a further feature of the invention, the loading device is in the form of a plate which is mounted over the trough and adapted to be oscillated in relation to the trough.

The plate may have a greater thickness at its centre to form ramp-like guide surfaces descending towards the side. Preferably deflecting elements are provided at the sides of the plate. The plate is preferably of triangular or trapezoidal formation in plan view with its sides converging towards each other in the direction of the working face. Means is preferably provided for continuously oscillating the plate over the trough and this means may be a combination of piston and cylinder units and a cable or similar traction means interconnecting the units. Alternatively the plate may be connected with the beam so as to reciprocate as the beam moves horizontally in the course of the detaching work.

When the machine is used in an inclined gallery or tunnel, particularly when the floor ascends at a considerable gradient, it is advisable to connect to the rear of the machine an assembly composed of two interconnected relatively displaceable frames provided with locking devices engageable with the side wall of a tunnel or working to rigidly secure the frames, the assembly being disposed remote from the working face. The two frames of the assembly are advantageously provided with skids by means of which the frames can slide over the floor.

The frames may be of identical construction and flexibly interconnected by hydraulic piston and cylinder units able to effect relative displacement between the frames. Preferably the frames each have two locking devices each of which can be pivoted out to contact the wall of the tunnel gallery or other working, transversally of the driving direction. By alternately clamping and driving the frames the entire machine can be moved up when desired. When the detaching and loading work is commenced both frames can be braced against the tunnel to secure the machine.

The invention may be understood more readily and various other features of the invention may become apparent from consideration of the following description.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic side view of a machine made in accordance with the invention;

FIG. 2 is a plan view of the machine represented in FIG. 1;

FIG. 3 is a diagrammatic side view of part of another machine made in accordance with the invention;

FIG. 4 is a diagrammatic side view of a further machine made in accordance with the invention; and

FIG. 5 is a plan view of the machine represented in FIG. 4.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring initially to FIGS. 1 and 2 the machine has a main chassis assembly **12** with side parts **10** supported on endless tracks **11**, e.g. caterpillar type tracks. These tracks **11** are driven hydraulically to propel the machine and the tracks can be operated independently thus allowing the machine to be steered if desired. The chassis **12** carries a turntable **13** which can be pivoted about a vertical axis with the aid of two piston and cylinder units **14** articulated to the turntable **13** and the chassis **12.** The turntable **13** has a mounting frame **15** with a horizontal shaft **17** on which a beam **16** is pivotably supported. Piston and cylinder units **18** are connected between the beam **16** and the frame **15** and serve to swing the beam **16** upwardly or downwardly about the shaft **17.** The beam **16** can thus itself be moved vertically in the arcuate direction of arrow T in FIG. 1 and/or moved with the turntable **13** horizontally in the arcuate direction of arrow S in FIG. **2.**

A cutting device **19** is disposed at the end of the beam **16** and this device **19** may be composed of two rotatable wheels or rollers **21** carrying cutters **20** or a drum carrying such cutters **20.** These cutters are interchangeable and act on a working face when the device **19** is rotated, e.g. in the direction of arrow R. The device **19** is rotatably driven via gearing accommodated within the beam **16** itself and preferably electric power is used to drive the device **19.** This provides higher efficiency, which is desirable since the device **19** consumes more power than the driven tracks **11.** Electric power is also more adaptable to sudden high loading which may occur during operation. The electric power may be provided by a cable trailed by the machine and connected to a water-cooled electric motor disposed in the beam **16.**

An inclined loading trough or chute **23** is located beneath the beam **16.** As shown in FIG. **1** the trough **23** tapers outwardly in a lateral sense to widen in a direction away from the chassis **12.** The trough **23** has a leading end **23'** which normally rests on the floor of the working supporting the machine. The trough **23** also has side walls and to each of these side walls is secured, as at **26,** a scraper-chain conveyor **24.** The conveyor **24** converges towards the rear of the machine. Each conveyor **24** has two-laterally spaced chains to which is affixed scrapers **25.** The scraper-chain assembly of each conveyor **24** is circulated over a floor or conveying surface and between rollers **27, 28,** the roller **27** being driven in order to effect this circulation. The trough **23** and the conveyors **24** form a constructional unit as will become apparent hereinafter. The conveyors **24** serve

to take up material at their leading ends (28) and discharge the material from their rear ends (27).

The leading end of each conveyor 24 is disposed rearwardly of the front leading end 23' of the trough 23 and just above the floor surface of the working.

As shown in FIG. 1, each conveyor 24 has an ascending section 24' inclined upwardly from the leading end at the same angle as the trough 23 and terminating at about the centre of the machine adjacent a seat 29 for use by the operator of the machine. The seat 29 is located on a control station supported by the chassis 12. The section 24' adjoins a horizontal section 24' projecting rearwardly beyond the chassis 12 of the machine so that the rear end of the conveyor is disposed at some distance above the floor. The section 24'' of each conveyor 24 is supported by means of an upright central pillar 30 attached to the chassis 12.

The upper end of the pillar 30 has a horizontal shaft 32 having its axis parallel and co-planar with the longitudinal centre of the chassis 12. The shaft 32 in turn supports a further shaft 31 extending perpendicularly thereto and interconnecting the sections 24'' of the conveyors 24. The shafts 31, 32 thus form a universal joint enabling the sections of the conveyors 24 to tilt about the axis of either of the shafts 31, 32. The entire constructional unit 24, 23 is thus carried on the pillar 30 and the unit can be pivoted about the axis of the shaft 31 to raise or lower the front end of the unit in relation to the chassis, 12.

The front and rear ends of the chassis 12 are each provided with a pair of support members 33 located generally at the corners of the chassis 12 and extending outwardly from the chassis 12 at an angle in relation to the longitudinal centre of the chassis 12. Each member 33 is pivotably carried on a shaft 34 extending perpendicularly to the member 33 and in a horizontal plane. Each member 33 has an upwardly directed outer end to which a piston and cylinder unit 35 is articulated. Each unit 35 is also articulated to a support lug or bracket on the chassis 12. The units 35 are arranged to effect raising or lowering of the members 33 about the axes of the shafts 34. The members 33 can thus be pressed against the floor to rigidly brace the machine during operation. If desired, the members 33 can lift the tracks 11 off the floor completely, e.g. for maintenance purposes. The front members 33 can also be used to raise or lower the trough 23 and conveyors 24.

A loading device in the form of a plate 36 is pivotably supported on a shaft 37 carried by the trough 23 and extending perpendicularly thereto. The plate 36 is triangular or trapezoidal shape in plan view and has lateral edges 38 converging towards the front end 23' of the trough 23. These edges 38 have outwardly-directed deflecting elements 39. The plate 36 is thicker at its centre 440 and tapers in thickness therefrom towards the edges 38 to form ramp-like guiding surfaces. Two piston and cylinder units 41 are connected to the chassis 12 and each unit 41 is supported in a position parallel to the adjacent conveyor 24. The units 41 are interconnected by means of a traction member 42 such as a cable or chain also secured to the plate 36. The traction member 42 is guided over pulleys 43 supported by the chassis 12. By operating the units 41 in alternation the plate 36 can be oscillated about the shaft 27 in the direction of arrow Q in FIG. 2.

During operation the device 19 is used to detach mineral or some other material from a working face, and the material or mineral falls onto the trough 23. The beam 16 can be swung about horizontally by means of the units 14 and generally a complete cycle of horizontal movement of the beam 16 takes place in about 25 seconds. The beam 16 can also be made to swing vertically by means of the units 18. The plate 36 is oscillated to and fro to transfer the material to the conveyors 24. Generally a complete movement of the plate 36 from one side to the other takes about 12 seconds. The conveyors 24 in turn convey the material rearwardly for discharge into receptacles such as trucks or bins or the like. Alternatively the material can be discharged from the conveyors 24 onto a further conveyor.

The members 33 serve to brace the machine and the front members 33 can lift the unit 23, 24 clear of the floor, to enable the machine to be advanced with the aid of tracks 11 to follow up the progress of the work.

In a modified construction the plate 36 is carried by the beam 16 and not by the trough 23 although the plate 36 still serves to transfer material to the conveyors 24. It is possible in this case to dispense with the units 41 and the traction member 42 and in this case the requisite movement of the plate 36 would be achieved by swinging the turntable 13 with the aid of the units 14.

The machine represented in FIG. 3 is similar to that described above and illustrated in FIGS. 1 and 2 and like reference numerals are used to denote like parts. Essentially the main difference between the machine represented in FIG. 3 in relation to that represented in FIGS. 1 and 2 is the support for the unit composed of the trough 23 and the conveyors 24. Referring now to FIG. 3, the chassis 12 has a bracket 50 formed with an apertured linkage 51. A complementary bracket 53 secured to the trough 23 has a pin 52 which is received in the linkage 51; one pin 52 extending perpendicularly to the main surface of the trough 23. The pin 52 and linkage 51 form a thrust bearing for the trough 23 so that when the latter is advanced in rubble or encounters an obstacle in its path the forces are transferred through the bearing to the chassis 12 and centrally thereof.

The rear support means for the conveyors 24, designated 54, is also modified. More particularly, the support pillar 30 carries a roller 55 rotatably supported by roller bearings 56. The roller 55 has a peripheral concavity such as a continuously or part-continuous groove 57. The conveyors 24 are interconnected by a transverse girder to which is affixed a short rod 58 having a cross-sectional shape commensurate with the groove 57. The rod 58 engages in the groove 57 so that the conveyors 24 can move longitudinally of the machine i.e. in the axial direction of the rod 58 as well as pivot about the axis of the roller 55. In addition the conveyors 24 and the trough 23 can also rock about the axis of the rod 58 i.e. about the longitudinal centre of the machine. The pin 52 will pivot in the linkage 51 during this motion. The rod 58 is inclined downwardly towards the rear end (27) of the conveyors 24 and this tends to urge the pin 52 into its linkage 51.

The front end 23' of the trough 23 again normally rests on the floor of the working and can be raised in the direction of arrow P, by the support members 33 (FIGS. 1 and 2) or by special lifting jacks (not shown). The conveyors 24 affixed to the trough 23 would also pivot and may be displaced slightly longitudinally of the machine as the trough 23 is raised. When the trough 23

is raised in this manner the pin **52** slides downwardly in the linkage **51.** It is possible to construct the conveyors **24** so that they counterbalance on the support means (**30, 55**) and thereby only a small amount of force is required to raise the trough **23** from the floor.

The machine depicted in FIGS. **4** and **5** is also similar to that described in connection with FIGS. **1** to **3** and again like reference numerals are used to denote like parts.

Referring now to FIGS. **4** and **5** the machine is provided with an assembly **60** composed of two hollow frames **61, 62** of similar construction interconnected by means of two double-acting hydraulic piston and cylinder units **63** arranged parallel to one another. These units **63** are connected to the frames **61, 62** with upstanding pivot pins **64, 65** and extend within the frames **61, 62.** The frame **61** has a coupling bracket **66** which enables the assembly **60** to be detachably articulated to the chassis of the machine with a stout upstanding pivot pin **67.** Each frame **61, 6255** has a skid **73** slidably engaging the floor of the working. Each frame **61, 62** supports locking devices **68** disposed at the sides of the frame **61, 62** and the devices **68** can be pivoted outwardly or inwardly about vertical joints **69.** The devices **68** are each connected to the associated frame **61, 62** with the aid of a piston and cylinder unit **70** articulated to the frame **61, 62** and the devices **68** and joints **71,** 72. The units **70** can thus urge the devices **68** outwardly to engage the surface of a gallery or the like in which the machine is used. Thereby the machine can be firmly braced in its operating position.

The machine is also provided with the support members **33** described previously. When the machine is to be moved forwards the front members **33** lift the trough **23** off the floor and the devices **68** of the frame **61** are retracted inwardly. The units **63** are now operated using the frame **62** still braced against the sides of the gallery by the devices **68** to urge the machine and the frame **61** forwards. When the machine has been moved up sufficiently the devices **68** of the frame **61** are again pivoted outwards to engage the side of the gallery and the devices **68** of the frame **62** are retracted inwardly. The units **63** are now operated to draw up the frame **62.** The devices **68** of the frame **62** are finally moved outwards again to engage the side of the gallery.

We claim:

1. A machine for use in tunnelling or mining; said machine comprising: a chassis, mobile support means for rendering the chassis displaceable, means for detaching material from a working face; means for supporting the detaching means for movement in two mutually-perpendicular planes relative to the chassis, a trough for receiving the material detached from the face, a conveyor located at each side of the trough for conveying the material rearwardly from the face and a separate loading device which is movable to transfer material from said trough to the conveyors in alternation.

2. A machine according to claim **1,** wherein the trough is inclined upwardly in a direction away from the working face.

3. A machine according to claim **1,** wherein each conveyor has an inclined section extending at substantially the same angle of inclination as the trough.

4. A machine according to claim **3,** wherein each conveyor has a horizontal section adjoining said inclined section, the horizontal section being supported by support means in an elevated position.

5. A machine according to claim **4,** wherein the conveyors are supported by a common support means.

6. A machine according to claim **4,** wherein each conveyor is displaceable in relation to said support means.

7. A machine according to claim **6,** wherein each conveyor is displaceable in a longitudinal direction and pivoted about an axis extending perpendicularly to said longitudinal direction.

8. A machine according to claim **7,** wherein each conveyor is pivotable about an axis extending parallel to said longitudinal direction.

9. A machine according to claim **8,** wherein the support means includes a roller having a peripheral groove receiving an elongate member attached to the associated conveyor or conveyors.

10. A machine according to claim **1,** wherein the conveyors converge in plan view in a direction away from the working face.

11. A machine according to claim **1,** wherein the loading device is in the form of a plate pivotably mounted on the trough and there is provided means for oscillating the plate in relation to the trough.

12. A machine according to claim **11,** wherein the plate has a central region of greater thickness than the side regions to form ramp-like guide surfaces inclined downwardly towards the sides of the trough.

13. A machine according to claim **11,** wherein deflecting elements are provided at the sides of the plate.

14. A machine according to claim **1,** wherein the loading device is in the form of a plate carried by the support means of the detaching means.

15. A machine according to claim **1,** wherein there is further provided means for raising and lowering the trough.

16. A machine according to claim **15,** wherein the raising and lowering means is in the form of floor-engageable support members actuated by piston and cylinder units.

17. A machine according to claim **1,** wherein the trough is connected to the chassis via a thrust-bearing adapted to permit raising and lowering and pivoting of the trough.

18. A machine according to claim **17,** wherein the thrust-bearing is in the form of a pin carried by the trough and engaging in an apertured linkage attached to the chassis.

19. A machine according to claim **1,** wherein there is further provided an assembly composed of two interconnected relatively displaceable frames provided with locking devices engageable with the side wall of a tunnel or working to rigidly secure the frames, the assembly being disposed remote from the working face.

20. A machine according to claim **19,** wherein the frames are provided with floor-engaging skids and at least one piston and cylinder unit is connected between the frames to effect relative displacement therebetween.

21. A machine according to claim **19,** wherein each frame has two locking devices, each device being pivotably supported by the frame and there is provided a piston and cylinder unit for pivoting each device to secure the associated frame.

22. A machine for use in tunnelling or mining; said machine comprising a chassis, means for detaching material from a working face, said detaching means being supported by the chassis, a trough for receiving mate-

rial detached from the face, a conveyor located on each side of the trough for conveying the material rearwardly from the faace, each conveyor having an inclined section and a substantially horizontal section adjoining said inclined section, means for supporting the horizontal section of each conveyor in an elevated position, each conveyor being displaceable in relation to said support means and a loading device for transferring material from the trough to the inclined sections of the conveyor.

23. A machine according to claim **22,** wherein each conveyor is displaceable in a longitudinal direction and pivoted about an axis extending perpendicularly to said longitudinal direction.

24. A machine according to claim **23,** wherein each conveyor is pivotable about an axis extending parallel to said longitudinal direction.

25. A machine according to claim **24,** wherein the support means includes a roller having a peripheral groove receiving an elongate member attached to the associated conveyor or conveyors.

26. A machine for use in mining or tunnelling operations; said machine comprising a main frame constituting a chassis, mobile support means rendering the chassis displaceable, a beam, means for supporting the beam and allowing the beam to move in horizontal and vertical planes relative to the main frame, means for detaching material from a working face, said detaching means being carried by the beam, conveyors disposed on both sides of the main frame, means for receiving material detached by the detaching means, said receiving means being connected to the conveyors, the conveyors and receiving means forming a constructional unit which is bodily displaceable in relation to the main frame, and a loading device mounted to swing to and fro over the receiving means to transfer material to said conveyors.

27. A macine according to claim **26,** wherein the conveyors are supported by support means and the constructional unit can pivot about said support means to raise or lower said receiving means.

28. A machine according to claim **27,** wherein the conveyors can also move longitudinally in relation to said support means.

29. A machine according to claim **26,** wherein the receiving means is pivotably connected to the main frame.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,873,157

DATED : March 25, 1975

INVENTOR(S) : Wilhelm STOLTEFUSS et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE HEADING:

Under Foreign Application Priority Data:

Delete "May 13, 1972" and insert -- April 13, 1972 --

Signed and sealed this 20th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks