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MINING MACHINE-COOLING SYSTEM

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Fig. 1.

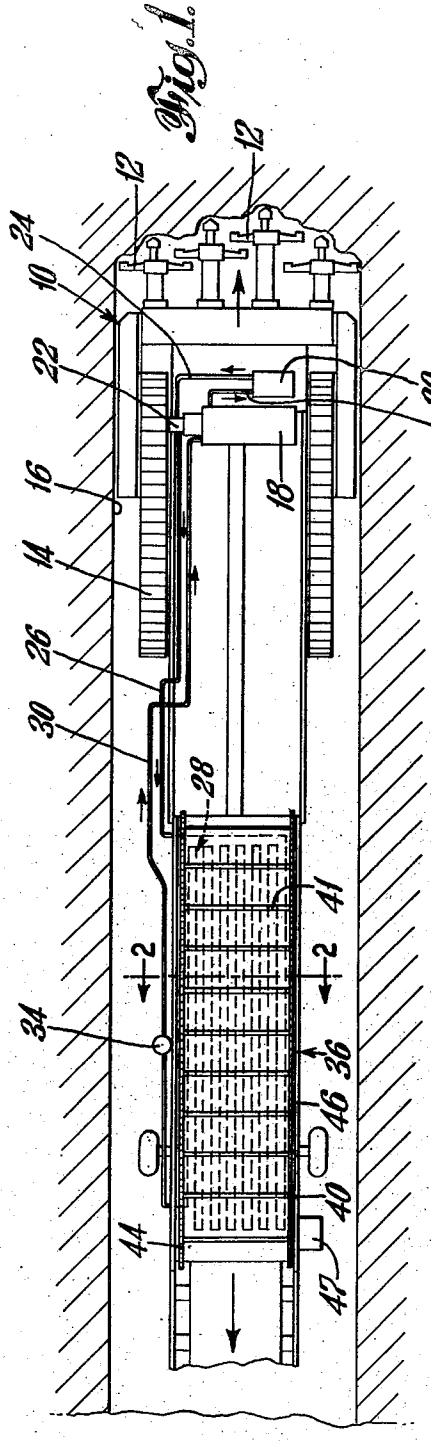
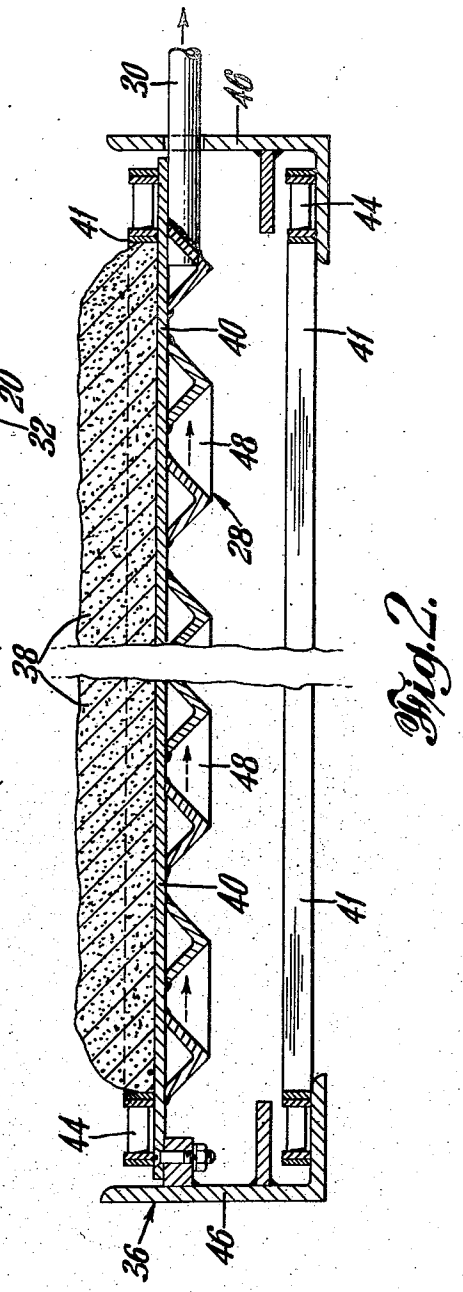


Fig. 2.



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MINING MACHINE-COOLING SYSTEM

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5 Claims. (Cl. 262—7)

This invention relates to cooling systems for granular earth-solid material handling equipment such as continuous coal mining machines and the like.

According to the invention there is provided a mining machine-cooling system, for example, in which a suitable liquid, such as oil, is used to cool drive-motors and/or gearing in a continuous bore-mining machine, which includes a flight conveyor for transferring the mined material such as granular coal, for example, rearwardly of the machine as the operation progresses in a bore-hole that is only slightly larger than the machine itself. The relatively hot oil is pumped from an oil reservoir through a filter and to a novel heat exchanger in the coal conveyor system, which heat exchanger comprises oil passages directly under the surface of a metal conveyor pan, which causes the hot oil to contact the underside thereof. Heat is transferred from such oil through the pan to the relatively cold granular coal dragged over its surface due to the operation of the flight conveyor. This process effectively cools the filtered oil which is returned to the mining machine. The heated coil is rapidly moved along the conveyor pan and delivered to following conveyors which in turn deliver it to the outside of the bore-hole. Thus heat is efficiently and continuously removed from the machine and the machine area by the coal or other material being mined. The relative motion of coal and conveyor elements with respect to the heat transfer surface have the further great advantage of effectively preventing the formation of deposits on that surface which would otherwise reduce heat transfer.

While not limited thereto the invention is especially applicable to continuous mining equipment, such as that disclosed in patent applications Serial No. 85,222 (now Patent No. 2,699,328) and Serial No. 353,932 (both of which have been assigned to Union Carbide and Carbon Corporation, assignee of the present invention), for the following reasons:

(*a*) Due to space restrictions and power requirements much heat is developed in the drive mechanisms of the continuous mining equipment which must be dissipated.

(*b*) Liquid cooling of motors and gearing is often required since the surrounding air is a poor coolant by reason of its relatively elevated temperature. The coolant liquid must itself then be cooled if it is to be recycled.

(*c*) Air cooling of the coolant liquid is often impractical, because of the elevated air temperature and because the air flow passages tend to become plugged by coal dust and small particles. Water cooling of the coolant liquid is generally impractical because of the length of hoses or pipes required to bring water to the mining machine and return it to its source.

(*d*) Coal in situ is generally of a relatively low, constant temperature. Cutting (mining) of the coal by mechanical means increases its temperature only slightly (perhaps 1 to 2° F.). Thus a stream of cool granular coal is available whenever the machine is operating.

(*e*) Some form of conveyor is required on the cutting machine and a series of conveyors are usually provided behind the machine. Drag pan type conveyors are frequently used.

(*f*) The cooling system described herein can readily be incorporated in one or more such conveyors, as well as in the machine conveyor itself, if desired.

However, our novel system of cooling is not restricted to continuous mining equipment, but can be applied to any granular earth solid handling devices.

In the drawing:

Fig. 1 is a fragmentary horizontal section of a coal seam showing in plan a continuous mining machine embodying the invention in a bore-hole made by such machine in said seam; and

Fig. 2 is an enlarged fragmentary view in transverse cross-section taken on line 2—2 of Fig. 1, showing details of the conveyor immediately rearward of such machine.

As shown in the drawing, the continuous bore-mining machine 10 is provided with four front end cutters 12 which are driven by powerful motors located within the body of the machine as the entire machine is moved forwardly by continuous treads 14 which support the machine on the bottom of the resulting bore-hole 16, such treads also being driven by motors located within the body of the machine. By way of example, only one drive motor 18 is illustrated. Such motor tends to become very hot in operation, but is effectively cooled according to our invention, by a suitable liquid, such as oil, supplied from a reservoir 20 carried by the machine. The oil is circulated by a pump 22 that is driven by the motor 18 through a circuit comprising an inlet pipe 24 communicating with the reservoir, an outlet pipe 26 communicating with our novel heat exchanger 28, a cool-oil return pipe 30 leading from such heat exchanger back to oil cooling passages associated with the motor 18, and a pipe 32 which conducts the relatively hot oil back to the reservoir 20. The circuit also includes a suitable filter 34 in pipe 30 for keeping the oil clean.

The heat exchanger 28 comprises a portable conveyor 36 which, in the illustrated example, is attached to the rear of the machine 10 for continuously transferring the coal 38 (mined by the machine) rearwardly through the bore-hole 16. The coal conveyor comprises a metal pan or plate 40, Fig. 2, on which the coal 38 is dragged by transverse flights 41, the ends of which are connected to continuous chains 44. Such chains are guided by suitable sprockets between side-frames 46, and driven in unison by a suitable motor 47, Fig. 1. Welded to the underside of the plate 40 are a plurality of spaced parallel channels, the opposite ends of which are so connected by cross-channels 48 that the oil flows back-and-forth under the plate 40, being cooled by direct transfer of heat through the plate (pan) to the granular earth solids (coal) 38 as the latter is moved along and in self-cleaning sliding contact with the surface of the plate 40.

More particularly, the liquid (oil) enters one end of the passage, flows through the entire length of the passage, and is discharged and returned to its source at a lower temperature. The passages shown are formed by welding angle iron of V-section to the plate to form, in effect, a continuous coil. However, other means might be used (e. g. pipe or tubing welded to the plate or a double plate) to provide thermal contact betwen the flowing liquid and the plate surface. Nor need a continuous, single pass coil be used: several parallel paths might also be utilized. Coal is dragged along the upper surface of the plate by moving chains and cross connecting flights, as shown, keeping such surface free of undesirable deposits. The flights, and consequently the coal, move in this case at a rate of approximately 100 feet/minute.

The return chains and flights pass beneath the pan and cooling coil, as shown.

As a consequence of its movement relative to the pan and its size distribution (very fine to perhaps 6 in. cube), a blanket of moving coal is formed on the upper surface of the plate. The contact time will vary according to the conveyor speed and the length of the plate, being in the case shown approximately 9 seconds. This time is sufficient to allow a certain amount of heat to flow from the plate to the coal particles. It has been shown by actual test that in the case of continuously mined coal, the coal bulk temperature and contact time are such as to allow a useful rate of heat transfer and consequently to produce a useful drop in temperature of the liquid (oil) flowing through the cooling passages. Additional heat will be radiated and convected from both sides of the plate depending upon ambient conditions.

The invention, while not restricted thereto, is well suited for cooling bore-mining machines. However, as pointed out above, the invention except as claimed is not limited to mining machines, but is suitable for other granular solid material handling equipment as will be apparent to those skilled in the art.

We claim:

1. In a continuous bore-mining machine including a drive motor having cooling passages, that is operated by remote control to mine coal from selected earth strata by boring a hole therein, the combination with a flight conveyor comprising a metal pan on which the coal is dragged as it is being mined, of a closed liquid cooling system for said motor comprising means for circulating liquid through such cooling passages in said drive motor of the machine and directly under said metal pan so that the relatively cold coal effectively cleans such pan and cools the liquid thereunder which, in turn, cools the motor.

2. Process of cooling a remotely controlled coal strata bore-mining machine which comprises boring and breaking relatively cold coal in a selected horizontal coal strata, continuously dragging such freshly mined broken coal as a refrigerant over and in direct contact with the upper surface of a relatively wide elongated flat relatively horizontal plate of heat conductive metal located near the top of such bore, while advancing such plate with the boring operation, continuously circulating a relatively hot liquid under and in heat exchange relation with the underside of such plate substantially throughout the length and width thereof so that such liquid is effectively cooled thereby, and continuously circulating the so-cooled liquid in heat interchange relation with internal boring and breaking drive parts of such bore-mining machine.

3. Apparatus for cooling a remotely controlled coal strata bore-mining machine which comprises means for boring and breaking relatively cold coal in a selected horizontal coal strata, a plate carried by said machine, means for continuously dragging such freshly mined broken coal as a refrigerant over and in direct contact with the upper surface of said plate, while advancing such plate with the machine as the boring operation progresses, means for continuously circulating a relatively hot liquid under and in heat exchange relation with the underside of such plate substantially throughout the length and width thereof so that such liquid is effectively cooled thereby, and means for continuously circulating the so-cooled liquid in heat interchange relation with internal boring and breaking drive parts of such bore-mining machine.

4. In granular earth-solid material continuous bore-mining equipment, the combination with a granular earth-solid material bore-mining machine having a drive motor therefor, and a flight conveyor comprising a metal pan and means for continuously dragging such freshly mined relatively cold material rearwardly of said machine on said pan as such material is progressively mined by said machine, of a cooling system for such drive motor of said machine comprising a closed liquid circuit associated only with said machine and said conveyor, said circuit including a liquid circulating pump, a heat exchanger incorporated with said flight conveyor for cooling relatively hot liquid in such circuit by the relatively cold newly-mined material dragged on said conveyor pan in direct contact with the upper surface thereof, a motor for driving said pump, said drive motor being provided with a cooling liquid passage, and a reservoir in said machine for such liquid, whereby the so-circulated liquid cools the drive motor of said machine and is, in turn, cooled through said pan by the freshly mined granular material as the latter is freshly mined by said machine and conveyed by said conveyor.

5. A coal mining machine-cooling system comprising the comibnation of a flight conveyor including a relatively horizontal relatively wide and elongated metal plate and means for continuously dragging freshly mined relatively cold coal on and in direct contact with the greater part of the area of the upper surface of such plate from one end to the other thereof, said plate constituting part of a heat exchanger comprising hot-oil passage means composed of metal for circulating oil to be cooled in direct contact with the greater part of the area of the underside of said plate, means for operating such mining machine comprising a drive motor carried thereby and provided with a cooling oil passsage, an oil reservoir carried by such mining machine, an oil circulating pump, and an oil circuit including an oil inlet pipe connecting said reservoir to said pump, an oil outlet pipe connecting said pump to said conveyor-oil passage means, a cool-oil return pipe connecting said hot-oil passage means to said motor-oil passage, and a pipe connecting the latter to said reservoir.

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