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[33] **Great Britain**

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[54] **APPARATUS AND METHODS FOR MAINTAINING
SINTER FEED MIXTURES BY X-RAY
FLUORESCENCE ANALYSIS**
16 Claims, 9 Drawing Figs.

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[51] Int. Cl. G01n 23/20

[50] Field of Search 250/51.5;
18/16.5

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ABSTRACT: A machine for forming samples of powder into pellets and analyzing the pellets by X-ray fluorescence analysis. The pellets are formed by compacting powder in a die ring at a first position of the die which is then moved on a rotatable turret head to a second position under an analyzer head for analysis. The pellet is then disposed of as the die ring moves back from its second to its first position. The powder is compacted by means of a ram operable into one end of the die ring, the other end of the ring being closed by a movable pressure plate held in position during compacting by an annular and sleeve arrangement, the sleeve providing a passage for the powder to be fed initially to the die ring.

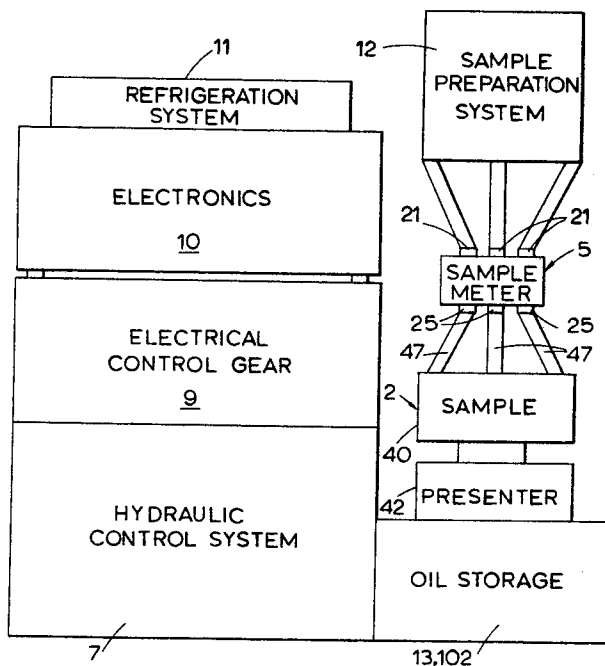
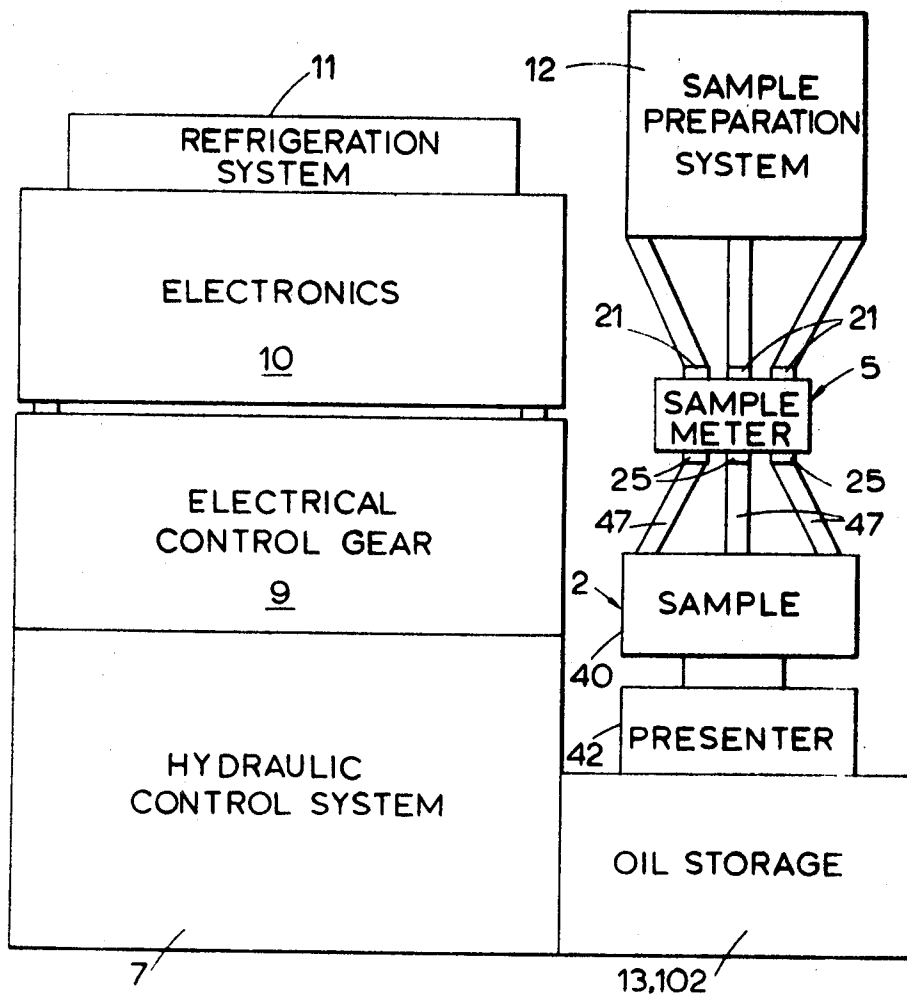
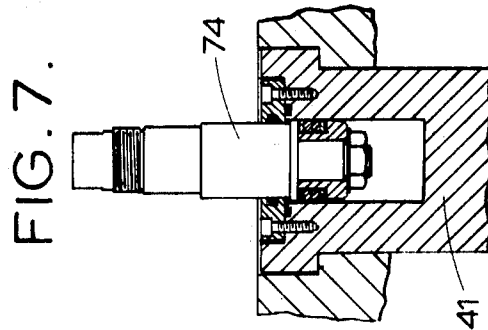
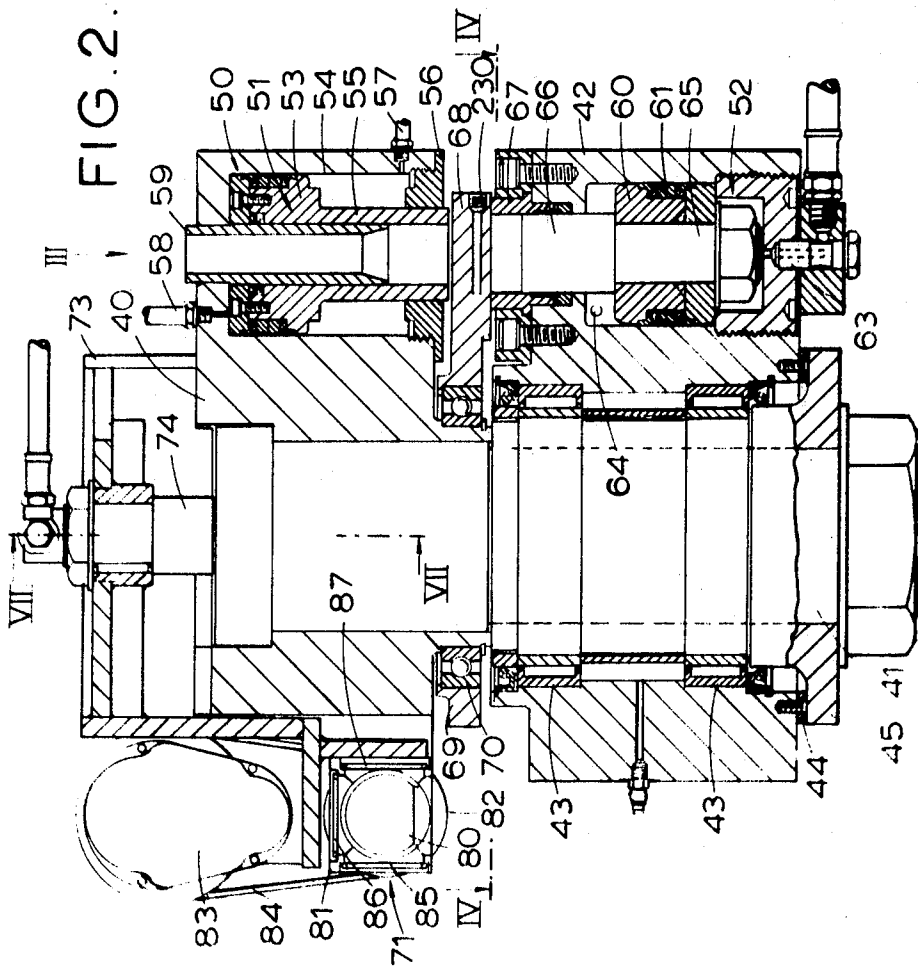


FIG. 1.





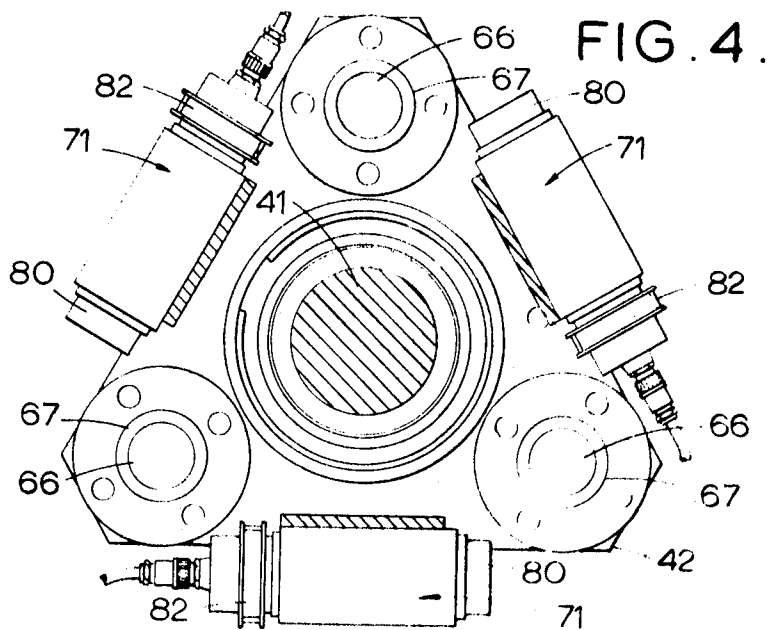
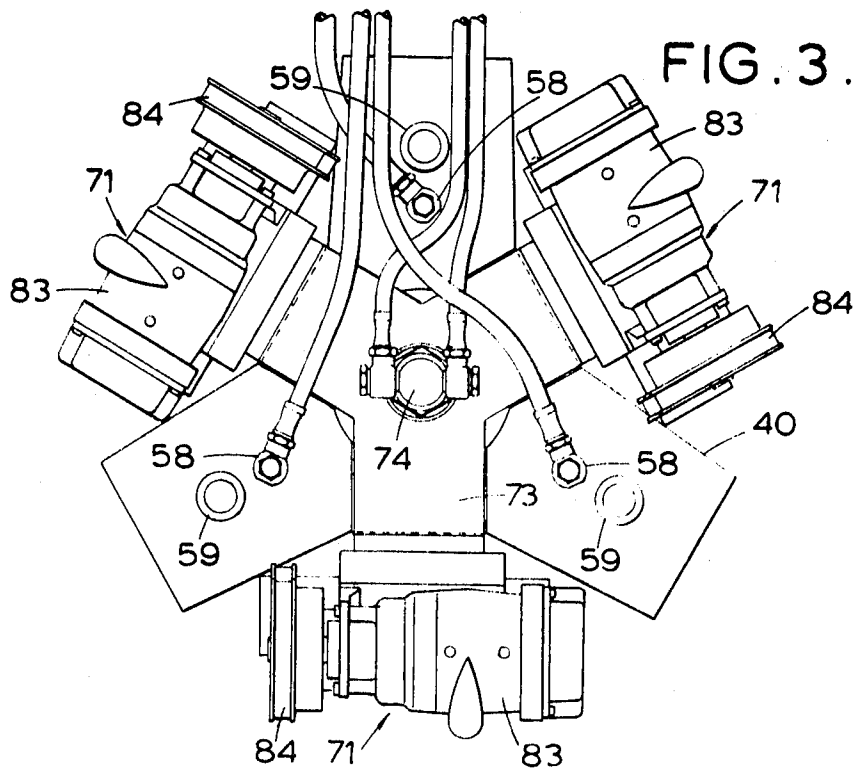


FIG. 5.

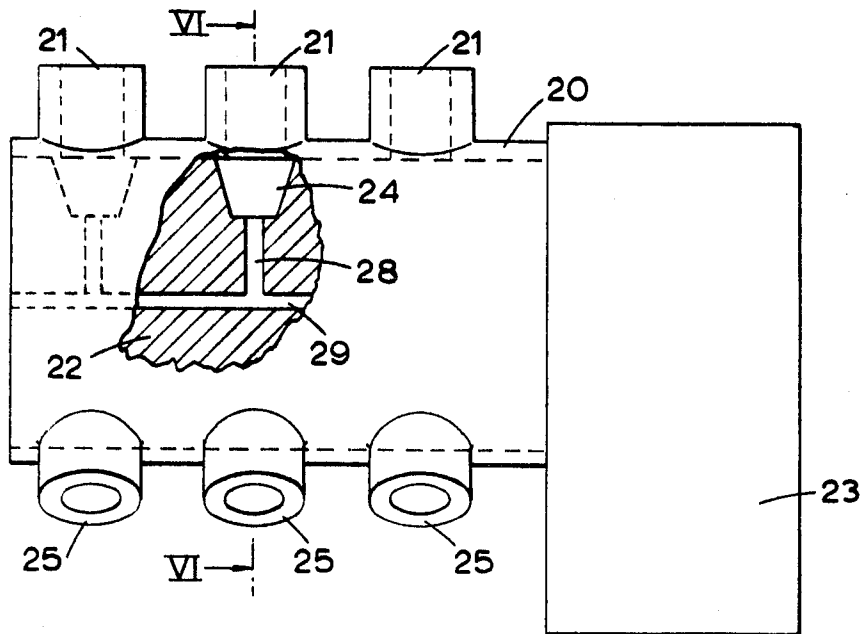
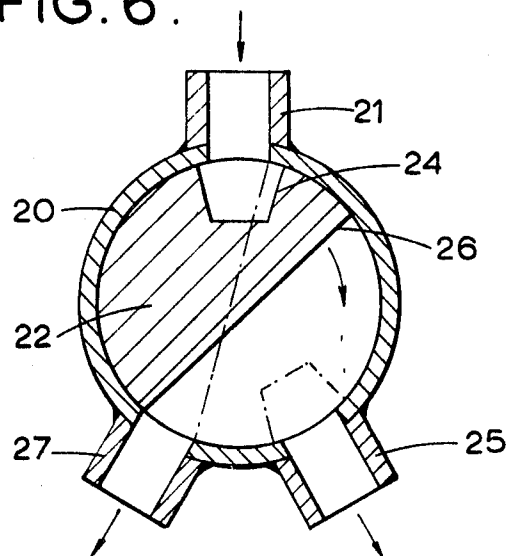


FIG. 6.



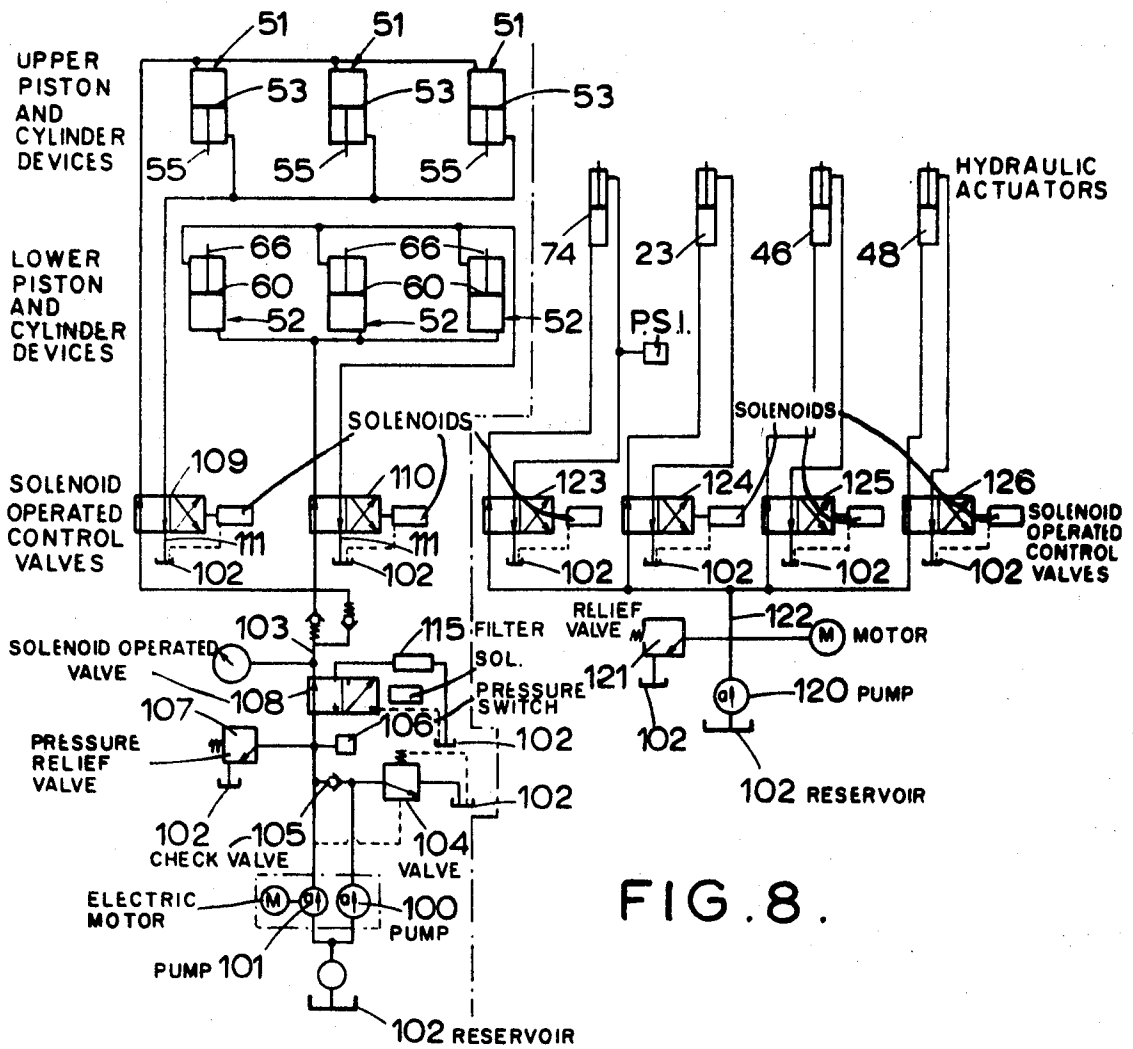


FIG. 8.

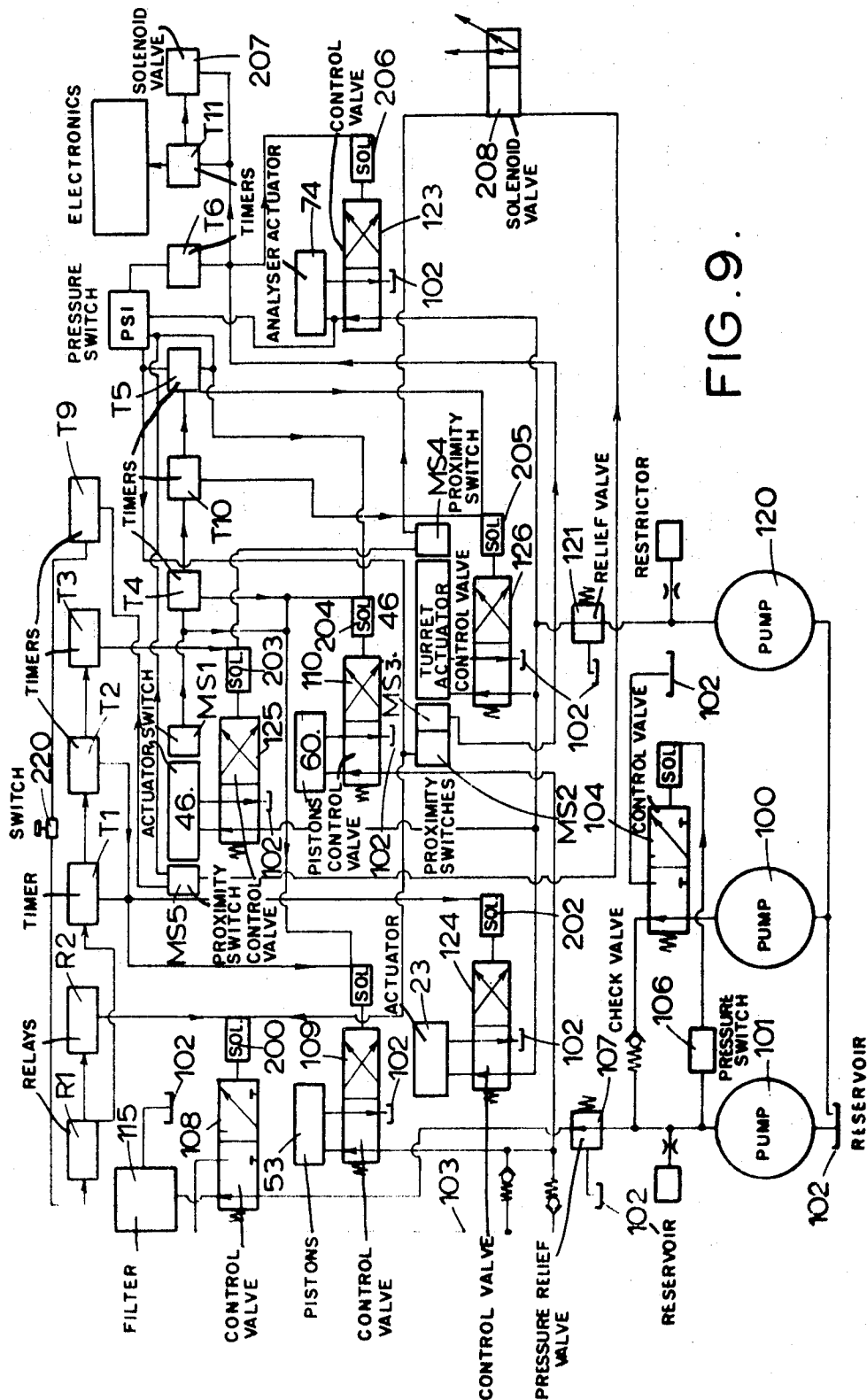


FIG. 9.

APPARATUS AND METHODS FOR MAINTAINING SINTER FEED MIXTURES BY X-RAY FLUORESCENCE ANALYSIS

This invention relates to improvements in apparatus and methods for analyzing granular material and is particularly but not exclusively concerned with the "online" analysis of the granular mixture of iron ores and other constituents which are fed to a sintering process before subsequent feed to a blast furnace for smelting the ore to pig iron.

As a preliminary to the production of pig iron in a blast furnace, either the whole or part of the iron ore fed to the furnace is preprepared by a sintering process. Ores, in a suitably sized granular form, taken from different geological sources are mixed with coke, as a fuel, together with a certain amount of water, and this mixture is then passed through a blast of heated air at a high temperature to be ignited to a self-sustaining combustion. The temperature of this combustion is high enough to cause localized fusion of the components of the mixture resulting in a sintered mass which is carried from the sintering process and broken down into suitable sized lumps for convenient feeding to the blast furnace. The sintering process is carried out in order to enhance the chemical and physical state of the feed mixture preparatory to the actual blast furnace process.

Efficient working of the blast furnace may be achieved by close control of the sinter composition; and it is thus important that the chemical composition of the raw sinter feed mixture should be known and maintained within close limits of predetermined optimum value on order that efficient and economical operation of the furnace may be achieved. In this respect, it is particularly desirable that the iron, calcium and silicon content of the sinter feed mixture is established in such a manner that corrective action may be taken requiring the quantities of those elements present in the sinter feed mixture by altering the proportion of the ores from different geological sources, which are utilized to make up the sinter feed mixture. A further particular interest in the control of the blast furnace is the relationship between the silicon and calcium content of the sinter feed mixture.

It is therefore an object of the present invention to provide a machine which may be placed "on line" in the sinter feed, to receive a random sample taken periodically from the sinter feed mixture and analyze it to give a direct readout in terms of the quantities of certain specific elements such as iron, calcium or silicon in the sinter feed mixture.

It is a further object of the present invention to provide a method of carrying out such an analysis.

Accordingly the present invention provides a machine for analyzing a powder comprising a fixed body member, a die movably mounted on said body member, means for moving said die between a first and second position on said body member, means for passing a quantity of said powder into said die and compacting that quantity of powder into a pellet within said die at said first position, an analyzer head carried on said body member at said second position of said die whereby an analysis of said pellet may be made when said pellet is presented to said analyzer in said die, and means between said first and second positions for disposing of said pellet after analysis.

Preferably said machine comprises a plurality of such dies so that a plurality of pellet may be formed at the same time and a plurality of such analyses may be made at the same time.

According to a further aspect of the present invention there is provided a method of analyzing a powder comprising taking a quantity of said powder and compacting that quantity into a pellet within a die in a first position of that die, moving said die with said pellet therein to a second position adjacent an analyzer head by means of which head an analysis of said pellet is made, and then returning said die to said first position ejecting said pellet from said die during movement between said first and second positions.

Preferably said method comprises taking a plurality of such quantities so that a plurality of pellets may be made at the same time and a plurality of such analysis may be made at the same time.

Preferably in either the above machine or method the analyzer head is an X-ray fluorescence analyzer head comprising a radioactive source of X-rays with which to irradiate said pellet or pellets and a countertube to detect the fluorescent radiations resulting from such irradiation.

In order to promote a fuller understanding of the present invention one embodiment will now be described, by way of example only with reference to the accompanying drawings, in which:

FIG. 1 is an overall schematic view of the machine of this embodiment;

FIG. 2 is a detailed cross-sectional view of the sample pelletizer and of the machine;

FIG. 3 is a plan view of the sample pelletizer and presenter of the machine;

FIG. 4 is a part-sectional view taken on the line IV-IV of FIG. 2;

FIG. 5 is a cross-sectioned elevation of the sample meter of the machine;

FIG. 6 is a cross-sectional view taken on the line VI-VI of FIG. 5;

FIG. 7 is a part cross-sectional view taken on the line VII-VII of FIG. 2;

FIG. 8 is a schematic hydraulic diagram associated with the operation of the machine; and

FIG. 9 is a simplified schematic circuit diagram of the electrical control equipment associated with the embodiment.

A detailed description of the embodiment now follows.

MECHANICAL DESIGN

FIG. 1 shows a general schematic outline of the machine of this embodiment of the invention. The apparatus comprises a sample pelletizer and presenter indicated generally at 2, and a sample meter indicated generally at 5 which feeds the sample pelletizer and presenter with a quantity of material to be analyzed in powdered form, taken from a sample preparation system, indicated generally at 12, which system does not form part of this embodiment of the invention. Associated with the sample pelletizer and presenter on a common basic structure is a hydraulic control system contained within a cabinet indicated generally at 7, an electrical control system contained within a cabinet indicated generally at 9, an electronic system, associated with the actual analysis method to be described subsequently, contained within a cabinet indicated generally at 10, a refrigeration system indicated generally at 11 for the electronic cabinet 10, and a hydraulic oil reservoir indicated generally at 13.

The general arrangement of operation is such that a sample of the sinter feed mixture is taken from a conveyor belt feeding the sintering process with that mixture, and that sample is reduced to a fine powdered form of a particle size less than 200 mesh by the sample preparation system 12. The finely ground sample is then fed to the sample meter 5 which takes three equal quantities of a predetermined size from the sample and feeds them to the sample pelletizer and presenter 2 while disposing of the remainder of the sample. The sample pelletizer and presenter 2 receives those three quantities of powder and compacts each of them into a pellet having at least one smooth flat surface, and then presents the flat surface of each pellet to a respective X-ray fluorescence analyzer head which by means of the electronic system within the cabinet 10 gives a direct readout of the presence of a particular element in the respective pellet.

FIGS. 5 and 6 show the sample meter 5 in more detail. The sample meter 5 comprises a barrel 20 which is mounted on the frame of the machine and which has three inlets 21 disposed along its upper part, each inlet 21 being connected by a pipe to the sample preparation system 12 so as to receive substan-

tially a third part of the sample fed to the apparatus by that system. A metering member 22 is carried within the barrel 20 so that it may be rotated through an angle of rather less than 180°. Rotation of the metering member 22 is achieved by means of a hydraulic rotary actuator 23.

The metering member 22 has three pockets 24 which are arranged so that when in an upper position they may be filled with sinter feed mixture powder from the respective inlets 21, and then on rotation of the metering member 22, are carried to a lower position they discharge their contents of sinter feed mixture powder, this being an amount predetermined by the size of the pockets 24, through outlets 25 arranged along the lower part of the barrel 20.

The metering member 22 is also provided with three slots 26 which are cut into the member nearly to the diameter of the member, and positioned so that when the pockets 24 are in cooperation with the outlets 25, the slots 26 provide a free path from the inlets 21 to a series of second outlets 27 arranged along the lower part of the body 20. Thus when a sample taken from a sinter feed mixture is presented to the inlets 21, a predetermined amount is taken in the pockets 24 and on rotation of the metering member 22 discharged through the outlets 25 and the remainder of that sample is then discharged through the outlets 27 which are led back to the sinter feed mixture conveyor for disposal of the remainder of the sample or to some other means of disposal. Thus it can be seen that the sample meter 5 provides three predetermined small quantities of powdered sinter feed mixture at the outlet 25 and disposes of the remainder of the sample. In order to ensure that the predetermined quantity of powdered sinter feed mixture in the pocket 24 is totally discharged, the pockets are made tapered and air jets 28 may be provided so that they may be connected to a suitable source of compressed air, at the appropriate instant in time by the machine control system, by way of a conduit 29.

The sample pelletizer and presenter indicated at 2 in FIG. 1 is shown in more detail in FIG. 2 which is a schematic cross-sectional view of the pelletizer and presenter.

The sample pelletizer and presenter comprises a fixed body member 40 which is supported on the frame of the machine above the hydraulic reservoir 13. A spigot 41 is rigidly mounted in the body 40 extending downwardly therefrom and carries a rotatable turrethead 42 on its lower end by means of two needle roller bearings 43. The weight of the turrethead 42 is carried by a thrust bearing formed by a brass thrust washer 44 and a shoulder 45 formed on the spigot 41.

As seen particularly in FIGS. 2 and 3, three hydraulically operated pellet forming assemblies indicated generally at 50 are carried jointly in the body member 40 and the turrethead 42. Each pellet forming assembly 50 comprises an upper part 51 carried in the body member 40, and a lower part 52 carried in the turret head 42.

The upper part 51 of each pellet forming assembly 50 comprises an annular piston 53 which is slidable in a bore 54 provided in the body member 40 to form an upper double acting hydraulic piston and cylinder device. The annular piston 53 has a downwardly extending sleeve portion 55 which extends below the body member 40 through a sealing ring 56. Hydraulic pressure can be applied to either side of the annular piston 53 by way of a port 57 for upward movement, or a port 58 for downward movement. The piston and cylinder device so formed is completed by a fixed hollow piston rod 59 which is carried in the body member 40 in fluid pressure tight manner so that the annular piston 53 moves over the piston rod 59 under hydraulic pressure from the respective ports 57 and 58.

The lower part 52 of each pellet forming assembly comprises a piston 60 which is slidable in a bore 61 formed in the turrethead 42 to form a lower double acting hydraulic piston and cylinder device, which is movable under hydraulic pressure supplied for upward movement by way of a port 64. The piston 60 is provided with a piston rod 65 which extends upwardly within the turrethead 42 into a ram portion 66. The ram portion 66 is slidable within a die ring 67 which is carried on the upper surface of the turrethead 42.

A pressure plate 68 for each pellet forming assembly is carried on an annular frame 69 which is rotatably mounted by way of a ball bearing 70 on the body 40, so that the three pressure plates 68 may be rotated by means of a hydraulic piston and cylinder device 46 between a first position disposed between the upper and lower part of their respective pellet forming assemblies or to a second position clear of those assemblies.

Each hollow piston rod 59 is connected by way of a flexible pipe 47 to one of the outlets 26 from the sample meter. Thus it can be seen that on operation of the sample meter 5, a measured quantity of powdered sinter feed mixture will run down the hollow piston rod 59. It is arranged that, at that time, the pressure plates 68 are in their second position clear of the pellet forming assemblies and that the sleeves 55 are lowered to contact the die rings 67; consequently the three measured quantities of sinter feed mixture are allowed to drop down into the respective die rings 67 to rest in the spaces formed therein by the rams 66 being in their lower position as shown in FIG. 2.

The sleeves 55 are raised, the pressure plates 68 are then moved back to their first position as shown in FIG. 2 and a quantity of sinter feed mixture is then trapped within each die ring 67. The pistons 53 are then brought down under hydraulic pressure so that the sleeves 55 contact the pressure plates 68 and holds them firmly against the upper surface of the die ring 67. The pistons 60 are then brought up so that the rams 66 compress and compact the sinter feed mixture powder into a pellet within each die ring 67.

The pressure plate 68 is provided with a hardened steel lower surface, either of integral construction or as an added part, and this surface is ground to a high polished finish. Consequently it can be seen that a pellet of compacted sinter feed mixture is formed in each die ring 67, which presents a smooth flat surface across the upper face of the die ring 67.

As mentioned previously the turrethead 42 is rotatable about the spigot 41 and the arrangement is such that the turrethead 42 may be indexed after a pellet has been so formed, by means of a hydraulic piston and cylinder device 48 from a first position as shown in FIG. 2, with the lower part 52 of each pellet forming assembly beneath the upper part 51; to a second position where each lower part 52 is carried with a pellet in the die ring 67 to present the smooth upper surface of that pellet to an analyzer head indicated generally at 71. The three analyzer heads 71 are carried on a frame 72 which is supported on the piston rod 73 of a hydraulic piston and cylinder device 74 formed in the upper end of the spigot 41. Thus the analyzer heads 71 may be raised to an upper position as shown in FIG. 2, or alternatively lowered to a lower position in which the lower surface of the analyzer head 71 may make immediate contact with the upper surface of the die ring 67 and consequently the pellet formed therein.

The analyzer heads 71 provided for each of the three pellets are of the X-ray fluorescence type and as far as the principle of analysis is concerned operate on known principles. Briefly, the pellet is irradiated, when presented to the analyzer head 71, with primary X-rays generated by a radioactive source mounted within the analyzer head 71 to cause a fluorescent emission of radiation characteristic of the elements present in the sample pellet. The radiation is detected by a proportional counter including a gas filled tube, the output of which is fed by way of a suitable electronic amplifier and pulse height analyzer unit to a counter and timer unit, all contained within the cabinet 10 to give a direct digital reading indicative of the concentration of a particular chosen element present in the pellet. Thus with the three sample pellets in this embodiment it is possible to achieve an analysis in respect of three separate element constituents of the sinter feed mixture, at the same time.

Since the sensitivity of such an analyzer head varies progressively from day to day, it is necessary to provide for calibration of the analyzer head against standard samples having known concentrations of the element for which the particular analyzer is being used.

For this purpose the actual radioactive source and counter tube are together mounted as an assembly so as to be rotatable in the housing 81 of the analyzer head 71. The countertube is provided at one end with a pulley wheel 82 which is coupled to an electric motor 83 by way of a toothed belt drive 84 so that the motor 83 may rotate the countertube and radioactive source.

Three known composition calibration samples 85, 86 and 87 are arranged around the inside of the housing 81 so that the source and countertube may successively analyze each one in turn on rotation thereto by the motor 83. This gives therefore three known calibration points on the output reading of each analyzer head 71 from which a calibration graph may be plotted for that particular analyzer head. On completion of the calibration reading against the samples 85, 86 and 87, the rotary member is rotated back again ready to analyze a sample pellet when such is presented to it. Such calibration is carried out either by manual control or by automatic control from the electrical control circuits associated with the machine. The calibration operation is carried out periodically during use of the machine in accordance with the needs associated with accuracy of analysis and variation of reading head characteristics so that the accuracy of the results produced does not deteriorate from these causes.

When the rams 66 have been raised to compact the pellets in the die rings 67, the pistons 53 are lifted so that the sleeves 55 concerned clear from the pressure plates 68, the rams 66 are lowered and the turret head 42 is then indexed by means of the hydraulic cylinder 48 to carry the die rings 67 to their second position beneath the analyzer head 71 which are then lowered onto the pellets in the die rings by the hydraulic cylinder 74 in order that the analysis may be carried out.

When the analysis is completed, the analyzer heads 71 are lifted again by the hydraulic cylinder 74 and the die rings 72 are returned to the first position again by means of the hydraulic cylinder 48. During the return of the die rings, the hydraulic pistons 60 are raised so that the tops of the rams 66 are brought flush with the top faces of the die ring 67 lifting the then analyzed pellets up out of the die rings 67. The thus raised pellets are removed from the die rings by means of scraper blades positioned on the body member 40 one adjacent each pellet forming assembly, which scraper blades deflect the pellet down a discard chute to disposal either by return to the sinter feed mixer conveyor or otherwise.

Thus it can be seen that the machine of this embodiment provides for the reception of a sample of sinter feed mixture in powdered form, pelletization of that sample into three pellets which may then be presented individually to an X-ray fluorescent analyzer head and subsequently disposed of. It will be realized that three analyzer heads are shown in this embodiment because it is arranged to provide an analysis for three element constituents of the pellets. However, if it is desired, this number may be increased either by the provision of further pellets forming assemblies on the machine body member and turret head, with associated analyzer heads, or alternatively by providing a second pelletizing and presenting assembly on the machine arranged to operate from the same control system in parallel.

When the machine is used for analysis of sinter feed mixture, the three analyzer heads 71 are preferably used for iron, calcium and silicon content. The head used for silicon is flushed with either hydrogen or helium so as to minimize the absorption of the fluorescent radiation which would occur in air within the head. This is achieved with a solenoid operated valve controlled from the electrical circuit of the machine to provide a high rate of supply initially before analysis to clear the head, dropping to a lower rate of supply when the head is seated down on the pellet.

Further the pressure plates 68 are provided with air jets which are connected by way of port 230 to a source of compressed air by a solenoid operated valve under the control of the electrical circuit, to blow away any remaining debris from a pellet after analysis as the dies 67 are brought back to their first position.

The hydraulic system associated with the above mechanism and the electrical system for the control of the hydraulic system and the machine as a whole will now be described in more detail under those headings.

MACHINE CONTROL

FIG. 8 shows the schematic hydraulic circuit diagram for the control of the machine. Where features relating to the hydraulic circuit are common with those shown in other FIGS. they are given like reference numerals.

The hydraulic system associated with the pellet forming assemblies 50 comprises two electric motor driven pumps 100, 101, which draw hydraulic fluid from a common reservoir indicated at 102 housed within the machine frame at 13. The pump 100 is a high capacity pump capable of giving up to 140 cu. inches of fluid per minute at 3000 lbs. per sq. inch, and the pump 101 is of lower capacity being capable of delivering up to 60 cu. inches per minute at a similar pressure. Both the pumps 100 and 101 feed hydraulic oil under pressure to a common supply line 103, the pump 100 feeding by way of a solenoid operated valve 104 and a one-way check valve 105. A pressure switch 106 is connected in the supply line 103 and arranged to operate the solenoid valve 104 to divert the output from the high capacity pump 100 back to the reservoir 102 when the pressure in the supply line 103 reaches a predetermined value, which in this embodiment is set at 500 lbs. per sq. inch. The check valve 105 then protects the valve 104 from the high pressure which is continued to be supplied by the pump 101.

The line 103 takes the high pressure hydraulic supply by way of an excess pressure relief valve 107 and a solenoid operated valve 108 to two solenoid operated control valves 109 and 110. The control valve 109 and 110 are connected respectively to the piston and cylinder devices in the upper part 51 of each pellet forming assembly 50 and the piston and cylinder devices in the lower part 52 of each pellet forming assembly 50 and on operation of their respective solenoids, cause those piston cylinder devices to move in appropriate directions by connecting one side of the respective pistons 53 and 60 to the line 103 and the other side of the pistons 53 and 60 to the line 111 which returns to the reservoir 102.

A one-way check valve 112 and a combined one-way valve and restrictor 113 are connected in the line 114 from the valve 110 to the lower side of the pistons 60 in the lower part 52 of each pellet forming assembly 50. The arrangement is such that the restrictor 113 ensures that the pistons 60 run more slowly than the pistons 53 and thus ensure that the pressure plates 68 are firmly held on the die rings 67 by the pistons 53 before the rams 66 start to compact the sample into a pellet.

Further the pressure switch 106 allows the high capacity pump 100 to be effective for fast movement of the pistons 53 and 60 but as soon as they meet resistance in their operative stroke and the pressure in the supply line 103 rises indicating a lack of demand for a further large quantity of hydraulic fluid, the high capacity pump 100 is switched to return to the reservoir 102 leaving the lower capacity pump 101 to supply any further quantity of fluid at the high pressure. Further, during the operative cycle of the machine, it can be seen that at certain times, such as during the actual analysis when the samples are presented to the analyzer heads 71, no supply of hydraulic oil is required and the valve 108 can be operated to switch the flow from the line 103 through a filter 115 back to the reservoir 102 so that the hydraulic fluid therein is periodically filtered.

The hydraulic system associated with the operation of the turret head 42, the pressure plates 68, the lifting of the analyzer heads, and the operation of the sample meter, is supplied by a further hydraulic pump 120 which also draws hydraulic fluid from the common reservoir 102. The pump 120 supplies hydraulic fluid at moderate pressure by way of an excess pressure relief valve 121 to a supply line 122 and thence to solenoid operated control valves 123, 124, 125 and 126 associated respectively with the hydraulic piston and

cylinder device 74 for raising and lowering the analyzer head, the hydraulic actuator 23 for the sample meter, the hydraulic piston and cylinder device 46 for moving the pressure plates 68, and the hydraulic piston and cylinder device 48 for moving the turrethead 42. Each of those hydraulic devices are double acting and the valves 123, 124, 125 and 126 connect the supply line 122 to one or the other side of those devices while connecting the opposite side back to the reservoir 102, under the control of the electrical circuit.

ELECTRICAL CONTROL CIRCUIT

FIG. 9 shows the electrical control circuit associated with the hydraulic circuit described above, in simplified block schematic form. Those components of the hydraulic circuit also shown in FIG. 9 which correspond to those described with reference to FIG. 8 are given the same reference numerals and no further description will therefore be given.

The whole machine operational sequence is initiated by means of relay R1 which in the first instance is energized by a key switch or start button on the machine control panel. Relay R1 operates relay R2 and also starts timer T1. Relay R2 operates the solenoid 200 associated with control valve 108 to switch the output of the pump 101 and 100 from the filter to the main supply line 103, and also operates solenoid 201 associated with the control valve 109 to lower the pistons 53 to bring the sleeves 55 down to the die rings 67 ready for the feed of powder into the dies.

On completion of its timing cycle, T1 then operates solenoid 202 associated with the control valve 124 controlling the sample meter to cause the quantities of powder to fall down through the piston rods 59 into the dies 67 as described. At the same time timer T1 also initiates timer T2 which after completing its timing run operates solenoids 201 and 202 respectively to raise the sleeves 55 and return the sample meter to its initial position.

On completion of its timing cycle T2 initiates a timer T3 which allows time for the previous operations to be completed, and then operates a solenoid 203 associated with control valve 125 which controls the pressure plate operating hydraulic cylinder 46, to move the pressure plates 68 from their second position to their first position above the die rings 67. On reaching the first position, the pressure plates 68 operate a proximity switch MS1 which itself operates timer T4, solenoid 201 and a solenoid 204 associated with control valve 110 operating the pistons 60 and the rams 66. As a consequence of this, the pistons 53 are brought down so that the sleeves 55 clamp the pressure plate 68 on top of the die rings as described, and the rams 66 are brought up to compact the powder within the die ring to form a pellet.

When timer T4 has run its time which is made sufficient to allow the compacting process to be completed, it operates solenoids 201 and 204 to lift the sleeves 55 and to release the pressure on the rams 66 ready for the turrethead to index to carry the formed pellets to the second or analyzing position. On completion of its run, time T4 also initiates timer T10 which allows time for the last operations and on completion of its run operates a solenoid 205 associated with control valve 126 operating the turrethead moving hydraulic cylinder 46, to index the turret from its first position to carry the die rings to their second position beneath the analyzer heads 71. When the turrethead has carried the dies to their second position, it operates proximity switches MS2 and MS3. The proximity switch MS2 operates solenoid 200 to divert the high pressure supply from line 103 to the filter 115 and the proximity switch MS3 initiates timer T6, timer T11 and a solenoid 206 associated with control valve 123 operating the analyzer head lifting hydraulic cylinder 74 to lower the analyzer heads onto the pellets for analysis. Proximity switch MS3 also operates a solenoid operated valve 207 which switches on the high rate supply of helium gas to the analyzer head associated with silicon detection, and timer T11 in due course switches the solenoid valve 207 to provide the lower rate supply when the

analyzer head is seated over the pellet. Timer T11 also initiates the electronic circuitry associated with the analyzer heads 71 so that they complete their fluorescent radiation counting operation under the control of timers provided within the electronic circuitry.

When timer T6 has run its time, it operates solenoid 206 to raise the analyzer heads 71 again to produce high pressure on the lift side of the hydraulic cylinder 74 which is detected by pressure switch PS2, giving an indication that the analyzer heads 71 are in their fully up position.

Pressure switch PS2 then operates solenoid 204 to raise the rams 66 lifting the pellets clear of the die rings 67 and allows timer T5 which is arranged to be started by timer T10 at the end of its timing period, to operate solenoid 205 to move the turrethead to carry the dies 67 back to their first position.

When the turrethead is back in its first position, a proximity switch MS4 is operated thereby which operates a solenoid 208 supply the air to the pressure plates 68 providing the cleaning airblast, and also operates solenoid 203 to move the pressure plates 68 to their second position clear of the dies 67 when they return to their first position. When the pressure plates 68 are moved to their second position, they operate a proximity switch MS5 which operates solenoid 208 to cut off the airblast and also operates solenoid 204 to lower the rams 66 to their lowermost position ready to receive a fresh quantity of powder. Proximity switch MS5 also starts timer T9 which runs for a period sufficient to allow all the previous operations to be completed and then again initiates relay R1 to repeat the whole operative cycle, unless stopped at a stop switch 220.

The pressure switch PS2 is arranged to switch the high pressure hydraulic supply from the filter 115 to the supply line 103 again when the turrethead is in its second position and the analyzer heads 71 are lifted clear of the pellets in that second position, so that the pistons 60 may again be operated.

We claim:

1. A machine for X-ray analyzing a powder comprising a fixed body member; a turrethead rotatably carried on said fixed body member; a die mounted on said turrethead for movement therewith; means for rotating said turrethead to move said die between a first position and a second position; means for feeding a quantity of said powder into said die and compacting said quantity of powder into a pellet within said die at said first position of said die; an X-ray analyzer head carried on said body member at said second position of said die whereby an X-ray analysis of said pellet may be made at said second position of said die; and means between said second and said first position of said die for disposing of said pellet as said die is moved from said second to said first position.

2. A machine as claimed in claim 1, wherein said die is in the form of a die ring having a ram operable axially through one end thereof by means of fluid pressure to compact said quantity of powder when such is in said die.

3. A machine as claimed in claim 1, wherein a pressure plate is movably mounted on said body member for movement between a first position covering the other end of said die ring and a second position clear of said die ring.

4. A machine for analyzing a powder comprising a fixed body member, a turrethead rotatably carried on said fixed body member, a die mounted on said turrethead to move said die between a first position and a second position, means for feeding a quantity of said powder into said die at said first position of said die, said die being in the form of a die ring having a ram operable axially through one end thereof by means of fluid pressure to compact said quantity of powder into a pellet within said die at said first position of said die, a pressure plate movably mounted on said body member for movement between a first position covering the other end of said die ring and a second position clear of said die ring, a fluid pressure operable annular piston provided on said body member at said body member at said first position of said die, said annular piston having a hollow sleeve extension arranged to engage said pressure plate when said pressure plate is in its

first position, to hold said pressure plate over said other end of said die ring against the operation of said ram, an analyzer head carried on said body member at said second position of said die whereby an analysis of said pellet may be made at said second position of said die, and means between said second and said first position of said die for disposing of said pellet as said die is moved from said second to said first position.

5. A machine as claimed in claim 4, wherein said annular piston is arranged to slide over a hollow piston rod rigidly mounted in said body member, said hollow piston rod and said hollow extension sleeve providing a passage for said quantity of said powder to be fed to said die when said pressure plate is in its second position.

6. A machine as claimed in claim 4, including a plurality of such dies, analyzer heads, pressure plates, rams and annular pistons.

7. A machine as claimed in claim 6 wherein each such analyzer head is an X-ray fluorescence analyzer head comprising a source of primary X-rays for irradiating said pellet and a countertube arranged to detect fluorescent radiations from said pellet.

8. A machine as claimed in claim 7, including an electronic pulse height analyzer connected to the counter tube of each such analyzer head so that each such analyzer head may be used to assess the concentration of a single element in the pellet presented to it.

9. A machine as claimed in claim 8, wherein one of said analyzer heads is provided with means for flushing it with a light gas.

10. A machine as claimed in claim 7, wherein said X-ray source and said countertube are carried in a body which is rotatably mounted in the housing of said analyzer head and which is arranged to be driven by an electric motor so that two or more standard samples carried within said housing may be successively analyzed in order to calibrate the analyzer head periodically.

11. A machine as claimed in claim 6, wherein each analyzer head is movably mounted on said body member so that it may be moved clear of the pellet and die during movement of the pellet and die to and from its second position.

12. A machine as claimed in claim 6 including a sample meter comprising a barrel having an inlet for a sample of said powder and a first outlet for powder associated with each said die and a metering member rotatably mounted in said barrel, having a pocket and a slot therein associated with each said die, said pocket being of a volume to contain said quantity of powder and being arranged to receive that quantity of powder from said inlet and carry said quantity to said first outlet on rotation of said metering member, and said slot being arranged to connect said inlet to a further outlet when said pocket is adjacent said first outlet.

13. A machine as claimed in claim 4, wherein said ram is arranged to push said pellet out of said die ring during movement of said die from said second to said first position and a scraper is provided mounted on said body member to deflect said pellet off the machine for disposal during said movement of said die.

14. A method of X-ray analyzing a powder comprising making a quantity of that powder into a pellet within a die at a first position of that die, moving said die with said pellet therein to a second position of said die adjacent an X-ray analyzer head, irradiating said pellet with a source of primary X-rays whereby an analysis of said pellet is made, and then returning said die to said first position removing said pellet from said die during the return movement from said second to said first position of said die.

15. A method of X-ray analyzing a powder as claimed in claim 14, wherein said X-ray analysis includes detecting the fluorescent radiation produced in said pellet with a countertube and feeding the electrical output of said countertube to a pulse counter by way of a pulse height analyzer to give an indication of the concentration of a particular element within said pellet.

16. A method of X-ray analyzing a powder as claimed in claim 15, wherein a plurality of such quantities of powder are taken and formed into a plurality of such pellets which are presented each to one of a plurality of such X-ray analyzer heads to achieve an X-ray analysis of the concentrations of a plurality of elements in said powder.

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