

Oct. 14, 1969

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3,472,375

APPARATUS AND METHOD FOR SEPARATING ORE

Filed Oct. 27, 1967

4 Sheets-Sheet 1

FIG. 1.

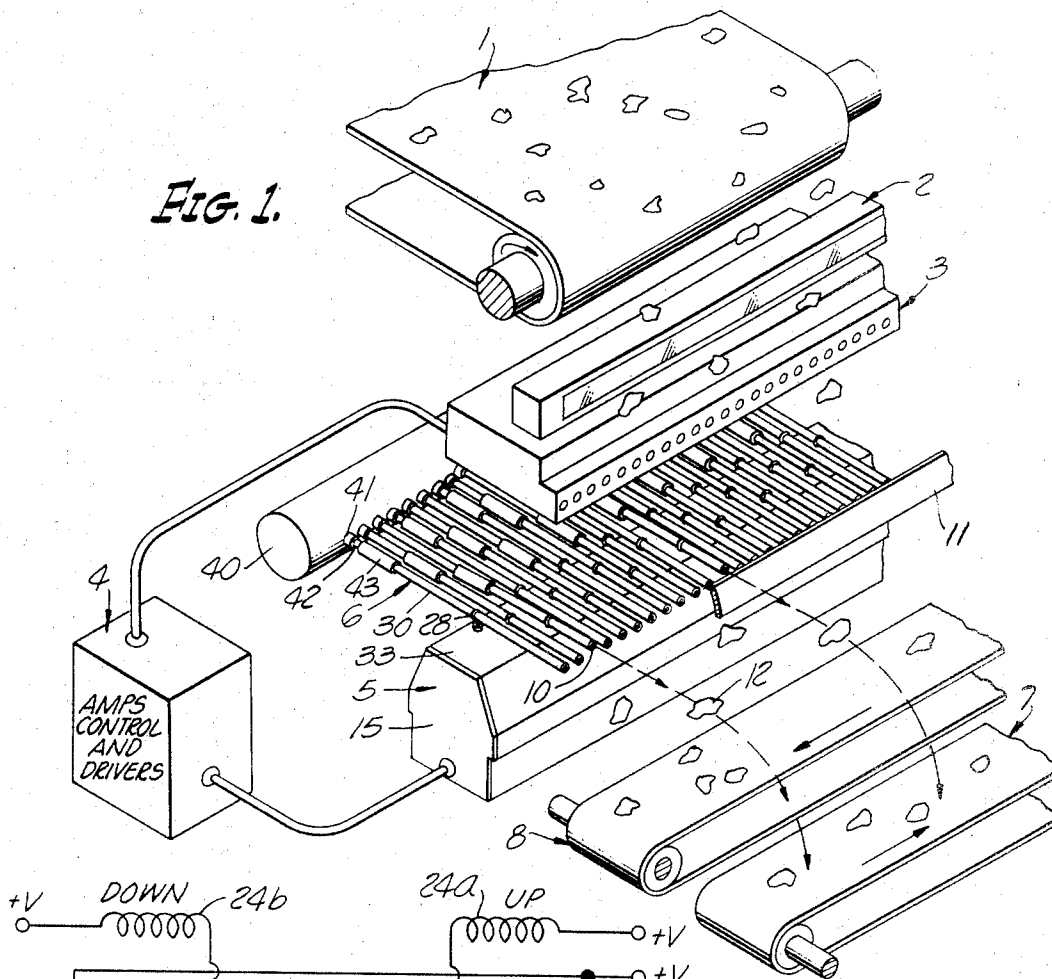
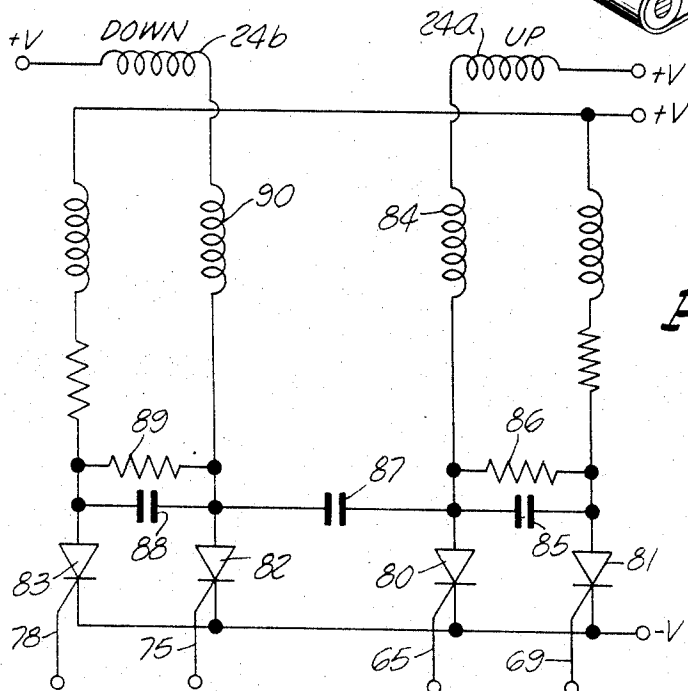


FIG. 9.

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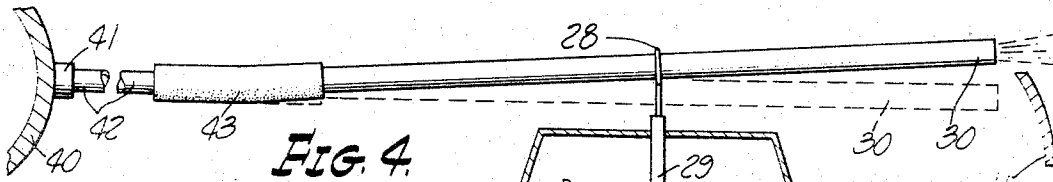
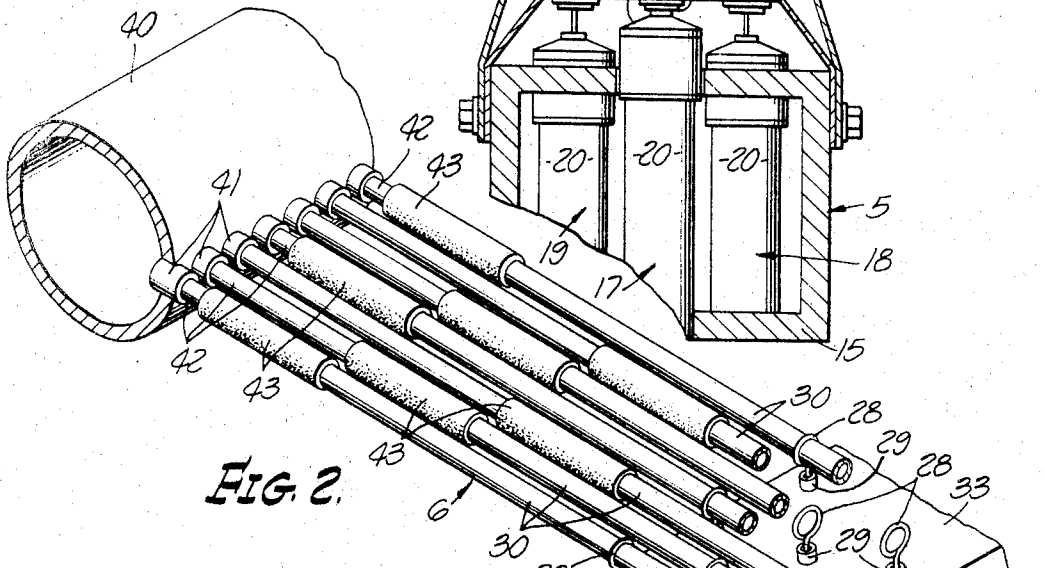
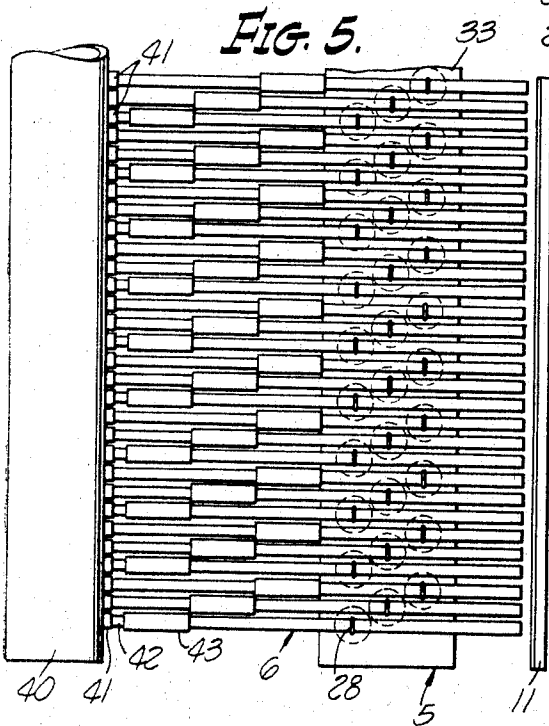
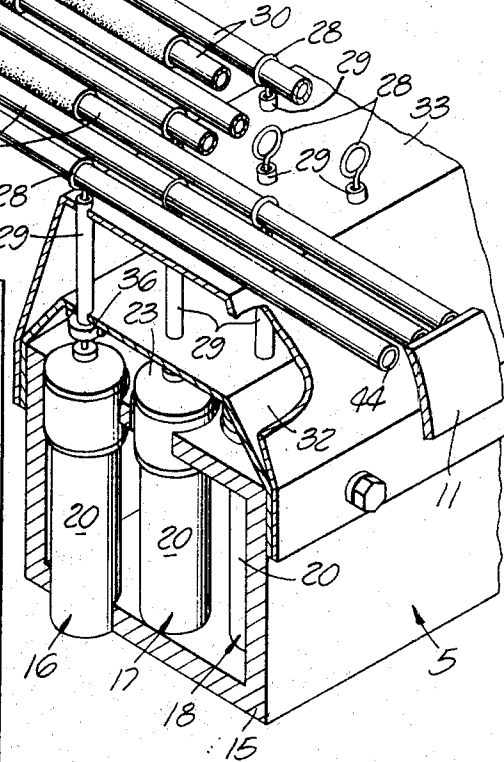
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4 Sheets-Sheet 3

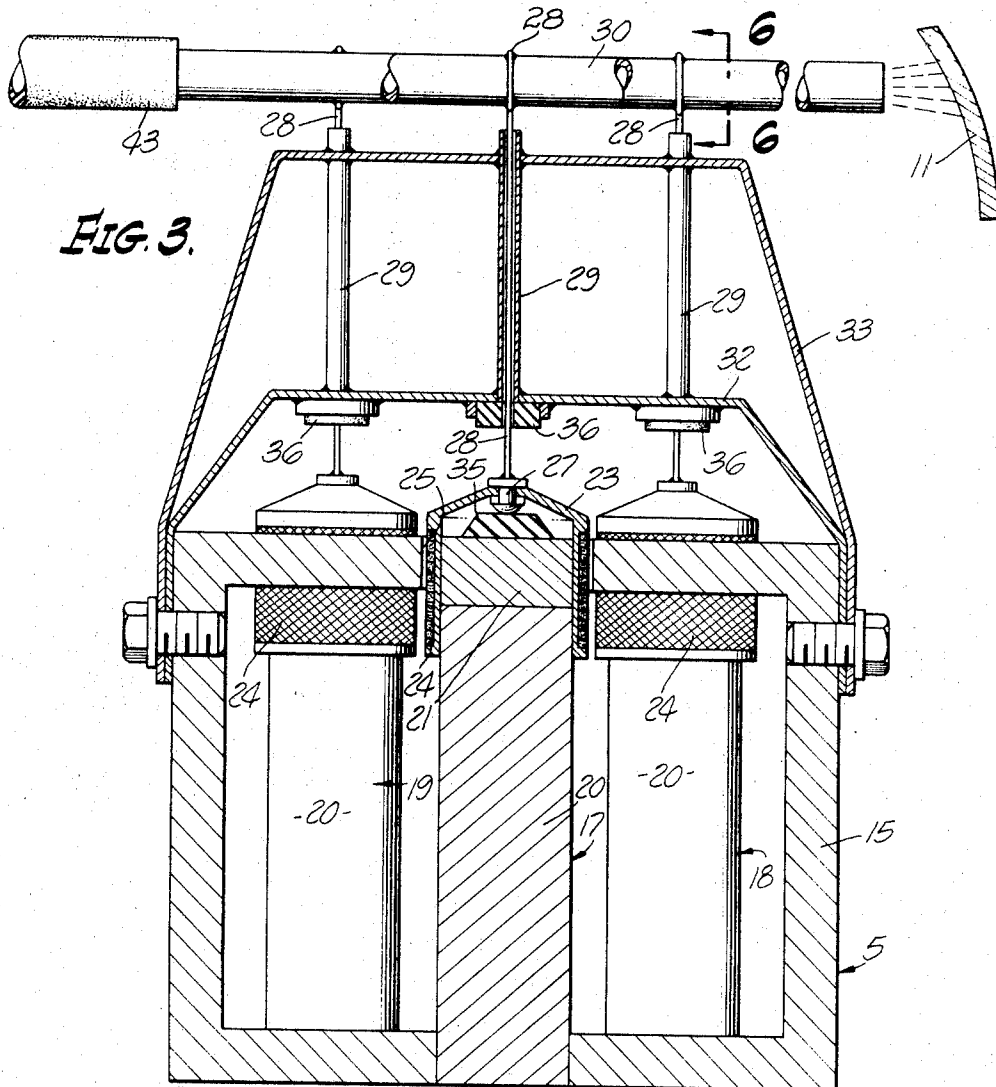
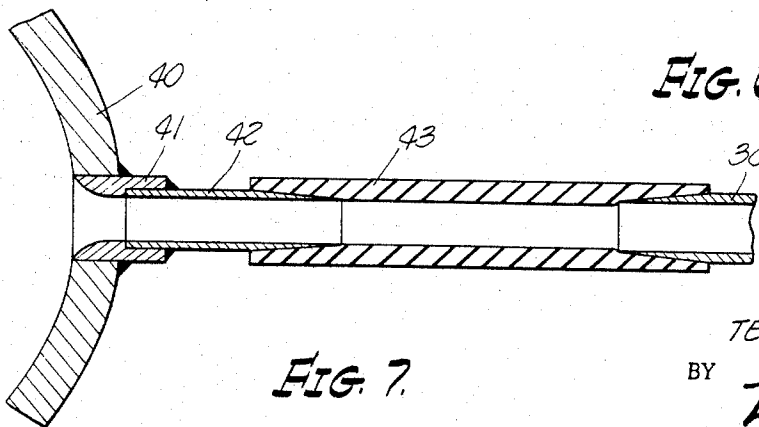
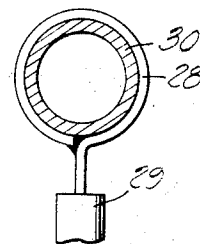


FIG. 6.



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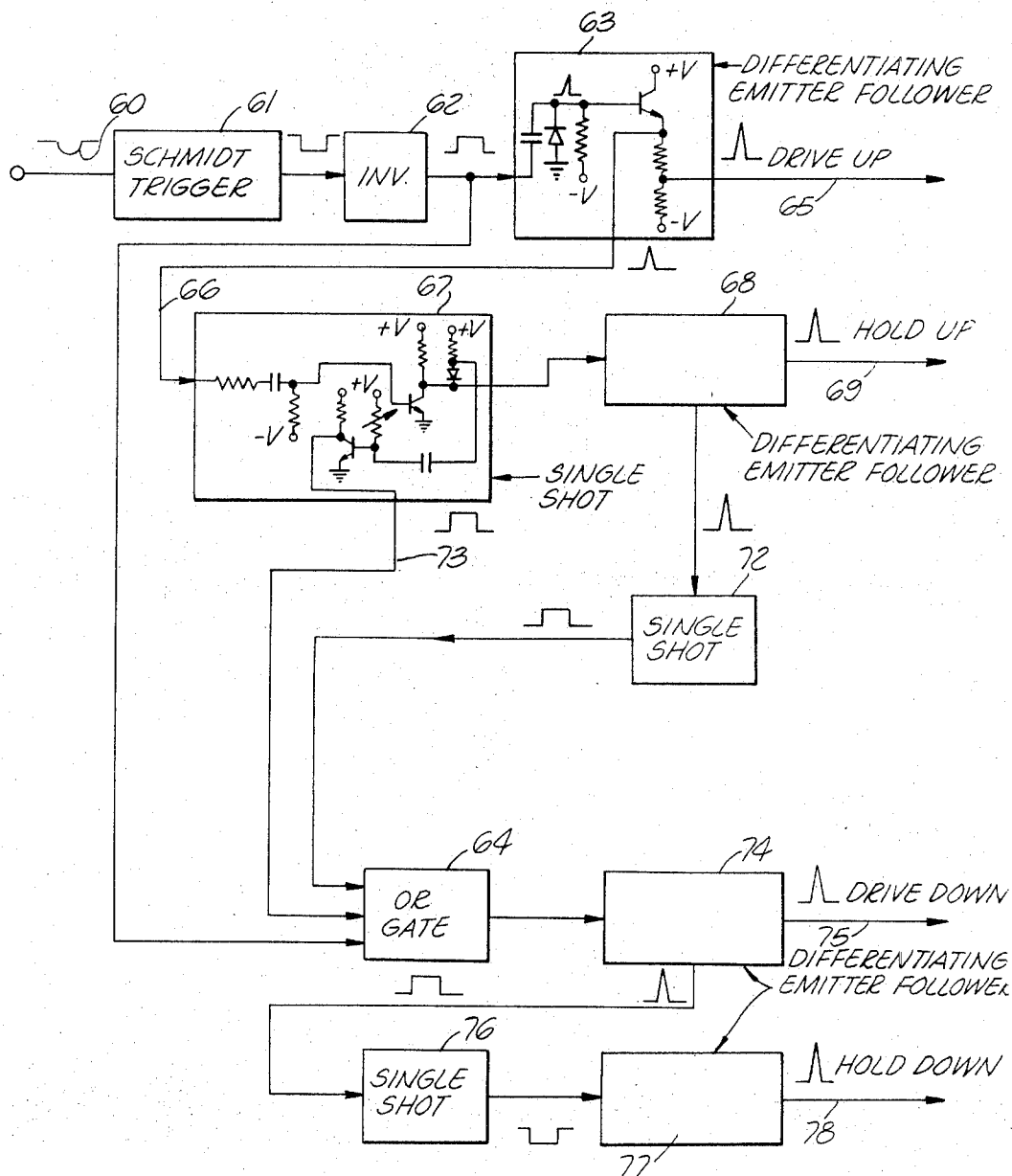


FIG. 8.

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APPARATUS AND METHOD FOR SEPARATING ORE

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Continuation-in-part of application Ser. No. 416,293,
Dec. 7, 1964. This application Oct. 27, 1967, Ser.
No. 678,647

Int. Cl. B07c 5/34

U.S. Cl. 209—74

14 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed herein an apparatus and method wherein desired ore is separated from a quantity of ore by sensing radiation from the ore and controlling fluid streams for effecting the separation. One or more of a plurality of tubes emitting streams of fluid such as water may be pivoted by an actuator assembly to direct water streams at ore particles to cause these particles to be separated from the remaining quantity of undesired ore.

This invention is a continuation-in-part of my U.S. patent application Ser. No. 416,293, entitled "Separation of Ore Particles Preferentially Coated With Liquid Fluorescent Material," filed Dec. 7, 1964, now U.S. Patent No. 3,356,211.

This invention pertains to the separation of desired ore from a quantity of ore. A common condition in many mining operations requires the mining of large quantities of worthless rock, and the like, to enable the recovery of the valuable mineral portion. All of this material usually is crushed, ground and treated before extracting the desired mineral.

To reduce the mill load it is desirable to reject at the mine the worthless material. In the instance where a strong visual contrast exists between the mineral and the worthless material, the mineral is often picked by hand to up-grade the feed for the subsequent crushing and grinding operations. Heretofore, it also has been proposed to automatically separate the mineral from the worthless portion by means which detect the difference in the natural color or radioactivity of the mineral and the worthless portion. However, these techniques have limited utility since at many mines visual or radioactive contrast does not exist and, hence, these ores may not be treated economically in this manner. Additionally, it has been proposed to employ compressed air to provide an air blast which is controlled by a valve or the like to change the trajectory of ore for separation purposes. Although compressed air can be used to separate small ore, large compressors and air pipes are required to move large rocks and such equipment is relatively cumbersome.

In accordance with my above-noted copending application Ser. No. 416,293, the disclosure of which is incorporated herein by reference, desired mineral is separated from the worthless quantity by radiating the ore to cause a portion of the ore to emit at a characteristic wavelength, and the emitted rays are sensed and used to operate means for separating the ore into desired and undesired portions. In an embodiment disclosed in said application, the separation may be achieved by first treating a quantity of the ore with a liquid which preferentially coats the particles of one of the portions of the ore and which also is capable of emitting at a characteristic wavelength upon exposure to ultraviolet light, X-rays, or other suitable types of electromagnetic radiation. The treated ore is then passed to a separation zone where an electromagnetic wave means sensitive to the characteristic wavelength detects which particles are coated and which particles are not. The sensing means then functions to actuate a deflect-

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ing means which physically removes the coated particles from the body of ore particles. Thus, a desired or undesired type of mineral may be removed in this manner from the mass of ore.

In accordance with the concepts of the present invention, there is provided an apparatus and method for separating desired ore from a quantity of ore by sensing radiation emission. Radiation emitted from ore particles is sensed and employed to operate an actuator assembly including a plurality of electromechanical actuators. These actuators are coupled with means supplying a substantially continuous fluid stream to cause the same to be directed at certain ore and thus separate the same from the mass of ore. The fluid stream is effective for a time period which is a function of ore size.

Accordingly, it is an object of the present invention to provide novel apparatus for effecting ore separation.

It is an additional object of this invention to provide apparatus wherein a substantially continuous fluid stream may be controlled for effecting ore separation.

It is another object of this invention to provide a novel actuator assembly.

A further object of this invention is to provide a novel method of effecting ore separation.

Another object of this invention is to provide a method of ore separation wherein the same is accomplished through control of a substantially continuous fluid stream.

These and other objects and advantages of the present invention will become more apparent upon a consideration of the following description taken in conjunction with the drawings in which:

FIGURE 1 is a perspective view of apparatus for effecting ore separation according to the present invention;

FIGURE 2 is a partial cut-away perspective view of a portion of an actuator assembly and tubes controlled thereby for supplying liquid streams;

FIGURE 3 is a cross-sectional view of the actuator assembly;

FIGURE 4 is a cross-sectional view of the actuator assembly illustrating the manner in which a liquid stream tube is raised above a deflector plate;

FIGURE 5 is a partial plan view of the liquid stream tubes;

FIGURE 6 is a cross-sectional view of a liquid stream tube taken along a line 6—6 of FIGURE 3;

FIGURE 7 is a cross-sectional view illustrating the manner in which the liquid stream tubes are coupled with a header; and

FIGURES 8 and 9 are respectively an electrical block diagram and an electrical circuit which may be employed in controlling an actuator of the actuator assembly.

Turning now to the drawings, ore, which is a preferred embodiment, has been treated with a fluorescent material to provide both coated and uncoated particles, is placed on a conveyor 1 and caused to drop from the end of the conveyor in a downward path past a radiation source 2, into a zone where the characteristic radiation emitted by the coated particles of ore is received in an electromagnetic wave sensing means 3. The wave energy received by the wave sensing means 3 produces a signal which is fed into an electrical system 4, the output of which controls an actuator assembly 5. The actuator assembly 5 operates deflecting means 6 which comprises a plurality of movable tubes providing liquid jets or streams to knock any particles emitting at the characteristic wavelength out of the falling stream of ore particles. The deflected particles are received by a collector 7 which may take the form of a conveyor moving in one direction, and the balance of the particles fall to a collector 8 which may take the form of a conveyor moving in another direction. Preferably the apparatus is covered to prevent external radiation from reaching the wave sensing means 3.

Turning for the moment to the initial treatment of the ore, a portion of a body of ore is caused to emit a characteristic wavelength which wavelength is unlike that emitted by the rest of the ore. The ore particles are then separated according to whether or not they emit the characteristic wavelength. This may be accomplished according to said copending application by first treating a quantity of ore containing at least one valuable mineral portion with a liquid which preferentially coats the particles of one of the minerals in the ore. The coating liquid, in addition to being specific to particles of the minerals in the ore, is also capable of fluorescing at a characteristic wavelength after exposure to ultraviolet, X-rays, or any other suitable type of radiation. For example, the coating liquid may be any one of a number of well-known long chain hydrocarbons selected to match with the mineral through surface chemistry. The source 2 may be a broad spectrum source with a filter to obtain the desired wavelength of radiation. For example, the filter may pass a radiation band below 3,600 angstroms, and a filter may be used on the detector 3 to pass radiation in a band above 3,800 angstroms to allow the detector to pick up secondary emission from the rock caused by radiation from the source. By providing separate wavelength bands in this manner, radiation from the source reaching the detector, as by reflection from the ore as distinguished from the secondary emission from the desired ore, will not pass the detector filter and cause improper operation of the actuator 5.

While in the preferred form of the invention, a portion of the ore particles is preferentially coated to provide the characteristic emissions upon excitation from the source, the coating may be dispensed with in the case of natural fluorescing or other radiation emitting ores. These ores, upon excitation, emit at a characteristic wavelength which can be used to activate the separation operation. Typical materials which can be recovered from ore mixtures without coating or other pretreatment are willemite, hydrozincite, uraninite, calcite and sheelite. Other ores may be first pretreated to provide the preferential coating capable of emitting at a characteristic wavelength upon exposure to one of the many forms of electromagnetic radiation.

Herein, the ore particles which emit at a characteristic wavelength upon excitation are sometimes referred to as being "fluorescent." Likewise, the coating materials used in many cases to provide this property are referred to as "fluorescent materials." In a narrow sense, fluorescence refers to the property of absorbing radiation at one particular wavelength and re-emitting it as light of a different wavelength so long as the stimulus is active. However, it is intended herein by the term "fluorescence" to indicate that property of absorbing radiation at one particular wavelength and re-emitting it at a different wavelength, whether or not visible, during exposure to the active stimulus, or after exposure, or during both of these time periods. Thus, fluorescence is used generically herein to include the limited definitions of both fluorescence and phosphoresence, and envisions the emission of a characteristic wavelength whether or not visible.

As described in said copending application, a wide variety of organic materials which fluoresce at a characteristic wavelength upon excitation by ultraviolet light, X-rays, or other radiation may be used to preferentially coat either the desired or undesired portion of the ore.

Turning now more specifically to the detector 3, control system 4, actuator assembly 5 and a deflecting means 6, the detector 3 may employ a plurality of photomultipliers for detecting the characteristic radiation emitted by the radiated particles. It is generally necessary that the source and detectors be located relatively close to the deflecting means 6, such as one half inch to several inches between the detectors and the deflecting means. In order to have a relatively compact detector 3, the photomultipliers may be arranged in two rows with fiber optics or well-known

glass fibers used for conveying the characteristic radiation to the photomultipliers. For example, thirty-six photomultipliers in two rows of eighteen may be provided with one-eighth inch diameter glass rods extending from the photomultipliers to the exterior of the detector 3. The signals from the photomultipliers are applied to a control system 4 which will be discussed in greater detail subsequently. Briefly, the control system 4 includes amplifiers, trigger circuits and drivers to control the operation of electromagnetic actuators housed within the actuator assembly 5. The actuators are operated electrically to deflect a fluid jet tube, for example a tube 10, above a deflector plate 11 to allow the fluid to force a desired ore particle 12 onto the conveyer 7. A typical deflection is three-eighths inch for the three-eighths inch outside diameter tube. A typical spacing between the detector 3 and deflecting means 6 is approximately four inches to prevent the fluid, for example water, from spraying on the detector.

Turning now to more detailed discussion of the actuating assembly 5 and deflecting means 6, the same are illustrated in greater detail in FIGURES 2 through 7. Considering first principally the enlarged showings thereof in FIGURES 2 and 3, the actuator assembly includes a housing 15 in the form of an elongated box. The housing has a plurality of apertures in the bottom and top thereof for receiving a plurality of magnet-armature assemblies, such as assemblies 16 through 19. These assemblies are arranged in staggered rows as best seen in FIGURES 2 and 5. Each includes a permanent magnet 20 and a soft iron slug affixed, as by an epoxy cement, to the upper end thereof which serves as an armature. A cylindrical coil form 23 having a coil 24 thereon is positioned in an annular air gap 25 which is defined by an upper aperture in the box 15 and the slug 21. The housing 15 serves as a yoke for each of the "voice-coil" drivers, and when the coil 24 is energized the coil form 23 will move up or down. The housing 15 may be made of 1010 iron. The slug 21 may be deleted in which case the permanent magnet 20 extends from the top to the bottom of the housing 15, but preferably the soft iron slug 21 is employed. Similarly, a soft iron slug may be used at the bottom of the housing 15 to improve the magnetic coupling with the housing. An electromagnet rather than a permanent magnet 20 also may be employed.

The coil form 23 preferably is machined from polytetrafluoroethylene such as that sold under the name Teflon, and preferably includes two layers of eighty-seven turns each of number thirty wire forming a bifilar winding for the coil 24. A rivet 27 is affixed to the upper end of the coil form 23, and a rod 28, such as small diameter music wire, is affixed to the rivet 27 and extends through a tube guide 29 and is coupled with a liquid jet or stream tube 30, like the tube 10 in FIGURE 1, as best seen in FIGURES 3, 4 and 6. An armature frame 32 and a cover frame 33 are secured to the sides of the housing 15 by any suitable means, such as bolts. These frames 32 and 33 extend the length of the top of the housing 15. The tube 29, as well as the other similar tubes, are secured to the frames 32 and 33 as by soldering. A rubber bumper 35 is secured to the upper end of the slug 21, and a rubber bumper 36 is secured to the underside of the armature frame 32, and these bumpers determine the limit of travel of the coil form 23. From the foregoing, it will be apparent to those skilled in the art that when the coil 24 is approximately energized, the coil form 23 will rise thereby causing the end of the tube 30 to rise above the deflection plate 11 as illustrated in FIGURE 4.

The deflecting means 6 includes a header 40 having a plurality of plugs 41 extending through bores therein and soldered thereto as best seen in FIGURE 7. Outlet tubes 42 are coupled with the plugs and soldered thereto. Sections of flexible air hose 43 couple the outlet tubes 42 with the tubes 30. A fluid, such as water, is continuously supplied to the header under pressure, and thus continu-

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ous fluid jets or streams emanate from the ends 44 of the tubes 30 and the fluid is deflected downwardly by the deflection plate 11 unless a tube is raised by a respective driver. As an example, the tube 30 may be formed from three-eighths inch outside diameter tubing with the shortest tube being approximately eight inches long and the longest being approximately thirteen inches long. The rods 28 are affixed to the tubes 30 at approximately the midpoint thereof. The deflecting means 6 may, for example, include thirty-six tubes spaced on one-half inch centers with the width of the deflecting means 6 from the first to the last tube being approximately eighteen inches. With the foregoing arrangement and approximately a sixty pound water head and one hundred feet per second water velocity, ore particles from approximately one-half inch to eight inches in size may be effectively handled. It is sometimes desirable to space the tubes 30 several inches, e.g., four inches, from the detector 3 to prevent splash on the detector. If this is done, the transit time of ore from the detector to the tubes 30 is increased, but the tubes 30 can be moved back from the vertical fall line of the ore such that the fluid streams must travel a longer distance to reach the ore. Thus, the spacing between the detector and tubes 30 as well as the position of the tubes with respect to the fall line may be adjusted as desired to provide the necessary time delay.

With one-half inch ore, approximately three milliseconds elapse as the ore passes a point and therefore the system should react within this time, i.e., a tube 30 be raised within this time. Accordingly, a high initiating current, for example eight amperes for one to one and one-half milliseconds, is employed to raise a tube 30, and once raised the current may be reduced to a holding current of, for example, three hundred milliamps. The electrical power requirements are based upon the mass of the tube 30, the fluid employer, and the height of the rise of the tube required to allow the fluid stream to flow past the deflector 11. Typical solenoid arrangements take approximately fifteen milliseconds to operate and thus are relatively slow as compared to the present system. Smaller ore, such as one-fourth inch ore, requires a reaction time of approximately one and one-half milliseconds. With such ore the preferred fluid is air, and the mechanical system should be lighter and more compact.

The electrical control system 4 includes a plurality of the circuits illustrated in FIGURES 8 and 9. This system responds to signals from photomultipliers within the detector 3 to operate the respective drivers within the actuator assembly 5. Basically, this system includes for each coil 24 a conventional impedance matching amplifier (not shown) coupling a photomultiplier to a digital control circuit such as shown in FIGURE 8 which in turn controls respective semiconductor coil drivers such as illustrated in FIGURE 9. When an ore particle emitting the characteristic radiation passes the detector 3, a photomultiplier therein provides a signal to the system 4. This signal then is amplified and applied to the digital control circuit of FIGURE 8. This signal applied to the control circuit is in the form of a pulse 60 which initiates four signals which are, (1) a high drive-up current, (2) a low hold-up current, (3) a high drive-down current, and (4) a low hold-down current. Inasmuch as there is a finite drive-up time, such as three to three and one-half milliseconds the distance between the detector 3 and the deflecting means 6 is selected to compensate for the finite time such that when a desired ore particle reaches the end of a tube 30 the tube has been raised to allow the fluid stream therefrom to deflect this particle. The pulse width of the pulse 60 is proportional to the size of the particle and thus is short for small particles and long for large particles thereby enabling the fluid jet operating time to be variable depending on rock size.

The pulse 60 is almost a square wave but is applied to a Schmidt trigger 61 to standardize the pulse. The output of the trigger 61 is applied through an inverter 62 to the input of a differentiating emitter follower 63 and to an

or gate 64. The positive-going leading edge of the pulse applied to the emitter follower 63 causes this circuit to provide an output spike pulse on an output line 65. This pulse may be termed a drive-up pulse which, as will be explained subsequently in connection with a description of FIGURE 9, causes a semiconductor gate to apply a high drive-up current to the coil 24. An output of the emitter follower 63 is applied through a line 66 and a single shot 67 to another differentiating emitter follower 68 the same as the emitter follower 63. The positive-going trailing edge of the pulse applied from the single shot 67 causes an output from the emitter follower 68 on a line 69, and this pulse occurs after the pulse on the line 65 and is termed a hold-up pulse. The time difference is determined by the time delay of the single shot 67 and this delay typically may be one to one and one-half milliseconds. The arrangement described thus far enables a high drive-up current to be applied to the coil 24 to raise a tube 30, and then this current is reduced to a level which is sufficient to maintain the tube in its raised position.

An output of the emitter follower 68 is applied through another single shot 72 to the or gate 64, and an inverted pulse output is applied through a line 73 from the single shot 67 to the or gate 64. The output of the gate 64 is applied to a third differentiating emitter follower 74 which provides a spike pulse determined by the trailing edge of the input pulse 60, and this pulse on a line 75 is termed a drive-down pulse. An output from the emitter follower 74 is coupled through another single shot 76 which in turn is coupled to a fourth differentiating emitter follower 77. This latter emitter follower 77 provides an output hold-down pulse on an output line 78.

The output lines from the emitter followers 63, 68, 74 and 77 in FIGURE 8 are coupled to the input of a coil driving circuit such as that illustrated in FIGURE 9. This circuit essentially responds to the outputs of the emitter followers to supply the necessary drive and hold currents to the coil 24. The coil 24 is a bifilar winding illustrated as 24a and 24b in FIGURE 9. The pulses from the emitter followers control silicon controlled rectifier gates 80 through 83. It will be apparent to those skilled in the art that other types of gating devices, such as transistor gates, may be employed. The pulse on the drive-up line 65 turns on the gate 80 thereby causing a large current to flow through coil winding 24a and an inductance 84 while a capacitor 85 charges. When the hold-up pulse on line 69 occurs, the gate 81 turns on and the resulting charge on the capacitor 85 blocks the gate 80 for a sufficient time period to turn the gate 80 off. Hold-up current then flows through the gate 81, and resistance 86, the inductance 84 and the winding 24a. Upon the occurrence of the drive-down pulse on the line 75, the gate 82 turns on and a capacitor 87 reverses the voltage applied to the gate 81 thereby turning the gate 81 off. The second winding 24b of the coil 24 is then driven with a high current in a manner similar to the winding 24a to drive down the coil form 23 and associated tube 30. When the hold-down pulse occurs on the line 78, the gate 83 turns on and the charge on a capacitor 88 blocks the gate 82 thereby turning it off, and a hold-down current flows through the gate 83, resistance 89, inductance 90 and winding 24b. When the gate 80 is again turned on by the drive-up pulse on the line 65, the capacitor 87 reverses the voltage on the gate 83 to turn the same off, and a drive-up current is applied to the winding 24a in the same manner described above.

What is claimed is:

1. Apparatus for separating first and second types of ore particles wherein the first type of ore particles emits radiation of a characteristic wavelength comprising
 - a detecting means for detecting the radiation emitted by said first type of ore particles for providing initiating signals,
 - a control means responsive to said initiating signals for providing gating signals, and

actuating means responsive to said gating signals for changing the direction of one or more flowing liquid streams to cause each such stream to impinge upon ore particles of said first type from which radiation was received by said detecting means to cause said last named ore particles to be separated from said second type of ore particles.

2. Apparatus for separating first and second types of ore particles wherein the first type of ore particles emits radiation of a characteristic wavelength comprising

detecting means for detecting the radiation emitted by said first type of ore particles for providing initiating signals,

control means responsive to said initiating signals for providing gating signals, and

actuating means responsive to said gating signals for controlling one or more liquid streams to impinge upon ore particles of said first type from which radiation was received by said detecting means to cause said last named ore particles to be separated from said second type of ore particles, said actuating means comprises a plurality of driving means coupled with liquid stream tubes, and said control means causes one of said driving means to move one of said tubes for each respective particle of said first type from which radiation is received by said detecting means.

3. Apparatus for separating first and second types of ore particles wherein the first type of ore particles emits radiation of a characteristic wavelength comprising

detecting means for detecting the radiation emitted by said first type of ore particles for providing initiating signals,

control means responsive to said initiating signals for providing gating signals, and

actuating means responsive to said gating signals for controlling one or more liquid streams to impinge upon ore particles of said first type from which radiation was received by said detecting means to cause said last named ore particles to be separated from said second type of ore particles, said actuating means includes a housing forming a yoke and a plurality of magnet assemblies mounted therein and a plurality of coil means cooperating with said magnet assemblies, said coil means being coupled with respective liquid stream tubes for deflecting said liquid streams in response to signals from said control means.

4. Apparatus for separating first and second types of ore particles wherein the first type of ore particles emits radiation of a characteristic wavelength comprising

detecting means for detecting the radiation emitted by said first type of ore particles for providing initiating signals,

control means responsive to said initiating signals for providing up signals and down signals,

a plurality of movable fluid stream tubes which in one position supply fluid which is deflected by a deflecting means and which in a second position supply a fluid stream for impinging upon said first type of ore particles, and

actuating means responsive to said up and down signals for deflecting one or more of said tubes from its first to its second position, said actuating means including magnetic circuit means and movable coil means, said movable coil means being respectively coupled with said tubes and movable up or down in response to said respective up and down signals.

5. Apparatus as in claim 4 wherein

said magnetic circuit means includes a housing and a plurality of magnet-armature assemblies arranged in a staggered relationship and mounted in said housing, a plurality of coil means respectively magnetically coupled with said magnet-armature means, and means coupling said coil means with respective tubes.

6. Apparatus as in claim 4 wherein

said magnetic circuit means includes an elongated housing forming a yoke, said housing having a plurality of apertures therein, a plurality of magnet-armature assemblies mounted in staggered rows in said housing with the armature assemblies extending into the apertures of said housing whereby said armature assemblies and housing form a plurality of air-gaps, and said movable coil means includes a plurality of coil members respectively arranged in said air-gaps for movement up or down in response to signals applied to said coil members.

7. Apparatus as in claim 6 wherein

said coil members are respectively coupled with said fluid stream tubes for moving the same to said second position.

8. An actuating assembly comprising

magnetic circuit means including an elongated housing forming a yoke, said housing having a plurality of apertures therein, a plurality of magnet-armature assemblies mounted in staggered rows in said housing with the armature assemblies extending into the apertures of said housing whereby said armature assemblies and housing form a plurality of air-gaps, and movable coil means including a plurality of coil members respectively arranged in said air-gaps for movement up or down in response to electrical signals applied to said coil members.

9. An actuating assembly as in claim 8 including a plurality of movable fluid stream tubes which in one position supply fluid which is deflected by a deflecting means and which in a second position supply a fluid stream past said deflecting means, and means coupling said coil members respectively to said fluid stream tubes for moving the same to said second position.

10. A method for altering the trajectory of ore particles of a first type for separating said ore particles from ore particles of a second type comprising

providing a plurality of substantially continuous fluid streams and deflecting the same to prevent impingement thereof on said ore particles of said first and second types

sensing a characteristic of said ore particles of said first type, and

deflecting a respective fluid stream in response to detecting said characteristic of an ore particle to deflect the trajectory of the ore particle whose characteristic has been detected.

11. A method for altering the trajectory of ore particles of a first type for separating said ore particles from ore particles of a second type comprising

providing a plurality of substantially continuous fluid streams and deflecting the same to prevent impingement thereof on said ore particles of said first and second types

sensing a characteristic of said ore particles of said first type, and

deflecting a respective fluid stream for a period of time proportional to the size of the ore particle whose characteristic has been detected to deflect the trajectory of the same.

12. A method for altering the trajectory of ore particles of a first type for separating said ore particles from ore particles of a second type comprising

providing a plurality of substantially continuous fluid streams and deflecting the same to prevent impingement thereof on said ore particles of said first and second types

sensing a characteristic of said ore particles of said first type, and

deflecting a number of fluid streams in response to detecting said characteristic of an ore particle to deflect the trajectory of the same, said number of fluid streams being proportional to the size of said ore particle.

13. Apparatus for separating first and second solid articles wherein the first type of article has a particular characteristic, comprising

detecting means for detecting said characteristic of said first type article for providing initiating signals, control means responsive to said initiating signals for providing control signals,

a plurality of movable fluid stream tubes which in one position supply fluid which is deflected by a deflecting means and which in a second position supply a fluid stream for impinging upon said first type article, and

actuating means responsive to said control signals for deflecting one or more of said tubes from its first to its second position, said actuating means including magnetic circuit means and movable coil means, said movable coil means being respectively coupled with said tubes and movable in a first or a second direction in response to said control signals.

14. Apparatus for separating first and second solid articles wherein the first type article has a particular characteristic, comprising

detecting means for detecting said characteristic of said first type article and providing initiating signals, control means responsive to said initiating signals for providing control signals,

a plurality of movable fluid stream tubes which in one position supply fluid which is deflected by a deflect-

ing means and which in a second position supply a fluid stream for impinging upon said first type article, a manifold coupled with said fluid stream tubes for supplying fluid to said tubes, said tubes being flexibly coupled with said manifold for movement up or down of an end of said tubes remote from said manifold by said actuating means, said deflecting means being a deflection plate mounted near said ends of said tubes for normally deflecting said fluid for preventing impingement thereof on said articles, and actuating means responsive to said control signals for deflecting one or more of said tubes from its first to its second position, said actuating means including magnet circuit means and movable coil means, said movable coil means being respectively coupled with said tubes intermediate the ends of said tubes to selectively move said ends of said tubes remote from said manifold away from said deflection plate in response to said control signals to allow fluid streams to impinge upon said first type of article.

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